Comprehensive Amendment to the Fishery Management Plans (FMPs) of the U.S. Caribbean to Address Required Provisions of the Magnuson-Stevens Fishery Conservation and Management Act:

- **Amendment 2 to the FMP for the Spiny Lobster Fishery of Puerto Rico and the U.S. Virgin Islands**
- **Amendment 1 to FMP for the Queen Conch Resources of Puerto Rico and the U.S. Virgin Islands**
- **Amendment 3 to the FMP for the Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands**
- **Amendment 2 to the FMP for the Corals and Reef Associated Invertebrates of Puerto Rico and the U.S. Virgin Islands**

Including Supplemental Environmental Impact Statement, Regulatory Impact Review, and Regulatory Flexibility Act Analysis

24 May 2005

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Abbreviations and Acronyms

allowable biological catch (ABC)
advisory panel (AP)
biological opinion (BO)
biomass (B)
carapace length (CL)
catch (C)
catch per unit effort (CPUE)
Caribbean Fishery Management Council (CFMC)
Code of Federal Regulations (CFR)
draft environmental impact statement (DEIS)
Division of Fish and Wildlife – U.S. Virgin Islands (DFW)
Department of Natural and Environmental Resources–Puerto Rico (DNER)
Economic Assessment (EA)
Endangered Species Act (ESA)
environmental impact statement (EIS)
essential fish habitat (EFH)
exclusive economic zone (EEZ)
Federal Register (FR)
final environmental impact statement (FEIS)
final supplemental environmental impact statement (FSEIS)
fishery management plan (FMP)
fishery management unit (FMU)
fishing mortality (F)
fork length (FL)
habitat area of particular concern (HAPC)
highly migratory species (HMS)
Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA)
Marine Mammal Protection Act (MMPA)
Marine Recreational Fisheries Statistical Survey (MRFSS)
maximum fishing mortality threshold (MFMT)
maximum sustainable yield (MSY)
minimum stock size threshold (MSST)
National Environmental Policy Act (NEPA)
National Marine Fisheries Service (NMFS)
National Marine Fisheries Service Southeast Regional Office (SERO)
National Oceanic and Atmospheric Administration (NOAA)
National Standard (NS)
National Standard Guideline (NSG)
natural mortality rate (M)
optimum yield (OY)
Paperwork Reduction Act (PRA)
Puerto Rico (PR)
Regulatory Flexibility Act (RFA)
regulatory impact review (RIR)
Southeast Data Assessment and Review (SEDAR)
Southeast Fisheries Science Center (SEFSC)
Southeast Regional Office (SERO)
spawning potential ratio (SPR)
spawning stock biomass (SSB)
standard length (SL)
supplemental environmental impact statement (SEIS)
Sustainable Fisheries Act (SFA)
submerged aquatic vegetation (SAV)
The World Conservation Union (IUCN)
total allowable catch (TAC)
total length (TL)
U.S. Virgin Islands (USVI)

Supplemental Environmental Impact Statement (SEIS) Cover Sheet

Responsible Agencies:

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Title of Proposed Action:

Comprehensive Amendment to the Fishery Management Plans of the U.S. Caribbean to Address Required Provisions of the Magnuson-Stevens Fishery Conservation and Management Act

Status of SEIS:

( ) Draft (X) Final

Abstract:

The Caribbean Fishery Management Council (Council) developed the SEIS contained in this integrated fishery management plan (FMP) amendment to inform the public of its decisions about how best to address the required provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) in federal fisheries of the U.S. Caribbean, while achieving the objectives of the Council's Spiny Lobster, Queen Conch, Reef Fish, and Coral FMPs. The SEIS describes and evaluates the biological, ecological, social, economic, and administrative impacts associated with a wide range of alternatives for: defining fishery management units and sub-units; specifying biological reference points and stock status determination criteria; regulating fishing mortality; rebuilding overfished fisheries; conserving and protecting yellowfin grouper; and achieving the MSFCMA bycatch mandates.

Also incorporated into this FMP amendment are the preferred alternatives to describe and identify essential fish habitat (EFH) and habitat areas of particular concern (HAPC), and to minimize to the extent practicable the adverse effects of fishing on EFH. These alternatives were developed and evaluated in the FEIS for the Generic EFH Amendment to the FMPs of the U.S.

Caribbean (CFMC 2004). The notice of availability of the Record of Decision associated with the Generic EFH FEIS was published in the *Federal Register* on May 25, 2004 (69 FR 29693).

The notice of intent to develop an SEIS in association with this amendment was published in the *Federal Register* on May 31, 2002 (67 FR 38060). Section 11.3 (Appendix B) lists the dates and locations of scoping meetings and public hearings. The availability of the DSEIS was announced in the *Federal Register* March 18, 2005 (70 FR 13189), with a comment period ending May 2, 2005.

Comments and Response to DSEIS

No subtantive comments were received during the comment period on the DSEIS. The Environmental Protection Agency (EPA) concluded the proposed project alternatives would not result in significant environmental impacts. The U.S. Geological Survey reviewed the document and had no comments.

The USVI Department of Planning and Natural Resources, Division of Fish and Wildlife submitted comments following the Council's May 2005 meeting, and after the close of the comment period on the DSEIS. The FSEIS/amendment already addresses the many editorial suggestions, and attempts to address several of the more substantive comments. Many of the comments simply noted that the EIS lacked citation to more recent published and unpublished reports. Analyses needed to be complete for the Council to be able to make informed decisions on the various alternatives. Although these new studies would provide additional information for this document, they do not appear to provide a basis for reaching different conclusions than those presented in the current version of the FSEIS/amendment. NOAA Fisheries National Standards Guidelines, at 50 C.F.R. § 600.315(b)(2), provide that "FMPs must take into account the best scientific information available at the time of preparation. Between the initial drafting of an FP and its submission for final review, new information often becomes available. This new information should be incorporated into the final FMP where practicable; but it is unnecessary to start the FMP process over again, unless the information indicates that drastic changes have occurred in the fishery that might require revision of the management objectives or measures." The newer information does not appear to indicate drastic changes have occurred in any of the fisheries, and in light of the litigation deadline for the EFH provisions, and the affected public's interest in the measures in this FSEIS/amendment, NOAA Fisheries finds it is not practicable to incorporate the newer information into the document at this time.

1 Summary

This comprehensive amendment includes a final supplemental environmental impact statement (FSEIS), which examined the impacts of amending the FMPs of the Caribbean Fishery Management Council (Council) to comply with several provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) related to establishing biological reference points and stock status determination criteria, preventing overfishing and rebuilding overfished fisheries, and assessing and minimizing to the extent practicable bycatch. Federal fisheries in the U.S. Caribbean are managed under four FMPs: (1) the Spiny Lobster FMP, (2) the Queen Conch FMP, (3) the Reef Fish FMP, and (4) the Coral FMP. This integrated document is intended to supplement the existing EISs contained within those FMPs .

The alternatives address four MSFCMA provisions: (1) Assess and specify the present and probable future condition of, and the maximum sustainable yield and optimum yield from, fisheries (MSFCMA §303(a)(3)); (2) Specify objective and measurable criteria for identifying when a fishery is overfished (MSFCMA §303(a)(10)); (3) End overfishing and rebuild overfished stocks, and prevent overfishing in fisheries that are identified as approaching an overfished condition (MSFCMA §304(e)(3)); and (4) Establish a standardized reporting methodology to assess the amount and type of bycatch occurring in the fishery and implement conservation and management measures that minimize bycatch and bycatch mortality to the extent practicable (MSFCMA §303(a)(11)).

This amendment also includes the preferred alternatives to describe and identify EFH for managed stocks, 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. These alternatives were developed and evaluated in the FEIS for the Generic EFH Amendment to the FMPs of the U.S. Caribbean (CFMC 2004) in the context of the EFH mandates of the MSFCMA (§303(a)(7)). This integrated FMP summarizes and incorporates by reference the findings and conclusions of the FEIS for the Generic EFH Amendment to the FMPs of the U.S. Caribbean (EFH EIS).

1.1 Description of alternatives

The range of alternatives considered by the Council to address the MSFCMA requirements are described in Section 4.0 and summarized in Table 1. These alternatives are organized under seven general categories of actions: (1) Defining fishery management units (FMUs) and sub-units (Section 4.1), (2) Specifying biological reference points and stock status determination criteria (Section 4.2), (3) Regulating fishing mortality (Section 4.3), (4) Rebuilding overfished fisheries (Section 4.4), (5) Conserving and protecting yellowfin grouper (Section 4.5), (6) Achieving the MSFCMA bycatch mandates (Section 4.6), and (7) Achieving the MSFCMA EFH mandates (Section 4.7); the reasonable range of alternatives considered to achieve the MSFCMA EFH mandates can be found in Sections 2.3 - 2.5 of the EFH EIS. Additional alternatives considered to address the MSFCMA requirements, but ultimately rejected without detailed study, are presented in Section 11.0 of this amendment and Section 2.6 of the EFH EIS, along with the rationale for their rejection.

Table 1. Alternatives considered in this integrated FMP amendment to achieve the defined purpose and need. The preferred alternatives, where defined, are identified with an X. The acronym "AT" stands for aquarium trade species. The acronym "AO" stands for all other species in the FMU.

MANAGEMENT ACTION	CORAL		QUEEN CONCH		REEF FISH		LOBSTER
	AT	AO	QC	AO	AT	AO	
DEFINING FISHERY MANAGEMENT UNITS AND SUB-UNITS							
Defining FMUs and Sub-Units							
Alternative 1: No action. Retain the current FMUs designated by the original FMPs.							
Alternative 2: Redefine the FMUs and FMU sub-units in Council FMPs as detailed in Table 8. Delete from the Caribbean Conch Resource FMU the Caribbean helmet, Cassis tuberosa; Caribbean vase, Vasum muricatum; flame helmet, Cassis flammea; and whelk (West Indian top shell), Cittarium pica, leaving nine other species detailed in Table 2.	X	X	X	X	X	X	X
Alternative 3: With the exception of the aquarium trade species sub-units in the Coral and Reef Fish FMPs, redefine the FMUs and FMU sub-units in Council FMPs to be consistent with those specified in Table 8. Redefine the aquarium trade species sub-units to comprise those aquarium trade species recognized and managed by state governments, and that are not otherwise included in other sub-units of any FMU.							
Alternative 4: Delete the aquarium trade species from the Caribbean reef fish resource FMU.							
Additional Options for Aquarium Trade Species							
Alternative 1: No action. Continue to manage aquarium trade species.							
Alternative 2: Move aquarium trade species from a management to a data collection only category.	X				X		
Additional Options for Caribbean Conch Resources							
Alternative 1: No action. Continue to manage Caribbean conch resources.							
Alternative 2: Move all species in the Caribbean conch resource FMU, with the exception of queen conch, from a management to a data collection only category.				X			
SPECIFYING BIOLOGICAL REFERENCE POINTS AND STOCK STATUS DETERMINATION CRITERIA							
Maximum Sustainable Yield (MSY)							
Alternative 1: No action. Retain the current definitions of MSY (if any).							
Alternative 2: In the absence of MSY estimates, the proxy for MSY will be 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: $MSY = C / [(F_{CURR}/F_{MSY}) \times (B_{CURR}/B_{MSY})]$; where C is 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.			X			X	X
Alternative 3: Set MSY = 0.		X					
Alternative 4: Set MSY equal to long-term average catch based on commercial landings data from 1983-2001 and on recreational data provided by MRFSS for the years 2000-2001.							

MANAGEMENT ACTION	CORAL		QUEEN CONCH		REEF FISH		LOBSTER
	AT	AO	QC	AO	AT	AO	
Fishing Mortality (F) and Biomass (B) Ratios							
Alternative 1: No action. Do not define F and B ratios for managed stocks.							
Alternative 2: For each FMU sub-unit for which B_{CURR}/B_{MSY} and F_{CURR}/F_{MSY} have not been estimated through a stock assessment or other scientific exercise (i.e., stock status unknown), the following estimates will be used for the B_{CURR}/B_{MSY} and F_{CURR}/F_{MSY} proxies: 1) For species that are not believed to be at risk based on the best available information, the F_{CURR}/F_{MSY} proxy is estimated as 0.75 and the B_{CURR}/B_{MSY} proxy is estimated as 1.25; 2) For species for which no positive or negative determination can be made on the status of their condition, the default proxies for F_{CURR}/F_{MSY} and B_{CURR}/B_{MSY} are estimated as 1.00; and 3) For species that are believed to be at risk based on the best available information, the F_{CURR}/F_{MSY} proxy is estimated as 1.50 and the B_{CURR}/B_{MSY} proxy is estimated as 0.75.		X	X			X	X
Alternative 3: For each FMU sub-unit for which B_{CURR}/B_{MSY} and F_{CURR}/F_{MSY} have not been estimated through a stock assessment or other scientific exercise (i.e., stock status unknown), the following estimates will be used for the B_{CURR}/B_{MSY} and F_{CURR}/F_{MSY} proxies: 1) For species that are not believed to be at risk based on the best available information, the F_{CURR}/F_{MSY} proxy is estimated as 0.75 and the B_{CURR}/B_{MSY} proxy is estimated as 1.25; 2) For species for which no positive or negative determination can be made on the status of their condition, the default proxies for F_{CURR}/F_{MSY} and B_{CURR}/B_{MSY} are estimated as 1.00; and 3) For species that are believed to be at risk based on the best available information, the F_{CURR}/F_{MSY} proxy is estimated as 1.50 and the B_{CURR}/B_{MSY} proxy is estimated as 0.50.							
Alternative 4: For each FMU sub-unit for which B_{CURR}/B_{MSY} and F_{CURR}/F_{MSY} have not been estimated through a stock assessment or other scientific exercise (i.e., stock status unknown), the following estimates will be used for the F_{CURR}/F_{MSY} and B_{CURR}/B_{MSY} proxies: 1) The default proxies for F_{CURR}/F_{MSY} and B_{CURR}/B_{MSY} are estimated as 1.00; 2) For species that are believed to be at risk based on the best available information, the F_{CURR}/F_{MSY} proxy is estimated as 1.33 and the B_{CURR}/B_{MSY} proxy = max (1-c), whereas c is equal to the natural mortality rate (M) or 0.50, whichever is smaller; and 3) For species that are believed to be at high risk based on the best available information, the F_{CURR}/F_{MSY} proxy is estimated as 2.0 and the B_{CURR}/B_{MSY} proxy = 0.67(1-c), whereas c is equal to the natural mortality rate (M) or 0.50, whichever is smaller.							
Optimum Yield (OY)							
Alternative 1: No action. Retain current definitions of OY (if any).							
Alternative 2: Set OY = 0.75(MSY).							
Alternative 3: Set OY = 0.		X					
Alternative 4: Set OY equal to the average yield associated with fishing on a continuing basis at F_{OY}; where $F_{OY} = 0.75F_{MSY}$.			X			X	X
Minimum Stock Size Threshold (MSST)							
Alternative 1: No action. Do not define MSST for managed species.							
Alternative 2: Set MSST = B_{MSY}(1-c); where c = the natural mortality rate (M) or 0.50, whichever is smaller.		X	X			X	X
Alternative 3: Set MSST = B_{MSY}(0.50).							
Alternative 4: Set MSST = B_{MSY}.							
Maximum fishing mortality threshold (MFMT), and limit and target control rules.							
Alternative 1: No action. Do not define MFMT or control rules for FMU sub-units.							

MANAGEMENT ACTION	CORAL		QUEEN CONCH		REEF FISH		LOBSTER
	AT	AO	QC	AO	AT	AO	
Alternative 2: A) Specify an MSY control rule to define MFMT and ABC as follows: 1) If $B_{CURR}/B_{MSY} < B_{MIN}$, then ABC = 0; 2) If B_{CURR}/B_{MSY} 1, then ABC = MSY; and 3) If B_{CURR}/B_{MSY} is between B_{MIN} and 1, then ABC = (MSY/(1-B_{MIN}))((B_{CURR}/B_{MSY})-B_{MIN}); where B_{MIN} = 0.25; and B) Specify an OY control rule representing target catch levels such that: 1) If $B_{CURR}/B_{MSY} < B_{MIN}$, then target catch levels = 0; 2) If B_{CURR}/B_{MSY} 1, then target catch levels = OY; and 3) If B_{CURR}/B_{MSY} is between B_{MIN} and 1, then target catch levels = (OY/(1-B_{MIN}))(B_{CURR}/B_{MSY}-B_{MIN}); where B_{MIN} = 0.25.							
Alternative 3: A) Specify an MSY control rule to define MFMT and ABC as 0; and B) Specify an OY control rule to define target catch levels as 0.		X					
Alternative 4: A) Specify an MSY control rule to define MFMT and ABC as follows: 1) If $B_{CURR}/B_{MSY} < B_{MIN}$, then ABC = 0; 2) If B_{CURR}/B_{MSY} 1, then ABC = F_{MSY}(B); and 3) If B_{CURR}/B_{MSY} is between B_{MIN} and 1, then ABC = (F_{MSY}(B)/(1-B_{MIN}))((B_{CURR}/B_{MSY})-B_{MIN}); where B_{MIN} = 0.25. If F_{MSY} cannot be estimated directly, use M as a proxy; and B) Specify an OY control rule to define target catch levels such that: 1) If B_{CURR}/B_{MSY} is less than B_{MIN}, then target catch levels = 0; 2) If B_{CURR}/B_{MSY} is equal to or greater than 1, then target catch levels = F_{OY}(B); and 3) If B_{CURR}/B_{MSY} is between B_{MIN} and 1, then target catch levels = (F_{OY}(B)/(1-B_{MIN}))((B_{CURR}/B_{MSY})-B_{MIN}); where B_{MIN} = 0.25. If F_{OY} cannot be estimated directly, use 0.5(M) as a proxy.							
Alternative 5: A) Specify an MSY control rule to define MFMT and ABC as follows: 1) If B_{CURR}/B_{MSY} < MSST/B_{MSY}, ABC = 0.33MSY; 2) If B_{CURR}/B_{MSY} 1, ABC = MSY; and 3) If B_{CURR}/B_{MSY} is between MSST/B_{MSY} and 1, ABC = 0.67MSY; and B) Specify an OY control rule to define target catch levels such that: 1) If B_{CURR}/B_{MSY} < MSST/B_{MSY}, target catch levels = 0.25MSY; 2) If B_{CURR}/B_{MSY} 1, target catch levels = 0.75MSY; and 3) If B_{CURR}/B_{MSY} is between MSST/B_{MSY} and 1, target catch levels = 0.5MSY.							
Alternative 6: A) Specify an MSY control rule to define ABC = F_{MSY}(B). When the data needed to determine F_{MSY} are not available, use natural mortality (M) as a proxy for F_{MSY}; and B) Specify an OY control rule to define target catch limits such that they equal F_{OY}(B). If F_{OY} can not be determined, use 0.5(M) as a proxy.			X			X	X

MANAGEMENT ACTION	CORAL		QUEEN CONCH		REEF FISH		LOBSTER
	AT	AO	QC	AO	AT	AO	
Alternative 7. A) Specify an MSY control rule to define ABC = F_{MSY}(B). When the data needed to determine F_{MSY} are not available, use a proxy for F_{MSY} calculated as a fraction of the natural mortality rate (M) as follows: 1) Use 1.00(M) as a proxy for F_{MSY} for species that are not believed to be at risk based on the best available information; 2) Use 0.75(M) as a proxy for F_{MSY} for species for which no positive or negative determination can be made on the status of their condition; and 3) Use 0.50(M) as a proxy for F_{MSY} for species that are believed to be at risk based on the best available information; and B) Specify an OY control rule to define target catch levels equal to F_{MSY}(B)(OY/MSY). When the data needed to determine F_{MSY} are not available, use a proxy for F_{MSY} calculated as a fraction of the natural mortality rate (M) as follows: 1) Use 0.75(M) as a proxy for F_{MSY} for species that are not believed to be at risk based on the best available information; 2) Use 0.50(M) as a proxy for F_{MSY} for species for which no positive or negative determination can be made on the status of their condition; and 3) Use 0.25(M) as a proxy for F_{MSY} for species that are believed to be at risk based on the best available information.							
REGULATING FISHING MORTALITY							
Short-term management alternatives							
Alternative 1: No action. Do not adopt additional management measures.							
Alternative 2: Establish seasonal closures.						X	
Alternative 3: Establish area closures.							
Alternative 4: Eliminate the use of fish traps in the U.S. EEZ.							
Alternative 5: Eliminate the use of gill and trammel nets in the U.S. EEZ.						X	
Alternative 6. Develop a memorandum of understanding (MOU) between NMFS and the state governments to develop compatible regulations to achieve the management objectives set forth in all Council FMPs in state and federal waters of the U.S. Caribbean							
REBUILDING OVERFISHED FISHERIES							
Nassau Grouper (Rebuilding Schedule)							
Alternative 1: No action. Do not define a schedule/time frame for rebuilding Nassau grouper.							
Alternative 2: Rebuild Nassau grouper to B_{MSY} in 25 years, using the formula T_{min} (10 years) + one generation (15 years) = 25 years.						X	

MANAGEMENT ACTION	CORAL		QUEEN CONCH		REEF FISH		LOBSTER
	AT	AO	QC	AO	AT	AO	
Alternative 3: Rebuild Nassau grouper to B_{MSY} in 52.5 years, using the formula T_{min} (10 years) + one generation (42.5 years) = 52.5 years.							
Alternative 4: Rebuild Nassau grouper to B_{MSY} in 80 years, using the formula T_{min} (10 years) + one generation (70 years) = 80 years.							
Nassau Grouper (Rebuilding Strategy)							
Alternative 1: No action. Rely on current regulations to rebuild the stock to B_{MSY} within the required time frame.							
Alternative 2: 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.						X	
Alternative 3: Establish a seasonal or area closure to protect spawning stock.							
Alternative 4: 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 Caribbean Fishery Management Council's Reef Fish FMP in USVI and federal waters of the U.S. Caribbean.						X	
Goliath Grouper (Rebuilding Schedule)							
Alternative 1: No action. Do not define a schedule/time frame for rebuilding Goliath grouper.							
Alternative 2: Rebuild Goliath grouper to B_{MSY} in 30 years, using the formula T_{min} (10 years) + one generation (20 years) = 30 years.						X	
Alternative 3: Rebuild Goliath grouper to B_{MSY} in 67.5 years, using the formula T_{min} (10 years) + one generation (57.5 years) = 67.5 years.							
Alternative 4: Rebuild Goliath grouper to B_{MSY} in 105 years, using the formula T_{min} (10 years) + one generation (95 years) = 105 years.							
Goliath Grouper (Rebuilding Strategy)							
Alternative 1: No action. Rely on current regulations to rebuild the stock to B_{MSY} within the required time frame.							
Alternative 2: 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.						X	
Alternative 3: Establish a seasonal or area closure to protect spawning stock.							
Queen Conch (Rebuilding Schedule)							
Alternative 1: No action. Do not define a schedule/time frame for rebuilding queen conch.							
Alternative 2: Rebuild queen conch to B_{MSY} in 15 years, using the formula T_{min} (10 years) + one generation (5 years) = 15 years.			X				
Alternative 3: Rebuild queen conch to B_{MSY} in 20 years, using the formula T_{min} (15 years) + one generation (5 years) = 20 years.							

MANAGEMENT ACTION	CORAL		QUEEN CONCH		REEF FISH		LOBSTER
	AT	AO	QC	AO	AT	AO	
Queen Conch (Rebuilding Strategy)							
Alternative 1: No action. Rely on current regulations to rebuild the stock to B_{MSY} within the required time frame.							
Alternative 2: Prohibit commercial and recreational catch and possession of queen conch in federal waters of the U.S. Caribbean.							
Alternative 3: 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.			X				
Alternative 4: Develop a memorandum of understanding (MOU) between NMFS and the state governments to develop compatible regulations to achieve the management objectives set forth in the Council's Queen Conch FMP in state and federal waters of the U.S. Caribbean.							
Grouper Unit 4 (Rebuilding Schedule)							
Alternative 1: No action. Do not define a schedule/time frame for rebuilding Grouper Unit 4.							
Alternative 2: Rebuild Grouper Unit 4 to B_{MSY} in 10 years.						X	
Alternative 3: Rebuild Grouper Unit 4 to B_{MSY} in 2 years.							
Alternative 4: Rebuild Grouper Unit 4 to B_{MSY} in 6 years.							
CONSERVING AND PROTECTING YELLOWFIN GROUPER							
Alternative 1: No action. Do not establish a seasonal closure of the Grammanik Bank.							
Alternative 2: Close the Grammanik Bank to all fishing from February 1 to April 30 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18° 12.40' N, 64° 59.00' W; 18° 10.00' N, 64° 59.00' W; 18° 10.00' N, 64° 56.10' W; and 18° 12.40' N, 64° 56.10' W.							
Alternative 3: Close the Grammanik Bank to all fishing from February 1 to April 15 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18° 13.20' N, 64° 59.00' W; 18° 13.20' N, 64° 54.00' W; 18° 09.50' N, 64° 59.00' W; and 18° 09.50' N, 64° 54.00' W.							
Alternative 4: Close the Grammanik Bank to all fishing from February 1 to April 15 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18° 12.00' N, 64° 58.00' W; 18° 12.00' N, 64° 57.00' W; 18° 11.00' N, 64° 57.00' W; and 18° 11.00' N, 64° 58.00' W.							
Alternative 5: Close the Grammanik Bank to all fishing from February 1 to May 31 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18° 13.20' N, 64° 59.00' W; 18° 13.20' N, 64° 54.00' W; 18° 09.50' N, 64° 59.00' W; and 18° 09.50' N, 64° 54.00' W.							
Alternative 6: Close the Grammanik Bank to all fishing from February 1 to May 31 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18° 12.00' N, 64° 58.00' W; 18° 12.00' N, 64° 57.00' W; 18° 11.00' N, 64° 57.00' W; and 18° 11.00' N, 64° 58.00' W.							

MANAGEMENT ACTION	CORAL		QUEEN CONCH		REEF FISH		LOBSTER
	AT	AO	QC	AO	AT	AO	
Alternative 7. Close the Grammanik Bank to all fishing from February 1 to April 30 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18° 11.898' N, 64° 56.328' W; 18° 11.645' N, 64° 56.225' W; 18° 11.058' N, 64° 57.810' W; and 18° 11.311' N, 64° 57.913' W.			X			X	X
Alternative 8: Prohibit the harvest and possession of yellowfin grouper in the U.S. EEZ, in conjunction with the closure of the Grammanik Bank.							
ACHIEVING THE MSFCMA BYCATCH MANDATES							
Bycatch Reporting							
Alternative 1: No action. Do not establish a bycatch reporting program in the U.S. Caribbean.							
Alternative 2: Develop and implement a federal permit system for commercial and charter boat fishermen participating in Council-managed fisheries, with an associated mandatory monthly reporting requirement.							
Alternative 3: Utilize the MRFSS database to provide additional bycatch information on the recreational and subsistence sectors.	X		X	X	X	X	X
Alternative 4: Modify the trip ticket system currently in place in the U.S. Caribbean to require the collection of information on bycatch.	X		X	X	X	X	X
Minimizing Bycatch and Bycatch Mortality to the Extent Practicable							
Alternative 1: No action. Rely on current management measures to minimize bycatch and bycatch mortality.							
Alternative 2: Increase the minimum allowable mesh size for fish traps.							
Alternative 3: Establish a minimum mesh size of two inches and a maximum mesh size of six inches, stretched mesh, for gill and trammel nets. Additionally, gill and trammel nets must be tended at all times.							
Alternative 4: Amend current requirements for trap construction such that only one escape panel be required, which could be the door.							
ACHIEVING THE MSFCMA EFH MANDATES							
Describe and identify EFH							
Alternative 1. No action.							
Alternative 2. Implement the preferred alternative from the EFH EIS to describe and identify EFH according to functional relationships between life history stages of federally-managed species and Caribbean marine and estuarine habitats.		X	X			X	X
Alternative 3. Implement the preferred alternative from the EFH EIS to designate HAPCs.		X	X			X	X
Minimize adverse effects on EFH							
Alternative 1. No action.							
Alternative 2. Implement the preferred alternative from the EFH EIS to establish modifications to anchoring techniques; establish 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.		X	X			X	X

The alternatives to no action described in Section 4.1 would re-define the FMUs and sub-units in the Queen Conch, Reef Fish, and Coral FMPs. Changes to the status quo examined under these alternatives include: (1) Redefining select FMUs to represent only those species that are present in sufficient numbers in the U.S. EEZ to warrant inclusion in Council FMPs; (2) retaining select species in FMUs for data collection only, based on a lack of need for conservation and management in federal waters; and (3) defining or modifying FMU sub-units to include species that are best managed in coordination, for example, species that may be targeted collectively due to similar habitat and depth preference, or landed collectively due to gear type employed by the fishery.

The alternatives described in Section 4.2 define, or modify existing definitions of, stock status parameters necessary under the MSFCMA, including maximum sustainable yield, optimum yield, minimum stock size threshold, and maximum fishing mortality threshold. Additionally, these alternatives provide quantitative definitions of stock status based on the best available scientific infomation on the condition of individual stocks and fisheries, and would establish control rules, or pre-agreed upon strategies for managing catches to achieve established goals and objectives. The parameters that would result for each stock or stock complex under each of these alternatives are detailed in Tables 8-11 .

Section 4.3 includes alternatives to keep catches in line with the preferred targets and thresholds described in Section 4.2 through regulation of fishing effort. The alternatives are designed to achieve immediate reductions in fishing mortality and include closed seasons and areas, gear restrictions, and administrative actions to foster the development of consistent regulations in state and federal waters.

Section 4.4 describes alternative schedules and management strategies to rebuild four stocks, or FMU sub-units, under the Council's jurisdiction: Goliath grouper, Grouper Unit 4 (misty grouper, red grouper, tiger grouper, yellowedge grouper, and yellowfin grouper), Nassau grouper, and queen conch. Goliath grouper, Nassau grouper, and queen conch are classified as overfished in NOAA’s National Marine Fisheries Service’s (NMFS) most recent report to Congress on the status of fisheries of the United States (NMFS 2003a). Grouper Unit 4 will be considered to be overfished when the Council's preferred definitions of FMU sub-units (Section 4.1) and stock status determination criteria (4.2) are adopted and implemented through this amendment.

Alternative rebuilding schedules evaluated in this amendment are consistent with the guidance provided in NMFS’ National Standard Guidelines (50 CFR §600.310(e)). The shortest possible rebuilding period is defined as the length of time for a stock to rebuild in the absence of fishing mortality on that stock (T_{MIN}). The longest recommended rebuilding period is defined as ten years if $T_{MIN} < 10$, or T_{MIN} plus one mean generation time if $T_{MIN} > 10$. Generally, the mid-point between the shortest possible and longest allowable rebuilding periods is evaluated as a third alternative. Alternatives for achieving rebuilding targets include seasonal and area closures, a prohibition on the filleting of fish at sea, catch restrictions, and administrative action to promote the development of compatible regulations in state waters.

Section 4.5 outlines additional management actions the Council could adopt to increase protections for yellowfin grouper, one of the species included in the Council's proposed Grouper Unit 4. These alternatives examine various closed areas and seasons designed to protect an identified yellowfin grouper spawning aggregation on Grammanik Bank, south of St. Thomas. They were originally being developed in a separate amendment to the Reef Fish FMP, but were transferred to this amendment to streamline the administrative process and to reduce the amount of time before they were brought before the Council for final consideration.

Section 4.6 describes alternatives considered by the Council to: (1) Establish a standardized reporting methodology to assess the amount and type of bycatch occurring in federal fisheries (Section 4.6.1), and (2) minimize bycatch and bycatch mortality to the extent practicable (Section 4.6.2). Alternatives to establish a bycatch reporting methodology include developing a federal permit and reporting system, modifying the current state reporting systems, and no action. Management measures evaluated for their ability to further reduce bycatch include various types of gear modifications, such as increasing the minimum allowable mesh size used in traps and nets.

Finally, the alternatives contained in Section 4.7 describe and identify EFH for managed stocks, 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. The EFH preferred alternatives describe and identify EFH according to functional relationships between life history stages of federally-managed species and Caribbean marine and estuarine habitats. Also identified are habitat areas of particular concern (HAPCs), based on confirmed spawning aggregations of managed species, or based on areas or sites identified as having particular ecological importance to Caribbean reef fish or coral species. The alternative to minimize impacts on EFH includes the requirement to use at least one buoy that floats on the surface on all individual traps/pots, or at each end of trap lines linking traps/pots for all fishing vessels that fish for or possess Caribbean spiny lobster or Caribbean reef fish species; the requirement of an anchor retrieval system for commercial and recreational fishing vessels that fish for or possess Caribbean reef species; and the prohibition of the use of pots/traps, gill/trammel nets, and bottom longlines on coral or hard bottom habitat at documented reef fish spawning areas.

1.2 Environmental consequences

Section 6.0 describes the potential impacts of the alternatives considered in this amendment to the physical, biological/ecological, social/economic, and administrative environments in the U.S. Caribbean.

1.2.1 Physical environment

Generally, impacts to the physical environment are expected to be minimal. Some alternatives regulating the type of gear used or areas fished could benefit habitat. However, since only about 14% of fishable habitat (for the purposes of this amendment, fishable habitat is defined as all habitat within 100 fathoms of depth) in the U.S. Caribbean occurs in federal waters (Section 2.11; Figure 1), such benefits would not be expected to be significant. A notable exception would be the potential implementation of Memoranda of Understanding (MOUs) with the States, in conjunction with an alternative to restrict or prohibit the use of a certain gear type (e.g., fish traps), which could lead to significant benefits to the physical environment.

1.2.2 Biological/ecological environment

Impacts to the biological/ecological environment associated with most alternatives to no action are expected to be largely positive. But, again, these impacts are not likely to be significant (excluding a potential MOU scenario), as the majority of affected species harvested in the U.S. Caribbean occur in state waters.

Given the suite of stock status parameters adopted in Section 4.2, harvest needs to be reduced, which will benefit the stocks of reef fish that are over-exploited. The more significant impacts to the biological environment would result from those alternatives in Section 4.3. Gear restrictions or area/seasonal closures are expected to reduce fishery-related impacts on habitat, as well as reduce fishing mortality on numerous reef fish species.

Alternatives in Section 4.4 would primarily have a species-specific effect, as rebuilding strategies are aimed at rebuilding those species that are determined to be overfished. However, some rebuilding strategies could indirectly impact other species. For example, a regulation prohibiting the filleting of fish at sea could improve species identification and data collection, while stemming the poaching of prohibited species and deterring the harvest of under-sized species. Furthermore, the administrative alternatives evaluated in this section could improve state management capacity and benefit numerous species by providing fishery managers a vehicle for enhancing federal-state cooperation.

The alternatives described in Section 4.5, which are designed to conserve and protect yellowfin grouper, also could benefit numerous other species. The closed area options are intended to result in the protection of yellowfin grouper spawning aggregations on Grammanik Bank. Since the alternatives would prohibit all fishing within the specified coordinates, other species, including those species in the Coral FMP that are considered EFH (i.e., corals), would benefit from the closure as well. However, as with any closed area or season, there could be negative effects associated with these alternatives. Intensified fishing before and after a closed season could reduce or negate benefits accrued during the closure. Likewise, displaced fishing activities could increase pressure on juveniles in state waters, or impair EFH through intensified fishing activities in waters outside the closed area.

The bycatch alternatives presented in Section 4.6 are intended to provide more and better data on bycatch in U.S. Caribbean fisheries, as well as reduce the amount of bycatch in federal waters. The gear prohibitions or modifications described in that section could benefit finfish species by reducing the number of juvenile or prohibited species harvested. Additionally, the prohibition of a specific gear type could benefit the environment should the gear adversely impact EFH. However, any such benefits could be reduced or negated if fishermen adapt existing or develop new gear types that have greater impacts, or if they intensify their fishing effort in response to new regulations.

Regardless of which alternative is selected, it is imperative to point out that the biological and ecological benefits are likely to be reduced or entirely negated if consistent action is not pursued in state waters. This is more fully discussed in Section 1.3.

1.2.3 Social/economic environment

Impacts to the social and economic environment associated with alternatives to no action are generally expected to be negative in the short term, and positive in the long term. The majority of alternatives in Sections 4.1 and 4.2 would not have a direct economic effect to fishermen. However, they could lead to indirect effects due to required reductions in fishing mortality associated with the selection of a particular control rule. This could restrict the number of fish available to fishermen in the short term, which could negatively impact fishermen's income. Regardless, any potential negative indirect effects are expected to be overshadowed by long-term benefits resulting from the rebuilding of overfished stocks, the prevention of overfishing, and the establishment of sustainable fisheries.

Alternatives described in Sections 4.3 and 4.4 could have a significant direct economic impact on fishermen in the short term. Due to the lack of information on the amount of fishing in federal waters, it is not possible to quantify the precise economic impact to fishermen. While the closed area alternatives, in particular, may reduce fishermen's income, they are unlikely to result in fishermen going out of business due to the fact that the majority of habitat and harvest occurs in state waters. Gear modifications and/or prohibitions, if adopted, would force fishermen either to displace their activities to state waters, or to modify/change their gear. This could present significant short-term social and economic impacts depending on the amount of gear employed by affected fishermen, and the extent to which those user groups fish in the EEZ. However, as mentioned earlier, any potential negative effects in the short term are expected to be overshadowed by long-term benefits resulting from the rebuilding of overfished stocks, the prevention of overfishing, and the establishment of sustainable fisheries.

The complete prohibition on queen conch harvest in the EEZ that is proposed in Section 4.4 is the most restrictive management action available to the Council to end overfishing of that species. Because the extent of queen conch harvest in federal waters appears to be very limited (particularly in Puerto Rico), the direct short-term adverse socioeconomic impacts associated with the fishery closure are likely to be relatively small. To the extent that the proposed closure of the federal waters would allow for recovery of the stock, however, any adverse impacts would likely be outweighed by long-term benefits. Furthermore, if the harvest of queen conch is not prohibited in federal waters, it is likely that landings will continue to decline and the fishery will approach or reach commercial extinction as has happened in other Caribbean and U.S. waters.

Similar to the closed area alternatives in Section 4.3.1, the closed area alternatives for Grammanik Bank in Section 4.5 could result in decreased revenue for fishermen during the closed season. The actual size and length of the closure would ultimately determine the extent of any socio-economic impact. Generally, the larger the closed area (e.g., Alternative 3 versus Alternative 4) and the longer the duration (e.g., Alternative 4 versus Alternative 6), the greater the economic impact. However, based on available landings information, the total prohibition on yellowfin grouper harvest and possession during the spawning period (i.e., Alternative 7) will likely not result in a significant economic impact.

The bycatch alternatives in Section 4.6 could potentially result in social and economic impacts, moreso in the USVI than Puerto Rico due to greater USVI fishermen utilization and dependence on the EEZ. Due to the current lack of a mandatory permit and reporting system in the EEZ, establishing a new federal permit system could result in confusion among fishing communities. Furthermore, there may be a resistance to purchase a federal permit, especially considering the limited harvest originating from the EEZ, the existence of mandatory state permitting requirements (i.e., paying for yet another permit), and the level of active enforcement in the area. Any gear prohibition or modification alternatives (Section 4.6.2) could result in economic impacts to fishermen who would be forced to modify their gear or switch to a new gear type, as well as social impacts stemming from confusion among fishing communities.

1.2.4 Administrative environment

Impacts associated with many of the alternatives to no action are expected to impose additional burdens on the administrative environment, but to result in a more manageable and responsive management system. Establishing biological reference points and stock status determination criteria should directly benefit (rather than burden) the administrative environment by providing fishery scientists and managers specific objective and measurable criteria to use in assessing the status and performance of Caribbean fisheries. The Council and regional fishermen have expressed a desire for improved enforcement in the region. In order to assure compliance with many of the alternatives proposed in this amendment, increased funding to improve the effectiveness of enforcement would be required. This would be especially important with regards to the closed area and gear prohibition alternatives. Additional personnel and boats would be required to properly monitor the closed areas to prevent poaching, and to inspect gear and fishermen's catch offshore. Due to the potential for inconsistent regulations between state and federal waters, an enhanced enforcement presence would be critical to ensure compliance with some of the proposed fishery regulations (e.g., seasonal yellowfin grouper harvest prohibition) unless local governments adopt complimentary regulations. Only under certain situations (e.g., preemption) would the federal government be able to control fisheries in state waters.

1.3 Major conclusions and areas of controversy

As noted throughout the amendment, consistent management in state waters is essential in order for most, if not all, of the proposed management actions to achieve the desired goals in federal waters. The majority of habitat, especially juvenile habitat, occurs in state waters. While available landings data do not differentiate between state and federal waters, it is generally understood that the vast majority of total landings in the U.S. Caribbean originate from state waters due to the disparity of fishable habitat between state and federal waters, which is discussed further in Section 2.1.1. Therefore, state cooperation and establishment of consistent fishery regulations will be crucial if fisheries are to be managed effectively. This is especially important with regards to rebuilding overfished species such as Nassau grouper and queen conch, where continued harvest in state waters jeopardizes federal rebuilding programs.

For example, while this amendment proposes to prohibit the harvest of queen conch, an overfished species, in federal waters, we only expect modest improvements in its condition without state action. This is validated by the fact that the status of Nassau grouper has yet to improve after almost a decade of prohibited catches in federal waters while the harvest of this species has been permitted in USVI waters. Puerto Rico had permitted the harvest of Nassau grouper and Goliath grouper; however, they implemented new regulations on March 12, 2004, to prohibit the possession or sale of these two species[1].

Consistent regulations in state waters would be desirable for any gear modifications or prohibitions, lest any regulatory or enforcement loopholes in state waters negate any benefits that could be achieved in federal waters. For example, a gear prohibition in federal waters could be ineffective if similar regulations are not implemented in state waters, since, in the absence of adequate at-sea enforcement in the EEZ, fishermen could simply state upon returning to the dock that their catch originated from state waters.

While there are likely to be negative social and economic impacts associated with some of the proposed alternatives, the social, economic, and biological consequences of not taking any action could be far more severe in the long-term. The preferred alternatives evaluated in this amendment, especially if implemented in conjunction with consistent state regulations, are expected to improve the biological status of fishery resources in the U.S. Caribbean and to establish long-term benefits to fishing communities, the U.S. Caribbean islands, and the nation.

1.4 Incomplete or unavailable information

Section 1502.22 of NEPA requires agencies to clearly state if information is incomplete or unavailable when evaluating reasonably foreseeable significant adverse effects on the human

[1] The new (2004) Puerto Rican fishing regulations established closed areas; implemented minimum sizes for several managed species, quotas for aquarium trade species, license and reporting requirements; and prohibited the harvest of certain species and the use of certain gear types.

environment in an EIS. The following summarizes the NEPA requirements when dealing with incomplete or unavailable information, as it pertains to this EIS:

1.4.1 Availability and completeness of the utilized information

This EIS utilizes the best available scientific information available through 2002 to evaluate the impacts on the human environment. However, the extent of that information limits the amount of detail that can be conducted during the various impact analyses, and requires that various reasonable assumptions and theoretical approaches be employed. Subsequent to the completion of analyses for this document, some additional information has become available regarding certain aspects of the fisheries in the region. Even so, the conclusions reached in this document would not change significantly, had this newer information been available.

There is a general absence of any regional stock assessments for species managed by the Caribbean Council. Furthermore, restrictions on biological data (e.g., natural mortality rates) in the U.S. Caribbean imposes other obstacles to accurately evaluating the conditions of the fisheries. Landings data are fairly rudimentary, with very coarse spatial effort information. Generally, Puerto Rico does not distinguish catch between state and federal waters, and while the USVI does indicate catch between these jurisdictions, the utility of that information is rather limited. This is due, in part, to the fact that USVI fishing activities could transpire in both the EEZ and in state waters on any given fishing trip due to the wider shelf and the narrower 3 nm state jurisdictional boundary. Due to these issues, it is currently impossible to parse out catch/effort specifically from the EEZ (i.e., Council jurisdiction). Another issue with the landings data is the lack of discrete species identification, specifically with USVI landings. Instead of individual species reported and grouped by gear type, some species are grouped together. For example, all snapper species are grouped together, as are all grouper species. This complicates the identification of declining catch in any particular species, which could indicate reduced biomass or an overfishing/overfished condition, as grouping at this scale could mask these species-specific trends.

There is a trivial amount of information on the U.S. Caribbean recreational fishery. While the Marine Recreational Fisheries Statistical Survey (MRFSS) has collected survey information from Puerto Rico since 2000, it does not gather recreational statistics from the USVI. Furthermore, as with the commercial landings data in Puerto Rico, MRFSS data do not differentiate between state and federal waters. Therefore, it is impossible to determine the extent of the recreational fishery that transpires solely in the EEZ.

There are also significant socio-economic information gaps. Until 2004, fishermen in Puerto Rico were not required to possess a fishing permit. Therefore, it is likely that unreported fishing activity transpired off Puerto Rico; the portion of that unreported activity that occurred specifically in the EEZ is unknown. While fishermen in Puerto Rico generally sell their catch to fish houses or dealers, no such structure exists in the USVI. Fishermen in the USVI typically market their catch directly. Due to the lack of a centralized infrastructure, it is possible that a portion of the potentially available socio-economic data (e.g., price per pound, revenue generated, etc.) is lost. While there have been some socio-economic studies performed in the U.S. Caribbean, due to the aforementioned issues with landings data, the utility of those studies is limited. Again, there is a paucity of information pertaining to the recreational fishery, including the fore-hire component.

Due to the excessive time required in obtaining this needed information (e.g., detailed stock assessments, discrete landings information specifically for the EEZ available in a long-time series, refined and accurate spatial effort data, etc.), as well as the complicated logistics and lack of fishery infrastructure in some areas that could impede successful data acquisition, the costs of obtaining this needed information would be exorbitant.

1.4.2 Relevance of the incomplete or unavailable information

The information currently not available is directly relevant to disseminating the status of managed marine resources (e.g., MSY, OY, etc.), as well as evaluating potential impacts resulting from the proposed management alternatives. Because of the lack of discrete biological data for the U.S. Caribbean, managers are handicapped and must rely on related studies conducted, and information gathered, in other geographic areas. Further, due to the caveats with the currently available landings data, assumptions must be made to arrive at any conclusions on the status of the managed resources or on impacts to potentially affected users as it relates to the EEZ (i.e., Council jurisdiction).

1.4.3 Summary of existing credible scientific evidence

Currently, the largest pool of area-specific information that can be utilized to evaluate the status of Council-managed species is the commercial landings data from Puerto Rico and the USVI, which is discussed in Section 5.3.1.4. Also, a very limited time series of recreational statistics from Puerto Rico is available from MRFSS, which is discussed in Section 5.3.2.3. No recent comprehensive stock assessments have been conducted on any Council-managed species; a preliminary assessment scenario was completed for queen conch in 2002, but it was not a full stock assessment.

When available, studies conducted in the U.S. Caribbean were used to develop biological profiles; this information was supplemented with information collected in analogous or reasonably comparable locales. For example, biological information from the Florida Keys reef tract were utilized for many species. These studies included data such as natural mortality rates, fecundity, age at maturity, habitat preferences, prey, etc. This information appears throughout Section 5.2, and is employed in Section 6 when evaluating the impacts to the geological and biological/ecological environments.

Statistics from the respective state governments, as well as numerous academic studies on the socio-economic aspects of U.S. Caribbean fisheries currently exist and were employed in this EIS. This includes statistics on the number of fishermen, number and type of boats, gear information, effort, age composition of fishermen, etc. This information appears throughout Section 5.3, and is utilized in Section 6 when evaluating the impacts to the socio-economic and administrative environments.

The studies that were utilized in this EIS to evaluate the effects on the human environment are cited in Section 10. Furthermore, all data that are included in the various tables in the Appendix are cited appropriately. As noted in Section 1.4.1, some new information has recently become available regarding the fish and fisheries of the region, but the conclusions reached here would not change significantly had that information been available during the time frame that analyses for this document were being conducted.

1.4.4 Evaluation of impacts

Due to the complete lack of both detailed stock assessments for Council-managed species and more discrete landings and effort data, the analyses in this amendment relied on informed judgement and theoretical approaches in some situations to provide a reasonable range of alternatives, as well as sufficient information that could be utilized to evaluate the potential impacts of the proposed alternatives. These determinations and approaches were developed by the SFA Working Group, which consisted of scientists, managers, and environmentalists. This methodology is generally accepted in the scientific community, especially in data-poor situations; as stated in Restrepo *et al.* (1998), "in cases of severe data limitations, qualitative approaches may be necessary, including expert opinion and consensus-building methods."

Fishery management sub-units were developed to allow for more refined and efficient management. These sub-units were grouped based on similarities in the biology (e.g., habitat preference) and perceived status of the species, and in the way in which the grouped species are harvested. Adjustment of the available commercial landings data was required due to differences in the format between Puerto Rico and USVI records. For example, due to the species grouping mentioned earlier, USVI snapper and grouper were extrapolated using USVI landings, and then modifying it by the percentage that the various grouper and snapper sub-units appeared in the Puerto Rican landings. The result of this effort appears in Table 5. Recreational reef fish landings for USVI were estimated by forecasting a recreational landings estimate using the same approach as done by Jennings (1992). The percentage of each species (or group) from Puerto Rico's recreational landings were used to derive recreational landings for the USVI, For the USVI, the recreational catch for queen conch and spiny lobster was assumed to be 50% of the USVI commercial landings, approximating the same commercial:recreational relationship as for that in Puerto Rico. The result of this effort appears in Table 6.

Due to the lack of discrete habitat mapping, as well as explicit spatial effort information, assumptions had to be made not only about catch, but moreover about catch specifically in the EEZ. An important assumption that was made, one that appears throughout this document, is that of "fishable habitat." The majority of managed species and fishing effort appears to be concentrated on the continental shelf around the U.S. Caribbean; the delineation for this area is the 100-fathom contour. Beyond 100 fathoms, the bathymetry gets very steep, and the increased water depth quickly precludes most fishing activities (i.e., for Council-managed species). The available biological information (e.g., depth range, habitat preference) on managed species that appears in Section 5.2 helps to support this conclusion. Only 14.39% of the EEZ (i.e., Council jurisdiction) is shallower than 100 fathoms. Therefore, it is a reasonable assumption that the majority of fishing activity occurs in state waters. This assumption is significant in regards to evaluating the impacts of various management alternatives in Section 6, such as the area closure alternatives.

In order to determine or scale the potential impacts of the various management alternatives, specifically those offered to reduce fishing mortality, a further assumption had to be made in how to utilize the landings data. Due to the absence of currently existing spatial catch and effort information in the U.S. Caribbean, it was assumed that catch was evenly distributed throughout the fishable habitat area. For example, 14.39% of total landings for the U.S. Caribbean, or from any particular sub-unit, that appear in Table 7 are assumed to have originated from the EEZ. That is, a 10% closure of waters 100 fathoms or less would result in a 10% reduction in fishing mortality. This approach obviously has some inherent drawbacks, but, due to the lack of more refined spatial effort and habitat information, it is within the rule of reason.

Therefore, due to the information deficiencies noted above, the costs of obtaining which would be exorbitant and would require time on the scale of years, the assumptions and theoretical approaches noted herein were employed for the purposes of this EIS.

2 Introduction

2.1 The fishery management process and applicable laws

2.1.1 Federal fishery management

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

Responsibility for federal fishery management decision-making is divided between the U.S. Secretary of Commerce and eight regional fishery management councils that represent the expertise and interests of constituent states. Regional councils are responsible for preparing, monitoring, and revising management plans for fisheries needing management within their jurisdiction. The Secretary of Commerce (Secretary) is responsible for promulgating regulations to implement proposed plans and amendments after ensuring that management measures are consistent with the MSFCMA, and with other applicable laws summarized in Section 8. In most cases, the Secretary has delegated this authority to NMFS.

The Council is responsible for fishery resources in federal waters of the U.S. Caribbean. These waters extend to 200 nautical miles offshore from the nine-mile seaward boundary of the Commonwealth of Puerto Rico and the three-mile seaward boundary of the territory of the U.S. Virgin Islands (USVI) (see Figure 1).

The total area of fishable habitat in the U.S. Caribbean is about 2,467 nm^2. Only 355 nm^2 (14.39%) of that area occurs in federal waters: 116 nm^2 (4.7%) off Puerto Rico; 240 nm^2 (9.7%), off the USVI. The vast majority of the fishable habitat in federal waters off Puerto Rico is located off the west coast. The vast majority of the fishable habitat in federal waters off the USVI is located off the north coast of St. Thomas. Due to the steep continental slopes that occur off Puerto Rico and the USVI, fishable habitat is defined as those waters 100 fathoms or shallower. The majority of fish habitat occurs in that area, 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 non-highly migratory species U.S. Caribbean fisheries.

The Council consists of seven voting members: four public members appointed by the Secretary, one each from the fishery agencies of Puerto Rico and the USVI, and one from NMFS. Public interests are also involved in the fishery management process through participation on advisory panels and through Council meetings which, with few exceptions for discussing personnel matters, are open to the public. In addition, the regulatory process is in accordance with the Administrative Procedures Act, in the form of "notice and comment" rulemaking, which provides extensive opportunity for public scrutiny and comment, and requires consideration of and response to those comments.

Regulations contained within FMPs are enforced through actions of the U.S. Coast Guard and state authorities. But enforcement in the Caribbean region is severely underfunded. Because personnel and equipment are limited, enforcement depends largely on voluntary compliance (The Heinz Center 2000).

The Fishery Conservation Amendments of 1990 (P.L. 101-627) conferred management authority for Atlantic highly migratory species (HMS), including tunas, oceanic sharks, marlins, sailfishes, and swordfish, to the Secretary from the Fishery Management Councils. At that time, the Secretary delegated authority to manage these species in the Atlantic Ocean, including the Gulf of Mexico and 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 MSFCMA, and with other applicable laws as summarized in Section 8 of this document. For additional information regarding the HMS management process and authority, please refer to the Fishery Management Plan for Atlantic Tunas, Swordfish, and Sharks (HMS FMP).

2.1.2 State fishery management

The governments of the Commonwealth of Puerto Rico and the Territory of the USVI have the authority to manage their respective state fisheries. As a Commonwealth, Puerto Rico has an autonomous government, but is voluntarily associated with the United States. The USVI is an unincorporated territory with a semi-autonomous government and its own constitution (OTA 1987).

Puerto Rico has jurisdiction over fisheries in waters extending nine nautical miles from shore. Those fisheries are managed by the Fisheries Research Laboratory of Puerto Rico's Department of Natural and Environmental Resources (DNER). Section 19 of Article 6 of the Constitution provides fishery rules and regulations.

The USVI has jurisdiction over fisheries in waters extending three nautical miles from shore, with the exception of about 5,650 acres of submerged lands off St. John, which are owned and managed by the National Park Service (Goenaga and Boulon 1991). The Department of Planning and Natural Resources' (DPNR) is the USVI's fishery management agency. Rules and regulations for USVI fisheries are codified in the Virgin Islands Code, primarily within Title 12.

Each state fishery management agency has a designated seat on the Council. The purpose of state representation at the Council level is to ensure state participation in federal fishery management decision-making and to promote the development of compatible regulations in state and federal waters. But, while the states have adopted compatible regulations for some stocks, some fishery regulations remain inconsistent. For example, both state agencies prohibit the taking of corals from state waters, consistent with federal regulations. But, until recently, neither state agency prohibited, or even regulated, catches of Nassau grouper, which have been prohibited in federal waters since 1990; Puerto Rico implemented new regulations on March 12, 2004, to prohibit the possession or sale of Nassau grouper but the USVI still permits the species' harvest. The lack of compatible regulations in state waters makes federal regulations difficult to enforce and hinders the Council's ability to achieve federal management objectives in some instances.

Both Puerto Rico and the USVI require commercial fishing permits and reporting. Puerto Rico requires a license for commercial fishermen, and have categories for full-time, part-time, novice, and non-resident commercial fishermen, and owners of rental boats, including charter and party/head boats. Additional commercial permits are issued for common lobster, conch, common land crab, incidental catch, and sirajo goby (i.e., ceti) fisheries. Puerto Rico also requires a recreational license for all recreational fishermen 13 years and older (excluding fishermen on charter or head boats). Additional recreational permits are required for common lobster, conch, common land crab, billfish, freshwater shrimp, and sirajo goby. The USVI only has a license requirement for commercial fishermen who are permanent USVI residents, with the exception of a recreational shrimp permit for Altona Lagoon and Great Pond on St. Croix, and for fishing activities in the Great St. James Marine Reserve off St. Thomas.

2.1.3 International issues

The "Wider Caribbean" region, referred to as the Western Central Atlantic (Fishery Statistical Area 31) by the United Nations Food and Agriculture Organization, 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. Caribbean Community (CARICOM) countries are distributed throughout the region, and their exclusive economic zones form a mosaic which includes most of the marine space in the region. While the USVI is not included as a CARICOM entity, Puerto Rico is considered an Observer State. A fisheries agreement between the United States and the United Kingdom of Great Britain and Northern Ireland is in effect for certain waters that are shared by fishermen from the British Virgin Islands and the United States, however, in May 2004 the United Kingdom government gave 90 days notice to dissolve this 1979 bilateral agreement. A similar agreement is being negotiated with the Dominican Republic (CFMC 1985).

Due to the potential for fisheries to be utilized by several different countries, the impact of other countries' fishing and nonfishing activities should be considered. For example, if the resident population of a particular species in one area depends on the input of a spawning population from a different area (i.e., larval input), excessive exploitation of the spawning population could jeopardize numerous "downstream" populations. However, note that recent studies of tropical reef environments have stressed the greater importance of localized recruitment (e.g., Swearer et al. 1999; Cowen et al. 2000).

2.2 History of federal fisheries management

The Council manages 179 fish stocks under four FMPs:

- Fishery Management Plan for the Spiny Lobster Fishery of Puerto Rico and the U.S. Virgin Islands
- Fishery Management Plan for the Queen Conch Resources of Puerto Rico and the U.S. Virgin Islands
- Fishery Management Plan for the Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands
- Fishery Management Plan for the Corals and Reef Associated Invertebrates of Puerto Rico and the U.S. Virgin Islands

The HMS Management Division of NMFS manages Atlantic albacore tuna, bigeye tuna, bluefin tuna, skipjack tuna, oceanic sharks, swordfish, white marlin, blue marlin, sailfish, and longbill spear fish under two FMPs:

- Fishery Management Plan for Atlantic Tunas, Swordfish, and Sharks
- Fishery Management Plan for The Atlantic Billfishes

The history of management measures developed and implemented under each Council FMP and subsequent generic amendments is detailed in Sections 2.2.1 - 2.2.5. The history of management measures developed and implemented under each HMS Management Division FMP is detailed in Sections 2.2.6 - 2.2.7.

2.2.1 Fishery Management Plan for the Spiny Lobster Fishery of Puerto Rico and the U.S. Virgin Islands

The Council's Spiny Lobster FMP (CFMC 1981; 49 FR 50049) was implemented in January 1985, and was supported by an EIS. The FMP defined the Caribbean spiny lobster fishery management unit to include *Panulirus argus* (Caribbean spiny lobster), described objectives for the spiny lobster fishery, and established management measures to achieve those objectives. Primary management measures included:

- The definition of MSY as 830,000 lbs per year;
- The definition of OY as "all the non-[egg-bearing] spiny lobsters in the management area having a carapace length of 3.5 inches or greater that can be harvested on an annual basis," which was estimated to range from 582,000 to 830,000 lbs per year;
- A prohibition on the retention of egg-bearing (berried) lobsters (berried female lobsters may be kept in pots or traps until the eggs are shed), and on all lobsters with a carapace length of less than 3.5 inches;
- A requirement to land lobster whole;
- A requirement to include a self-destruct panel and/or self-destruct door fastenings on traps and pots;
- A requirement to identify and mark traps, pots, buoys, and boats; and
- A prohibition on the use of poisons, drugs, or other chemicals, and on the use of spears, hooks, explosives, or similar devices to take spiny lobsters.

Amendment 1 to the Spiny Lobster FMP (CFMC 1990a; 56 FR 19098), implemented in May 1991, added to the FMP definitions of overfished and overfishing, and outlined framework actions that could be taken should overfishing occur. The amendment defined "overfished" as a biomass level below 20% of the spawning potential ratio (SPR). It defined "overfishing" as a harvest rate that is not consistent with a program implemented to rebuild the stock to the 20% SPR. That amendment was supported by an Environmental Assessment (EA) and a finding of no significant impact (FONSI).

2.2.2 Fishery Management Plan for the Queen Conch Resources of Puerto Rico and the U.S. Virgin Islands

The Council's Queen Conch FMP (CFMC 1996a; 61 FR 65481) was implemented in January 1997, and was supported by an EIS.

The FMP defined the queen conch fishery management unit (Table 2), described objectives for the queen conch fishery, and established management measures to achieve those objectives. Primary management measures included:

- The definition of the MSY of queen conch as 738,000 lbs per year;
- The definition of the OY of queen conch as “all queen conch commercially and recreationally harvested from the EEZ landed consistent with management measure set forth in this FMP under a goal of allowing 20% of the spawning stock biomass to remain intact;”
- A prohibition on the possession of queen conch that measure less than 9 inches total length or that have a shell lip thickness of less than 3/8 inches;
- A requirement that all conch species in the fishery management unit be landed in the shell;
- A prohibition on the sale of undersized queen conch and queen conch shells;
- A recreational bag limit of three queen conch per day, not to exceed 12 per boat;
- A commercial catch limit of 150 queen conch per day;
- An annual spawning season closure that extends from July 1 through September 30; and
- A prohibition on the use of hookah gear to harvest queen conch.

2.2.3 Fishery Management Plan for the Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands

The Council's Reef Fish FMP (CFMC 1985; 50 FR 34850) was implemented in September 1985. The FMP, which was supported by an EIS, defined the reef fish fishery management unit to include shallow water species only, described objectives for the shallow water reef fish fishery, and established management measures to achieve those objectives. Primary management measures included:

- The definition of MSY as equal to 7.7 million lbs;
- The definition of OY as “all of the fishes in the management unit that can be harvested by U.S. fishermen under the provisions of the FMP...This amount is currently estimated at 7.7 million lbs;”
- The specification of criteria for the construction of fish traps, which included a minimum 1 1/4-inch mesh size requirement and a requirement that fish traps contain a self-destruct panel and/or self-destruct door fastening;
- A requirement to identify and mark gear and boats;
- A prohibition on the use of poisons, drugs, and other chemicals and explosives to take reef fish;

- A prohibition on the take of yellowtail snapper that measure less than 8 inches total length for the first fishing year, to be increased one inch per year until the minimum size limit reached 12 inches;
- A prohibition on the take of Nassau grouper that measure less than 12 inches total length for the first fishing year, to be increased one inch per year until the minimum size limit reached 24 inches; and
- A prohibition on the take of Nassau grouper from January 1 to March 31 each year, a period that coincides with the spawning season of this species.

Amendment 1 to the Reef fish FMP (CFMC 1990b; 55 FR 46214) was implemented in December 1990. That amendment was supported by an EA with a FONSI. Primary management measures included:

- An increase in the minimum mesh size for traps to 2 inches;
- A prohibition on the take or possession of Nassau grouper; and
- A prohibition on fishing in an area southwest of St. Thomas, USVI from December 1 through February 28 of each year, a period that coincides with the spawning season for red hind (this seasonal closure would later become a year-round closure with the implementation of the Hind Bank Marine Conservation District through Amendment 1 to the Coral FMP).

Amendment 1also defined overfished and overfishing for shallow water reef fish. “Overfished” was defined as a biomass level below 20% of the spawning stock biomass per recruit (SSBR) that would occur in the absence of fishing. For stocks that are overfished, “overfishing” was defined as a rate of harvest that is not consistent with a program that has been established to rebuild a stock or stock complex to the 20% SSBR level. For stocks that are not overfished, “overfishing” was defined as “a harvesting rate that if continued would lead to a state of the stock or stock complex that would not at least allow a harvest of OY on a continuing basis.”

A regulatory amendment to the Reef Fish FMP (CFMC 1991; 56 FR 48755) was implemented October 1991. The primary management measures contained in this amendment, which was supported by an EA with a FONSI, included:

- A modification to the mesh size increase implemented through Amendment 1 to allow a mesh size of 1.5 inches for hexagonal mesh, and a change in the effective date of the 2-inch minimum mesh size requirement for square mesh to September 13, 1993; and
- A change in the specifications for degradable panels for fish traps related to the required number of panels (required two panels per trap), and their size, location, construction, and method of attachment.

Amendment 2 to the Reef Fish FMP (CFMC 1993; 58 FR 53145), implemented in November 1993, was supported by an SEIS. That amendment redefined the reef fish fishery management unit (Table 3) to include the major species of deep water reef fish and marine aquarium finfish. Primary management measures implemented through this amendment included:

- A prohibition on the use of any gear other than hand-held dip nets and slurp guns to collect marine aquarium fishes;
- A prohibition on the harvest or possession of Goliath grouper (formerly known as jewfish);
- A prohibition on the harvest, possession, and/or sale of certain species used in the aquarium trade, including seahorses and foureye, banded, and longsnout butterflyfish;
- A prohibition on fishing in an area off the west coast of Puerto Rico (Tourmaline Bank) from December 1 through February 28 each year, a period that coincides with the spawning season for red hind;
- A prohibition on fishing in an area off the east coast of St. Croix, USVI (Lang Bank) from December 1 through February 28 each year, a period that coincides with the spawning season for red hind; and
- A prohibition on fishing in an area off the southwest coast of St. Croix, USVI from March 1 through June 30 each year, a period that coincides with the spawning season for mutton snapper.

Existing definitions of MSY and OY were applied 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.

A technical amendment to the Reef Fish FMP (59 FR 11560), implemented in April 1994, clarified the minimum mesh size allowed for fish traps.

Finally, an additional regulatory amendment to the Reef Fish FMP (CFMC 1996b; 61 FR 64485) was implemented in January 1997. That action, supported by an EA, reduced the size of the Tourmaline Bank closure that was originally implemented in 1993, and prohibited fishing in two areas off the west coast of Puerto Rico (Abrir La Sierra Bank (Buoy 6) and Bajo de Cico) from 1 December to 28 February of each year, a period that coincides with the spawning season of red hind.

2.2.4 Fishery Management Plan for the Corals and Reef Associated Invertebrates of Puerto Rico and the U.S. Virgin Islands

The Council's Coral FMP (CFMC 1994; 60 FR 58221) was implemented in December 1995.

The FMP, which was supported by an EIS, defined the coral fishery management unit (Table 4), described objectives for Caribbean coral resources, and established management measures to achieve those objectives. Primary management measures included:

- A prohibition on the take or possession of gorgonians, stony corals, and any species in the fishery management unit if attached or existing upon live rock;
- A prohibition on the sale or possession of any prohibited coral unless fully documented as to point of origin;
- A prohibition on the use of chemicals, plants, or plant-derived toxins, and explosives to take species in the coral fishery management unit; and
- A requirement that dip nets, slurp guns, hands, and other non-habitat destructive gear types be used to harvest allowable corals.

The FMP also required that harvesters of allowable corals obtain a permit from the local or federal government.

Amendment Number 1 to the Coral FMP (CFMC 1999; 64 FR 60132) was implemented in December 1999. Supported by an SEIS, that amendment established a closed area in the U.S. EEZ southwest of St. Thomas, USVI. That area is known as the Hind Bank Marine Conservation District (MCD). Fishing for any species, and anchoring by all fishing vessels, are prohibited in the Hind Bank MCD year round.

2.2.5 Generic FMP amendments

The Council submitted the Generic Essential Fish Habitat Amendment to the Spiny Lobster, Queen Conch, Reef Fish, and Coral Fishery Management Plans (Generic EFH Amendment with an EA) to NMFS in 1998 to comply with the EFH provisions of the MSFCMA. NMFS partially disapproved that amendment on March 29, 1999, finding that it did not evaluate all managed species or all fishing gears with the potential to damage fish habitat (64 FR 14884). The document was subsequently challenged by a coalition of environmental groups and fishing associations on the grounds that it did not comply with the requirements of the MSFCMA and NEPA (*American Oceans Campaign et al. v. Daley et al.*, Civ. No. 99-982 [D.D.C.]). The federal court opinion upheld the plaintiffs' claim that the Generic EFH Amendment with an EA was in violation of NEPA, but determined that the amendment was in accordance with the MSFCMA. The Council recently completed an FEIS for the Generic EFH Amendment to comply with the September 14, 2000 court order. The notice of availability of the draft EFH EIS was published in the *Federal Register* on August 1, 2003 (68 FR 45237). The comment period on that document ended on October 30, 2003. The notice of availability for the Record of Decision on the EFH FEIS was published in the *Federal Register* on May 25, 2004 (69 FR 29693).

The draft Comprehensive Sustainable Fisheries Act Amendment to the Spiny Lobster, Queen Conch, Reef Fish, and Coral Fishery Management Plans (Comprehensive SFA Amendment) prepared by the Council and noticed in the *Federal Register* on January 25, 2002 (67 FR 3679), was intended to amend all four council plans to meet additional requirements added to the MSFCMA in 1996 through a Congressional amendment known as the Sustainable Fisheries Act (SFA). But a federal review determined that the Comprehensive SFA Amendment was inconsistent with the requirements of the SFA and NEPA. The lack of an adequate range of alternatives for defining biological reference points, rebuilding schedules, and bycatch reporting standards were the primary deficiencies cited in the notice of agency action to disapprove the document. That notice was published in the *Federal Register* on May 1, 2002 (67 FR 21598).

2.2.6 Fishery Management Plan for Atlantic Tunas, Swordfish, and Sharks

The HMS FMP was implemented in July 1999 (64 FR 29090).

The FMP, which was supported by and EIS, incorporated all existing management measures for Atlantic tuna and north Atlantic swordfish that had been issued previously under the authority of the Atlantic Tunas Convention Act (ATCA). It also incorporated all existing management measures for north Atlantic swordfish and Atlantic sharks that had been issued previously under the authority of the MSFCMA. Currently, south Atlantic Swordfish and south Atlantic albacore tuna are managed only under ATCA; Atlantic sharks are managed only under the MSFCMA.

The FMP described objectives for Atlantic HMS fisheries. The status determination criteria contained in the FMP allowed managers to determine whether overfishing was occurring or if stocks were overfished. The FMP also contained rebuilding programs for HMS that had been designated as overfished. Other measures selected in the HMS FMP included:

- Adopting quotas and time periods to rebuild Atlantic bluefin tuna, bigeye tuna, north Atlantic swordfish, and large coastal sharks stocks;
- Establishment of a foundation for international development of quotas and time periods to support rebuilding of bigeye tuna and north Atlantic swordfish;
- Limiting access to the commercial shark and swordfish fisheries; requiring both a shark and swordfish limited access permit to gain access to the commercial bigeye, albacore, yellowfin, and skipjack (BAYS) tuna pelagic longline fisheries;
- Implementing observer coverage on all HMS charter/headboat vessels;
- Prohibiting the use of pelagic driftnets in Atlantic tuna fisheries;
- Establishing a “School Reserve” category in the bluefin tuna fishery;
- Changing the fishing year for Atlantic tuna to June 1 through May 31;
- Requiring the use of a vessel monitoring system (VMS) for all HMS pelagic longline vessels and requiring gear marking for all HMS commercial net and longline fisheries;
- Changing the quota monitoring procedures for the Atlantic swordfish fishery including counting dead discards against the quota (subject to ICCAT adoption) and accounting for recreational fishing mortality;
- Requiring all vessel operators who must complete logbooks to complete and submit them within 48 hours of making a set but prior to offloading;
- Developing and implementing a bycatch and bycatch mortality reduction outreach strategy for recreational HMS fishery participants;

- Allowing retention of only those shark species known or expected to be able to withstand specified levels of fishing mortality;
- Changing the system of opening and closing shark fisheries and make seasonal quota adjustments;
- Reducing the recreational retention limit for sharks to one shark per vessel per trip with a minimum size of 4.5 feet and establishing an allowance of one Atlantic sharpnose shark per person per trip (no minimum size on Atlantic sharpnose sharks);
- Requiring that all sharks harvested by recreational anglers have heads, tails, and fins attached;
- Creating a new management unit of deepwater/other sharks and extending the anti-finning prohibition to this management unit;
- Counting dead discards and state landings after federal closures against federal quotas for all sharks;
- Dissolving the Shark Operations Team;
- Changing the quotas for pelagic and small coastal sharks and establishing separate quotas for porbeagle and for blue sharks;
- Requiring all charter/headboat vessels to obtain an annual vessel permit and, if selected, to submit logbooks for all HMS trips;
- Requiring registration of all HMS tournaments; and
- Establishing new permitting and reporting procedures for exempted fishing permits for shark for the purposes of public display.

Due to litigation, not all of the measures selected in the FMP were implemented.

Amendment 1 to the HMS FMP (68 FR 64621) was implemented in December 2003 and was supported by an EIS. Management measures selected in this amendment included:

- Aggregating the large coastal shark complex;
- Using maximum sustainable yield as a basis for setting commercial shark quotas;
- Eliminating the commercial shark minimum size;
- Establishing regional commercial shark quotas and trimester commercial shark fishing seasons;
- Adjusting the recreational shark bag and size limits;
- Establishing gear restrictions to reduce bycatch and bycatch mortality;
- Establishing a shark fishery time/area closure off the coast of North Carolina;
- Removing the deepwater/other sharks from the management unit;
- Establishing a mechanism for changing the species on the prohibited shark species list;
- Updating essential fish habitat identifications for five species of sharks; and
- Changing the administration for issuing permits for display purposes.

2.2.7 Fishery Management Plan for The Atlantic Billfishes

The Fishery Management Plan for the Atlantic Billfishes (53 FR 21501) was conjointly developed by five regional councils (Caribbean, Gulf, South Atlantic, Mid-Atlantic, New England) and implemented in October 1988 (53 FR 37765). The plan built upon the Preliminary Fishery Management Plan (PMP) for Atlantic Billfish and Sharks (43 FR 3818) that was published in January 1978. The PMP was supported by an EIS (42 FR 57716). The 1988 FMP defined the Atlantic billfish management unit to include *Istiophorus platyterus* (sailfish) from the West Atlantic Ocean; *Tetrapturus albidus* (white marlin) and *Makaira nigricans* (blue marlin) from the North Atlantic Ocean, and *Tetrapturus pfluegeri* (longbill spearfish) from the entire Atlantic Ocean, described objectives for the Atlantic billfish fishery, and established management measures to achieve those objectives. Primary management measures included:

- Defining OY in qualitative terms;
- A prohibition on the sale of Atlantic billfish, with an exemption for small-scale handline fishery in Puerto Rico;
- Establishment of minimum sizes for Atlantic billfish;
- A prohibition on possession of Atlantic billfish by commercial longline and drift net vessels; and
- Establishment of data reporting requirements

Amendment 1 to the Atlantic Billfish Fishery Management Plan was implemented in July 1999 (64 FR 29090). This amendment was supported by an EIS. Primary management measures included:

- Adjustment of minimum size regulations for Atlantic billfish;
- A prohibition on the retention of longbill spearfish;
- Maintenance of prohibitions on commercial possession and retention;
- Allowed removal of the hook from Atlantic billfish;
- A requirement for permits and logbook reporting for charterboats targeting billfish, if selected, as part of an HMS charter/headboat system;
- Implementation of billfish tournament notification requirements;
- Implementation of a June 1 to May 31 fishing year;
- Development and implementation of outreach programs; and
- An extension of the management unit for Atlantic marlins

3 Purpose of and need for action

3.1 Purpose of action

The purpose of this integrated FMP amendment is to address the deficiencies of the draft Comprehensive SFA Amendment that was disapproved in May 2002 and to modify, as needed, action taken in the Generic EFH Amendment to comply with the MSFCMA EFH requirements based on the findings of the Generic EFH EIS. Specifically, this amendment is intended to amend Council FMPs to accomplish the following:

1. Redefine as needed, based on FMP objectives, fishery management units and sub-units that reflect those stocks of fish that are best managed individually and those stocks of fish that are interrelated and best managed as a unit or in close coordination (Section 4.1);
2. Define biological reference points and status determination criteria for managed stocks (Section 4.2);
3. Reduce fishing mortality in federal fisheries to levels consistent with biological goals (Section 4.3);
4. Establish schedules and management measures, as needed, to end overfishing and rebuild Nassau grouper (*Epinephelus striatus*), Goliath grouper (*Epinephelus itajara*), queen conch (*Strombus gigas*), and Grouper Unit 4 (Section 4.4);
5. Provide additional protections to yellowfin grouper (*Mycteroperca venenosa*) in federal waters (Section 4.5);
6. Establish a standardized bycatch reporting program for federal fisheries (Section 4.6.1);
7. Minimize bycatch and bycatch mortality to the extent practicable in federal fisheries (Section 4.6.2);
8. Describe and identify EFH (Section 4.7.1);
9. Describe and identify HAPCs (Section 4.7.2);
10. Identify measures to prevent, mitigate or minimize to the extent practicable the adverse effects of fishing on EFH (Section 4.7.3); and
11. Define and describe the fishing communities of the U.S. Caribbean (Section 5.3).

More broadly, the purpose of this amendment and associated analyses is to review the best available scientific information on U.S. Caribbean fisheries and to take action, as needed, to ensure the sustainable stewardship of living marine resources for the benefit of the nation.

3.2 Need for action

The actions considered in this amendment are needed to bring the Council's FMPs for spiny lobster, queen conch, reef fish, and corals and reef associated plants and invertebrates into full compliance with new requirements added to the MSFCMA through the 1996 SFA. These requirements direct the Council to:

1. Assess and specify the present and probable future condition of, and the maximum sustainable yield and optimum yield from, fisheries (MSFCMA §303(a)(3)) and specify objective and measurable criteria for identifying when a fishery is overfished (MSFCMA 303(a)(10));
2. End overfishing, rebuild overfished stocks, and prevent overfishing in fisheries that are identified as approaching an overfished condition (MSFCMA §304(e)(3));
3. Establish a standardized reporting methodology to assess the amount and type of bycatch occurring in the fishery and implement conservation and management

measures that minimize bycatch and bycatch mortality to the extent practicable (MSFCMA §303(a)(11));

4. Describe and identify EFH for managed stocks, 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 (MSFCMA §303(a)(7)); and
5. Consistent with conservation requirements, provide for the sustained participation of fishing communities and minimize adverse economic impacts to such communities to the extent practicable (MSFCMA §301(a)(8)).

As noted in Section 2.2.5, the Draft Comprehensive SFA Amendment and Generic EFH Amendment prepared by the Council and noticed in the *Federal Register* on January 25, 2002 (67 FR 3679), and on March 29, 1999 (64 FR 14884), respectively, were intended to meet these requirements. But a federal review determined that the Comprehensive SFA Amendment was inconsistent with the requirements of the 1996 SFA and NEPA. And a legal challenge from several environmental groups (*American Oceans Campaign et al. v. Daley et al.* Civ. No. 99-982 [D.D.C.]) has resulted in the Council revisiting action taken in the Generic EFH Amendment based on the findings of the newly completed EFH EIS.

The alternatives considered within this amendment to address the deficiencies of the Draft Comprehensive SFA Amendment are based on: (1) Comments received from the public on the Council's draft Comprehensive SFA Amendment, which was made available to the public in January 2002 through a *Federal Register* notice; (2) comments received from the public in response to the notice of intent to develop an SEIS to support this revised integrated FMP amendment, which was published in the *Federal Register* in May 2002 (67 FR 38060); (3) the advice of the SFA Working Group, composed of representatives from NMFS, the Council, state agencies, and interested stakeholder groups, and appointed by the Council to recommend options to achieve MSFCMA requirements in U.S. Caribbean fisheries; and (4) the discussion and recommendations of the Council at its 110th through 117th meetings in 2002 through 2005. Section 11.3 (Appendix B) provides more detailed information on scoping, on the members and activities of the SFA Working Group, and on the development of alternatives to address the deficiencies of the Comprehensive SFA Amendment..

The alternatives considered within this amendment to address the MSFCMA EFH mandates were developed and evaluated in the EFH EIS. As mentioned in Section 2.2.5, a revised EFH EIS was required due to a legal challenge from several environmental groups (*American Oceans Campaign et al. v. Daley et al.*, Civ. No. 99-982 [D.D.C.]). The settlement stipulation specified a schedule for completion of the EIS and implementation of subsequent amendments (if necessary) 17 months following a Record of Decision.

4 Description and comparison of alternatives

The alternatives described in this section to achieve the purpose and satisfy the needs stated in Section 3.0 are grouped under the following seven categories of actions:

1. Defining fishery management units and sub-units;
2. Specifying biological reference points and stock status determination criteria;
3. Regulating fishing mortality;
4. Rebuilding overfished fisheries;
5. Conserving and protecting yellowfin grouper;
6. Achieving the MSFCMA bycatch mandates; and
7. Achieving the MSFCMA EFH mandates.

Alternatives identified by the Council as preferred are noted. The summary impact analysis following each suite of alternatives is based on the more detailed analysis provided in Section 6.0, with the exception of those alternatives in Section 4.7. The alternatives in Section 4.7 are the preferred alternatives identified in the EFH EIS. The summary comparison of those alternatives is based on the detailed analyses in the EFH EIS (CFMC 2004), which are summarized herein.

4.1 Fishery management units and sub-units

4.1.1 Defining fishery management units and sub-units

The fishery management unit (FMU) defined by each Council FMP identifies the specific fishery (or that portion thereof) that is relevant to the FMP's management objectives. 50 CFR §600.320(d)(1) provides that FMUs may be organized around biological, geographic, economic, technical, social, or ecological goals. Decisions about the composition of FMUs are an integral part of the plan development process, as FMUs define the specific species that are to be the target of conservation and management. A species may be included in an FMU for data collection purposes only if the Council determines there is not enough information available to specify biological reference points and/or management measures for that species (50 CFR §600.320(d)(2)).

In some cases, the FMUs of the Council FMPs have been subdivided into sub-units to facilitate conservation and management efforts. For example, the Coral FMP currently recognizes aquarium trade species as a sub-unit of the Caribbean coral reef resource FMU, and the Reef Fish FMP recognizes reef fish and aquarium trade species as sub-units of the Caribbean reef fish FMU. As currently defined, FMUs do not distinguish between managed versus data collection-only species.

4.1.1.1 Alternative 1. No action. Retain the current FMUs designated by the original FMPs.

The FMUs defined by the Council under its four FMPs are described in 50 CFR Part 622.2 and associated appendices under the definitions “Caribbean spiny lobster,” “Caribbean conch resource,” “Caribbean reef fish,” and “Caribbean coral reef resource.” These FMUs are defined, respectively by the Spiny Lobster FMP, the Queen Conch FMP, the Reef Fish FMP, and the Coral FMP.

The FMUs include virtually all finfish and invertebrates that are known or are believed to be captured by commercial, recreational, and/or subsistence fishermen for food and/or for the aquarium and ornamental trades, as well as plants and invertebrates that support the development and survival of those species. The Caribbean spiny lobster FMU is composed of a single species, *Panulirus argus*, that is taken in the directed fishery. The Caribbean conch resource FMU (Table 2), Caribbean coral reef resource FMU (Table 4), and Caribbean reef fish FMU (Table 3) are composed of multiple species that may be taken directly or incidentally in multi-species fisheries.

4.1.1.2 Alternative 2 (Preferred). Redefine the FMUs and FMU sub-units in Council FMPs as detailed in Table 8. Delete from the Caribbean Conch Resource FMU the Caribbean helmet, *Cassis tuberosa*; Caribbean vase, *Vasum muricatum*; flame helmet, *Cassis flammea*; and whelk (West Indian top shell), *Cittarium pica*, leaving nine other species detailed in Table 2.

The FMUs and FMU sub-units defined under this alternative are detailed in Table 8. This alternative deletes four species from the Caribbean conch resource FMU to narrow the definition of that FMU to include only those species that occur in federal waters.

Additionally, this alternative divides species in the Caribbean reef fish FMU into 21 sub-units to facilitate conservation and management efforts. These sub-units, described in Table 8, were delineated based on comments, guidance, and input from staff of the Council, the NMFS’ Southeast Regional Office (SERO) and Southeast Fisheries Science Center (SEFSC), the USVI and Puerto Rico fisheries management agencies, and several environmental non-governmental organizations represented on the Council's SFA Working Group, with minor adjustments made at the 110th Council meeting to reflect current knowledge of how species are primarily marketed in the region (e.g., for food fish versus for the aquarium trade). As illustrated in Table 8, most of these sub-units are based by taxonomic groupings. In the case of the grouper and snapper sub-units, these are based on additional rationale; in particular, they are grouped largely because they frequent the same habitat and depth range, and, therefore, they are harvested together.

Lastly, this alternative divides the Caribbean coral reef resource FMU into either an aquarium trade category or a prohibited corals and marine plants category, both of which are detailed in

Table 8. Additional alternatives for this coral reef resource category are discussed in Section 4.1.2.

Generally, these groupings are based on taxonomic families or subfamilies, modified by biological, geographic, economic, technical, social, and/or ecological criteria as provided for by 50 CFR 600.320(d). In particular, effort was directed at grouping species caught in similar habitats with similar gear and whose ecologies and current status were thought to be similar. Although much remains to be learned about these various components of Caribbean fisheries, managers have a better understanding of both species and fishery operations than they did when FMUs were first defined. For example, although fishery-dependent catch and permit (aquarium trade) data recorded by state governments still do not adequately distinguish catches in federal and state waters, they have provided additional information on how species are captured and marketed. Scientific data from published and gray literature have provided insight into the biology and ecology of many managed species. Both types of information were considered in defining species that would best be managed together as sub-units.

Landings and export data were used to make initial determinations about which species were utilized in the aquarium trade and which were important food fish. This information was then ground-truthed through state agency staff, industry representatives, and others who serve on the Council. Data on the depth distribution of species and the composition of landings by gear type were used to define complexes of food fish that are captured in similar depth ranges and with similar fishing gear.

4.1.1.3 Alternative 3. With the exception of the aquarium trade species sub-units in the Coral and Reef Fish FMPs, redefine the FMUs and FMU sub-units in Council FMPs to be consistent with those specified in Table 8. Redefine the aquarium trade species sub-units to comprise those aquarium trade species recognized and managed by state governments, and that are not otherwise included in other sub-units of any FMU.

With the exception of the Caribbean reef fish and Caribbean coral reef resource FMUs, the FMUs defined under this alternative would be consistent with the status quo. This alternative modifies the composition of the aquarium trade species sub-units within the Caribbean reef fish and Caribbean coral reef resource FMUs. The modification would not result in any additions to the current list of aquarium trade species. It would, however, result in a number of deletions. Species that would be deleted from the aquarium trade species sub-units of the Caribbean reef fish and coral reef resource FMUs if this alternative were to be adopted are identified in Tables 3 and 4, respectively.

4.1.1.4 Alternative 4. Delete the aquarium trade species from the Caribbean reef fish resource FMU.

This alternative modifies the definition of the Caribbean reef fish FMU to exclude all species that are currently recognized as aquarium trade species in the Reef Fish FMP (Table 3).

4.1.1.5 Comparison of the environmental effects of alternative definitions of FMUs and FMU sub-units

None of the alternatives to amend the FMUs and sub-units would have a direct environmental effect. However, selection of a particular alternative to amend the FMUs could have subsequent indirect impacts. Alternative 1introduces administrative impacts and would not permit effective resource management, as, in some cases, numerous biologically diverse species are grouped together (e.g., reef fish FMU). This would complicate the designation of stock status parameters and could inhibit the identification and management of overfished species. Alternative 2 offers a more ideal situation, in that it groups species in sub-units to facilitate management, as well as deleting several species that do not even occur in federal waters. Alternative 3 refines the management of aquarium trade species (Tables 3 and 4), the harvest of which largely occurs in state waters. However, Puerto Rico has yet to implement pending legislation that would better manage and conserve these species. Alternative 4 could allow unregulated exploitation of the aquarium trade species in federal waters, to a greater extent than Alternative 3. Since there are few restrictions currently in place, compounded with the fact that the majority of harvest of aquarium trade species occurs in state waters, it would appear that the environmental impact of both Alternatives 3 and 4 would not be significant. Due to the need for more refined management and to mitigate administrative impacts when establishing stock status parameters, the Council selected Alternative 2 as the preferred alternative.

4.1.2 Additional options for aquarium trade species

As noted in Section 4.1.1, FMUs defined by Council FMPs do not currently distinguish between managed versus monitored species. 50 CFR §600.320(d)(2) provides the authority to make such a distinction when there is not enough information available to specify biological reference points and/or management measures for one or more stocks. The Council is considering the following alternatives for moving aquarium trade species in the Caribbean reef fish and Caribbean coral reef FMUs to a data collection category as a means to better reflect the Council's role in meeting the management needs of those species.

4.1.2.1 Alternative 1. No action. Continue to manage aquarium trade species.

This alternative maintains the status quo. Aquarium trade species would be retained in the Caribbean reef fish and coral reef resource FMUs as managed species, and would be subject to existing and future regulation in federal waters of the U.S. Caribbean.

4.1.2.2 Alternative 2 (Preferred). Move aquarium trade species to a data collection only category.

This alternative mandates the collection of data on aquarium trade species under the Reef Fish and Coral FMPs, but removes these species from the purview of federal regulations. Consequently, 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 of a marine aquarium fish to hand-held dip nets or hand-held slurp guns (50 CFR 622.41§(b) will be eliminated if this action is approved and implemented. The regulation prohibiting the harvest and possession of butterflyfish and seahorses from federal waters of the U.S. Caribbean (50 CFR §622.32(b)(1)(ii)) also will be eliminated if this alternative were implemented. Tables 1 and 2 of Appendix A to 50 CFR 622 will also be revised to identify species in the aquarium trade sub-units of the Caribbean reef fish and coral reef resource FMUs. The definition of these FMU sub-units is consistent with those adopted by the Council in Section 4.1.1 of this amendment. Furthermore, inclusion in a data collection only category results in no specification of MSY, OY, or other stock status determination criteria for these species due to no real need for federal conservation and management of these species. Therefore, they are excluded from discussion in those sections.

4.1.2.3 Comparison of the environmental effects of alternative options for managing aquarium trade species

Neither alternative would likely have a significant environmental impact. Given the reality that the harvest of these species occur largely in state waters, and the levels of harvest are not significant for many of the species in the coral reef and reef fish FMUs, Alternative 1 would present significant administrative issues since it would require the Council to develop stock status parameters for numerous biologically diverse species that are in the aquarium trade. While Alternative 2 would remove several regulations pertaining to aquarium trade species, it is not expected to result in any environmental impact. For example, the current aquarium trade definition encompasses all reef fish under 5.5 inches. The harvest and possession of butterflyfish still occurs in state waters (i.e., Puerto Rico), and since the majority of this species' habitat occurs in state waters, the effect of the current prohibition is most likely negligible. The presence or absence of a gear restriction for aquarium trade species does not really have any impact, since aquarium trade dealers are already limited to this gear in order to be able to harvest the species without placing unwanted stress on the specimen. Further, the use of explosives and poisons is already prohibited under other MSFCMA regulations. Due to the administrative impacts that could result in attempting to specify stock status criteria for the aquarium trade species, and because there is no current need for conservation of these species in federal waters, the Council selected Alternative 2 as the preferred alternative.

4.1.3 Additional options for Caribbean conch resources

The Council also is considering the following alternatives to move select species in the Caribbean conch resource FMU to a data collection category.

4.1.3.1 Alternative 1. No action. Continue to manage Caribbean conch resources.

This alternative maintains the status quo. All conch species comprising the Caribbean conch resource FMU would be subject to regulation in federal waters of the U.S. Caribbean.

4.1.3.2 Alternative 2 (Preferred). Move all species in the Caribbean conch resource FMU, with the exception of queen conch, to a data collection only category.

This alternative mandates the collection of data on all species comprising the Caribbean conch resource FMU under the Queen Conch FMP, but would remove all species, with the exception of queen conch, from the purview of other federal regulations on allowable fishing practices. 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. Furthermore, inclusion in a data collection only category would result in no specification of MSY, OY, or other stock status determination criteria for these species due to no real need for federal conservation and management of these species. Therefore, they are excluded from discussion in those sections.

4.1.3.3 Comparison of the environmental effects of alternative options for managing Caribbean conch resources

The environmental effects for these two alternatives are similar to those discussed in Section 4.1.2.3. The harvest of other conch species does not appear to occur in significant levels, and largely occurs in state waters due to the species' habitat requirements. The retention of the other conch species in Alternative 2 would allow for continued monitoring of landings and other biological information, and would facilitate management should the need ever arise. Due to the administrative impacts that could result in attempting to specify stock status criteria for the aquarium trade species, and because there is no current need for conservation of these species in federal waters, the Council selected Alternative 2 as the preferred alternative.

4.2 Biological reference points and stock status determination criteria

The MSFCMA requires that each FMP define management reference points in the form of maximum sustainable yield (MSY) and optimum yield (OY). MSY is the greatest amount or yield of a species that can be sustainably harvested under prevailing environmental conditions, while OY is the amount or yield of a species that "will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems..." (16 U.S.C. §1802(28)).

While economic and social factors are to be considered in defining the OY for each fishery, OY may not be defined as an amount of fish that would compromise a stock's ability to produce MSY (i.e., OY can not be established in excess on MSY). OY must prevent overfishing, which occurs when fishing mortality exceeds the level at which fishing produces MSY. In the case of an overfished fishery, OY must provide for rebuilding to a stock biomass level that is consistent with that which would produce MSY (50 CFR §600.10).

The MSFCMA requires that each FMP specify objective and measurable criteria for identifying when a species is overfished. Status determination criteria are defined by 50 CFR §600.310 to include a minimum stock size threshold (MSST) and a maximum fishing mortality threshold (MFMT). The MSST represents the biomass level below which a species or species complex would not be capable of producing MSY. A species or species complex with a biomass below the MSST is considered to be overfished. The MFMT represents the maximum level of fishing mortality that a species or species complex can withstand, while still producing MSY on a continuing basis. A fishery experiencing a fishing mortality rate that exceeds the MFMT is considered to be undergoing overfishing.

Together, these four parameters are intended to provide fishery managers with the means to measure the status and performance of each species or sub-unit in the FMU. By evaluating annual catches, species biomass (B_{CURR}) and fishing mortality rates (F_{CURR}) in relation to MSY, OY, MSST, and MFMT, fishery managers can determine the status of a fishery at any given time and assess whether management measures are achieving established goals. The primary goal of federal fishery management, as described in National Standard 1 of the MSFCMA, is to conserve and manage U.S. fisheries to "...prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry" (16 U.S.C. §1851(a)(1)).

The National Standard Guidelines direct regional fishery management councils to use reasonable proxies when data are insufficient to provide direct estimates of biological reference points and status determination criteria for species under their jurisdiction. NMFS provides guidance at 50 CFR §600.310 and in Restrepo *et al.* (1998) on various proxies that could be used for MSY, MSST, and MFMT in data-poor situations.

This section describes the alternative proxies considered by the Council for the species comprising each FMU. These proxies are applied to the FMU sub-units defined by the Council's preferred FMU Alternative, described in Section 4.1.1.2. These sub-units are generally composed of species with taxonomic, biological, and ecological similarities, and/or species that co-occur and, thus, are often captured together. Also described in this section are target control rules, or pre-agreed upon strategies for managing catches to achieve a long-term average catch approximating OY. A target control rule should not specify a level of catch that would exceed that associated with fishing at the MFMT because the MFMT is defined by an MSY control rule, and OY cannot exceed MSY according to the MSFCMA.

4.2.1 Maximum sustainable yield (MSY)

4.2.1.1 Alternative 1. No action. Retain current definitions of MSY (if any).

This alternative retainsthe status quo definitions of MSY included in Council FMPs. The definitions of MSY that are currently in place for species under the Council's jurisdiction are detailed in Table 9 under the column "MSY Alt 1."

4.2.1.2 Alternative 2. In the absence of MSY estimates, the proxy for MSY will be 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 is 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[1].

This alternative is preferred for the Caribbean queen conch, spiny lobster, and all reef fish, excluding those species retained for data collection purposes.

This alternative defines MSY proxies based on average catch (C), and on the relationships between current biomass and biomass at MSY (B_{CURR}/B_{MSY}) and between the current fishing mortality rate and the fishing mortality rate at MSY (F_{CURR}/F_{MSY}).

50 CFR §600.310(c)(3) provides that, when data are insufficient to estimate MSY directly, the long-term average catch can be used to approximate MSY. Generally, it is best to average catches over as long a time series as possible to capture the fishery's response to changing conditions. But equally important is the need to base the average on years for which reliable catch data exist. This alternative would calculate average catch using commercial landings data for the years 1997-2001 for Puerto Rico, average catch of most species complexes and sub-units from 1994-2002 for the USVI, and recreational landings data for the years 2000-2001 because these represent the longest time periods in which data were considered to be relatively reliable, as determined by the SFA Working Group.

Commercial catch data would be derived from trip ticket reports collected by the state governments. Similar data do not exist for recreational fisheries. However, the Marine Recreational Fisheries Statistics Survey (MRFSS) provides data on recreational catches landed in Puerto Rico in 2000 and 2001. MRFSS obtains standardized and comparable estimates of participation, effort, and catch by recreational anglers in the marine waters of the United States *via* a telephone survey of households in coastal counties and an intercept survey of anglers at fishing access sites. Since MRFSS coverage does not currently extend to the USVI, recreational landings of finfish in the USVI would be derived by assuming the same commercial-recreational relationship as that for Puerto Rico (recreational catches averaging 43.77% of commercial catch levels). Thus, the total annual commercial catch of finfish landed in the USVI from 1994-2002 would be multiplied by 0.4377 to derive the total annual recreational catch during that same period of time.

The MRFSS data from Puerto Rico would also be used to estimate the composition of catches taken in USVI recreational finfisheries. In this case, it would be assumed that species were captured in the USVI at the same relative frequencies as they were in Puerto Rico, as measured in the MRFSS data. Recreational catches of queen conch and spiny lobster landed in the USVI

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[1] The exact process utilizing commercial and recreational landings in determining MSY is explained in Section 6.2.1.2.

would be assumed to be 50% of the USVI commercial landings based on information from Valle-Esquivel (pers. comm.). Recreational catches for all these species are defined to include both subsistence catches and more conventional recreational catches.

If we were to equate MSY to the average catch over a select period of time, we would be making the assumption that both the biomass and the fishing mortality rate associated with that catch period were consistent with that able to produce MSY. It is safe to make this assumption if the time period over which catches are averaged is sufficient to observe any trends in the fishery, if the catch data are reliable, and if the catch history does not show a pattern of decline (Restrepo *et al.* 1998).

Since the data for the U.S. Caribbean do not support these assumptions, we incorporated two additional terms into the definition of MSY: (1) the biomass, or B, ratio (current biomass (B_{CURR}) divided by biomass at MSY (B_{MSY})), and (2) the fishing mortality rate, or F, ratio (current fishing mortality rate (F_{CURR}) divided by the fishing mortality rate associated with MSY (F_{MSY})). This enables us to consider alternative definitions of MSY that reflect situations when biomass and/or fishing mortality rates are above or below the level needed to produce MSY during the defined catch period. Alternative B and F ratios evaluated by the Council are described in Section 4.2.2.

The MSY values that would result from this alternative if the Council's preferred definition of B and F ratios were to be adopted are detailed in Table 9 under the column "MSY Alt 2."

4.2.1.3 Alternative 3. Set MSY = 0.

This alternative is preferred for all species in the Coral Reef FMP, excluding those species retained for data collection purposes.

This alternative sets MSY equal to zero, indicating that no amount of harvest could be sustained over the long term.

4.2.1.4 Alternative 4. Set MSY equal to long-term average catch based on commercial landings data from 1983-2001 and on recreational data provided by MRFSS for the years 2000-2001.

This alternative defines MSY proxies based on average catch (C), calculated strictly using commercial landings data for the years 1983-2001 and recreational landings data for the years 2000-2001. Commercial catch data would be derived from trip ticket reports collected by the state governments. Recreational data would be derived from the MRFSS program. The MRFSS provides data on recreational catches landed in Puerto Rico in 2000-2001. Recreational landings of finfish in the USVI would be derived by assuming the same commercial-recreational relationship as that for Puerto Rico (recreational catches averaging 43.77% of commercial catch levels). Thus, the total annual commercial catch of finfish landed in the USVI from 1983-2001 would be multiplied by 0.4377 to derive the total annual recreational during that same period of time.

The MRFSS data from Puerto Rico would also be used to estimate the composition of catches taken in USVI recreational fisheries (excluding queen conch and spiny lobster). In this case, it would be assumed that species were captured in the USVI at the same relative frequencies as they were in Puerto Rico, as measured in the MRFSS data. Recreational catches of queen conch and spiny lobster landed in the USVI would be assumed to be 50% of the USVI commercial landings based on information from Valle-Esquivel (pers. comm.). Recreational catches for all these species are defined to include both subsistence catches and more conventional recreational catches.

Table 9, under the column "MSY Alt 4," presents the specific MSY values associated with this alternative for each stock or complex.

4.2.1.5 Comparison of the environmental effects of alternative MSY definitions

Defining MSY does not directly affect the biological, ecological, social, or economic environment in a positive or negative way because this parameter simply provides fishery managers with a biological reference point to use in assessing fishery status and performance. However, defining this target reference point will indirectly affect the biological, ecological, social, and economic environment by influencing the development of fishery management measures, which directly affect Caribbean fisheries.

In general, the lower the choice of MSY the greater these constraints will be, leading to more restrictions in the short-run and greater assurance of sustained benefits in the long-run. However, these constraints would only apply to federal waters, which make up a small portion of the fishable area in the U.S. Caribbean. Due to a lack of a long time series for recreational landings (i.e., more than two years), there is no difference in the use of that data between Alternatives 2 and 4. Likewise, there is a paucity of data regarding commercial exploitation on the aquarium trade complex on a long time scale, thus there is no difference in the data utilized on those sub-units between Alternatives 2 and 4. Alternative 3 leads to a prohibition on further fishing for the resource, resulting in significant benefits for the resource, and severe economic impacts to fishermen and related industries (with the exception of corals, the harvest of which is already prohibited). Overall, the use of a longer time series (Alternative 4) results in lower estimates of MSY (Table 9), although some would be higher under Alternative 4 than Alternative 2. The use of B and F ratios in Alternative 2 provides greater flexibility to produce MSY estimates that were tailored to the specific perceived conditions facing each stock or FMU sub-unit. Therefore, the Council selected Alternative 2 as the preferred alternative for those FMUs and FMPs indicated. Likewise, the Council selected Alternative 3 as the preferred alternative for coral species to reflect the importance of those species as EFH.

4.2.2 Fishing mortality (F) and biomass (B) ratios

In order to determine many of the stock status parameters for Caribbean FMU sub-units, most of which lack formal stock assessments and discrete data on current fishing mortality rates and biomass levels, assumptions on the perceived fishing mortality rates and relative biomass of managed species are required. These assumptions are not determinations on the official stock status (i.e., overfished, overfishing). For a species to be classified as overfished as outlined in the MSFCMA, a species biomass would have to fall below its MSST; this is addressed in Section 4.2.4.

The F ratio, or fishing mortality rate ratio, is the current fishing mortality rate (F_{CURR}) divided by the fishing mortality rate associated with MSY (F_{MSY}). Likewise, the B ratio, or biomass ratio, is the current biomass (B_{CURR}) divided by biomass at MSY (B_{MSY}). In general and all things being equal, a healthy stock would have a low fishing mortality rate (F) and a high relative biomass (B). Conversely, an unhealthy stock would have a high fishing mortality rate and a low biomass.

The fishing mortality and biomass status of each sub-unit (i.e., those that lack a stock assessment) was determined by the SFA Working Group, a Council-advisory group, which consisted of staff from the Council, the NMFS SERO and SEFSC, the USVI and Puerto Rico fisheries management agencies, and several environmental non-governmental organizations. As stated in Restrepo *et al.* (1998), "in cases of severe data limitations, qualitative approaches may be necessary, including expert opinion and consensus-building methods." More information on the composition of the SFA Working Group can be found in Section 11.3. Refinements to these determinations were made at the 117th Council meeting, which were largely based on public comment and anecdotal information.

The fishing mortality and biomass status determinations made by the SFA Working Group were based on best professional judgement, informed by available scientific and anecdotal information on a variety of factors (e.g., Appeldoorn *et al.* 1992), including the anecdotal observations of fishermen as reported by fishery managers, life history information, and the status of individual species as evaluated in other regions. For example, some snapper and grouper species are generally long-lived, are heavily targeted by fishermen, and are documented to spawn in aggregations that make them vulnerable to local overexploitation. This would likely translate to a high potential fishing mortality rate and a low potential relative biomass, possibly indicating an unhealthy condition. Therefore, applying a precautionary approach, these species (i.e., FMU sub-units) would be candidates for being determined to be potentially "at risk" of overfishing or potentially being overfished by the SFA Working Group, as illustrated in Table 8. Again, it should be pointed out that this is not an official determination that an overfished or overfishing condition exists per the MSFCMA, but simply an assumption on the current fishing mortality and relative biomass rates. A high fishing mortality rate and low relative biomass could lead to an overfished or overfishing condition if other factors (e.g., low natural mortality rate indicating a species is slow to recover to B_{MSY}) existed; this is discussed further in Sections 4.2.4 and 4.2.5. Conversely, if a species was felt to have a low fishing mortality rate and a high relative biomass, the SFA Working Group would determine that it was healthy and not to be "at risk" of overfishing or potentially being overfished. If there was insufficient information to make an informed judgement on the fishing mortality rate and/or relative biomass of a species or sub-unit, the default status of "unknown" was selected. Formal stock assessments do exist for queen conch, Nassau grouper, and goliath grouper, and they concluded that each of these species was overfished. Therefore, this official "overfished" status was utilized throughout the SFA Amendment for these three species. The discussion resulting in these determinations took place at the October 23-24, 2002 meeting of the SFA Working Group in Carolina, Puerto Rico. Notice of the meeting location, date, and agenda was provided in the *Federal Register* (67 FR 63622).

The resulting determinations made for each FMU sub-unit, following the methodology outlined above, are presented in Table 8 under the "Status" column. The exact values for the fishing mortality rate and relative biomass (i.e., F and B ratios) are offered in the following alternatives and are detailed in Table 9.

4.2.2.1 Alternative 1. No action. Do not define F and B ratios for managed stocks.

This alternative is preferred for all species in the Coral Reef FMP, excluding those species retained for data collection purposes.

This alternative leaves B and F ratios undefined.

4.2.2.2 Alternative 2. For each FMU sub-unit for which B_{CURR}/B_{MSY} and F_{CURR}/F_{MSY} have not been estimated through a stock assessment or other scientific exercise (i.e., stock status unknown), the following estimates will be used for the B_{CURR}/B_{MSY} and F_{CURR}/F_{MSY} proxies: 1) For species that are not believed to be "at risk" based on the best available information, the F_{CURR}/F_{MSY} proxy is estimated as 0.75 and the B_{CURR}/B_{MSY} proxy is estimated as 1.25; 2) For species for which no positive or negative determination can be made on the status of their condition, the default proxies for F_{CURR}/F_{MSY} and B_{CURR}/B_{MSY} are estimated as 1.00; and 3) For species that are believed to be "at risk" based on the best available information, the F_{CURR}/F_{MSY} proxy is estimated as 1.50 and the B_{CURR}/B_{MSY} proxy is estimated as 0.75.

This alternative is preferred for Caribbean queen conch, spiny lobster, and all reef fish, excluding those species retained for data collection purposes.

Because proper (formal) stock assessments are not available for most FMU sub-units, this alternative requires making an informed qualitative judgement about their condition. Restrepo *et al.* (1998) notes that "in cases of severe data limitations, qualitative approaches [to determining stock status and fishery status] may be necessary, including [the use of] expert opinion and consensus-building methods." This alternative defines B_{CURR}/B_{MSY} and F_{CURR}/F_{MSY} based on anecdotal information, observations (e.g., large decreases in catch rates, decrease in average individual size, more fishing effort needed to maintain historical landings), and other informed judgements on the condition of specific stocks and complexes. The F and B ratios that would result from this alternative are based on the perceived condition of stocks as determined by the SFA Workgroup, and are detailed in Table 9. Information on the SFA Workgroup is provided in Sections 11.3.

4.2.2.3 Alternative 3. For each FMU sub-unit for which B_{CURR}/B_{MSY} and F_{CURR}/F_{MSY} have not been estimated through a stock assessment or other scientific exercise (i.e., stock status unknown), the following estimates will be used for the B_{CURR}/B_{MSY} and F_{CURR}/F_{MSY} proxies: 1) For species that are not believed to be "at risk" based on the best available information, the F_{CURR}/F_{MSY} proxy is estimated as 0.75 and the B_{CURR}/B_{MSY} proxy is estimated as 1.25; 2) For species for which no positive or negative determination can be made on the status of their condition, the default proxies for F_{CURR}/F_{MSY} and B_{CURR}/B_{MSY} are estimated as 1.00; and 3) For species that are believed to be "at risk" based on the best available information, the F_{CURR}/F_{MSY} proxy is estimated as 1.50 and the B_{CURR}/B_{MSY} proxy is estimated as 0.50.

This alternative is similar to the Preferred Alternative 2, and also requires making an informed qualitative judgement about the condition of each species or FMU sub-unit. However, it would set the B ratio at 0.50, rather than 0.75, for species that are believed to be "at risk" based on the best available information. The F and B ratios that would result from this alternative, given the perceived condition of species as determined by the SFA workgroup, are presented in Table 9.

4.2.2.4 Alternative 4. For each FMU sub-unit for which B_{CURR}/B_{MSY} and F_{CURR}/F_{MSY} have not been estimated through a stock assessment or other scientific exercise (i.e., stock status unknown), the following estimates will be used for the F_{CURR}/F_{MSY} and B_{CURR}/B_{MSY} proxies: 1) The default proxies for F_{CURR}/F_{MSY} and B_{CURR}/B_{MSY} are estimated as 1.00; 2) For species that are believed to be "at risk" based on the best available information, the F_{CURR}/F_{MSY} proxy is estimated as 1.33 and the B_{CURR}/B_{MSY} proxy = c, whereas c is equal to the natural mortality rate (M) or 0.50, whichever is smaller; and 3) For species that overfished, the F_{CURR}/F_{MSY} proxy is estimated as 2.0 and the B_{CURR}/B_{MSY} proxy = 0.67c, whereas c is equal to the natural mortality rate (M) or 0.50, whichever is smaller.

This alternative is similar to Alternatives 2 and 3 in that it requires making an informed qualitative judgement about the condition of each FMU sub-unit. It differs from Alternatives 2 and 3 in that it would define more conservative (e.g., less optimistic) B and F ratios for those stocks that are determined to be healthy. Additionally, this alternative attempts to adjust the B and F ratios of stocks believed to be "at risk" using a formula that takes into account the natural mortality rate (M) of the individual species. Table 8 lists the M defined for each species utilizing the best available scientific information (i.e., most recent published literature or FishBase). In the case of a sub-unit with multiple M values (e.g., Snapper Unit 3), 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 F and B ratios that would result from this alternative, given the perceived condition of stocks as determined by the SFA workgroup, are presented in Table 9.

4.2.2.5 Comparison of the environmental effects of alternative F and B ratio definitions

Defining F and B ratios does not directly affect the biological, ecological, social, or economic environment in a positive or negative way because these parameters simply provide fishery managers with numerical values that could be used to calculate MSY. However, using F and B ratios in MSY calculations would result in indirect environmental biological, ecological, social, and economic effects because the numerical value used would influence the definition of MSY, and thus the development of fishery management measures, which directly affect Caribbean fisheries.

Because the status of the majority of the reef fish management sub-units is “unknown” (i.e., as determined by the SFA Working Group), there is no difference between Alternatives 2-4 in regard to those species. For species considered to be “at risk” (i.e., as determined by the SFA Working Group), Alternative 3 assumes the species’ biomass is more depressed when compared to Alternative 2, and would generate a higher MSY value. In some instances, Alternative 4 would increase MSY past both Alternatives 2 and 3 (e.g., triggerfish unit), while in some situations it would be less than Alternative 3, but more than Alternative 4 (e.g., Snapper Unit 1). For species considered to be “at risk,” Alternative 4 would support the lowest fishing mortality rate relative to Alternatives 2 and 3 when stock biomass was below B_{MSY}. This could result in more severe short-term social and economic effects in the short term if management measures are required to end overfishing and/or rebuild overfished stocks, as necessary.

A decision to define (Alternatives 2-4) or not define (Alternative 1) F and B ratios could directly affect the administrative environment if such ratios are needed to calculate MSY and/or other management reference points. Alternative 1 (no action) would result in significant administrative impacts as the MSY Preferred Alternative 2 requires an F and B ratio to generate the MSY proxy.

Therefore, the Council selected Alternative 2 as the preferred alternative for those FMUs and FMPs indicated as it represented an effective approach to address species considered to be “at risk” without potentially introducing more significant socioeconomic impacts (as compared to Alternative 4).

Because the status quo for coral species is the complete prohibition of harvest (i.e., F equal to zero), and because it would be problematic to estimate a biomass ratio due to the biological diversity of the numerous managed coral species and due to the influence of other environmental factors that influence coral biomass, the Council selected Alternative 1 as the preferred alternative for species in the Coral FMP, excluding those species retained for data collection purposes.

4.2.3 Optimum yield (OY)

As noted in Section 4.2, OY is defined as the amount of fish that "will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems; is prescribed as such on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor; and in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield in such fishery" (16 U.S.C. §1802(28)).

4.2.3.1 Alternative 1. No action. Retain current definitions of OY (if any).

The definitions of OY that are currently in place for species under the Council's jurisdiction are presented in Table 9.

4.2.3.2 Alternative 2. Set OY = 0.75(MSY).

This alternative sets OY equal to a proportion (75%) of the MSY defined for a stock or stock complex. The specific OY values that would result from this alternative if the preferred MSY alternatives were to be adopted are presented in Table 9.

4.2.3.3 Alternative 3. Set OY = 0.

This alternative is preferred for all species in the Caribbean coral reef resource FMU, excluding those species retained for data collection purposes.

This alternative sets OY equal to zero, indicating that maximum benefit to the Nation would be derived from prohibiting the take of the affected species or species complex.

4.2.3.4 Alternative 4. Set OY equal to the average yield associated with fishing on a continuing basis at F_{OY}; where $F_{OY} = 0.75F_{MSY}$.

This alternative is preferred for Caribbean queen conch, spiny lobster, and all reef fish, excluding those species retained for data collection purposes.

This alternative is derived from the technical guidance provided by Restrepo *et al.* (1998), which recommends that the target fishing mortality rate (F_{OY}) be set equal to the average yield available on a continuing basis from fishing at 75% of F_{MSY}. Studies using Mace's deterministic model (Mace 1994) indicate that, when a stock is at equilibrium, fishing at this level would result in yields equal to or greater than about 94% of MSY. The approximate OY values that would result from this alternative if the preferred MSY alternatives were to be adopted are presented in Table 9.

4.2.3.5 Comparison of the environmental effects of alternative OY definitions

Defining OY would not directly affect the biological, ecological, social, or economic environment in a positive or negative way because this parameter simply provides fishery managers with a defined target to use in assessing fishery status and performance. However, defining this target reference point will indirectly affect the biological, ecological, social, and economic environment by influencing the development of fishery management measures, which directly affect Caribbean fisheries.

A decision to redefine (Alternatives 2-4) or not define (Alternative 1) OY directly affects the administrative environment. The selection of Alternative 3 results in an OY of zero, thereby requiring additional alternatives that restrict catch to zero for those species. In regard to corals, as this is a preferred alternative for those species, this OY alternative is consistent with currently existing harvest prohibitions and results in no net environmental effect. Alternatives 2 and 4 differ in the amount of conservatism in the OY values; Alternative 4 sets a goal fairly close to MSY levels, whereas OY alternative 2 sets a more conservative goal for the fishery.

Therefore, the Council selected Alternative 4 as the preferred alternative for those FMUs and FMPs indicated as it would be more conservative and risk aversive than fishing at MSY, it would be consistent with the Technical Guidelines, and would not result in potentially overly-restrictive catch limits as a result of the subsequent selection of a control rule alternative. Furthermore, the Council selected Alternative 3 as the preferred alternative for coral species to reflect the importance of those species as EFH.

4.2.4 Minimum stock size threshold (MSST)

As noted in Section 4.2, the MSST defines the level below which a species would be considered overfished (i.e., B_{CURR} < MSST = overfished). 50 CFR §600.310(d)(2)(ii) specifies that "to the extent possible, the stock size threshold should equal whichever of the following is greater: One-half the MSY stock size, or the minimum stock size at which rebuilding to the MSY level would be expected to occur within ten years if the stock or stock complex were exploited at the maximum fishing mortality threshold...."

4.2.4.1 Alternative 1. No action. Do not define MSST for managed species.

This alternative is preferred for all species in the Coral Reef FMP, excluding those species retained for data collection purposes.

This alternative leaves MSST undefined.

NMFS is considering revisions to the National Standard 1 Guidelines, in particular to §600.310(d)(2). The proposed revisions would provide additional flexibility regarding the requirement for MSSTs for data-poor stocks. Depending on the publication of a Final Rule for such revisions, the Council may choose, in the future to re-evaluate its designations of MSST for some or all Caribbean stocks if it is determined that the available data are inadequate or insufficient for providing a defensible and meaningful estimate.

4.2.4.2 Alternative 2. Set MSST = $B_{MSY}(1\text{-}c)$; where c = the natural mortality rate (M) or 0.50, whichever is smaller.

This alternative is preferred for the Caribbean queen conch, spiny lobster, and all coral and reef fish species, excluding those species retained for data collection purposes.

This alternative is based on the default proxy recommended by Restrepo *et al.* (1998). It defines MSST as a function of the equilibrium biomass expected when fishing constantly at F_{MSY}. The M of a species provides an indication about its productivity, such that a species with a low M generally is not as productive, or capable of recovering to B_{MSY} as quickly, as a species with a high M. By setting c equal to 0.5 or M, whichever is smaller, this formula ties MSST to the productivity of a stock, such that MSST would be set further below B_{MSY} for those stocks that are highly productive and capable of recovering to B_{MSY} more quickly. But it would prevent MSST from being set at less than one-half the MSY level even for highly productive stocks to reduce the risk that stock biomass could decrease without warning to a level from which it would be difficult to rebuild the stock to B_{MSY} within ten years.

Table 8 lists the M defined for each species utilizing the best available scientific information (i.e., most recent published literature or FishBase). In the case of a sub-unit with multiple M values (e.g., Snapper Unit 3), the lowest documented M value would be used in this formula to reduce the risk 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 in Table 10 .

4.2.4.3 Alternative 3. Set MSST = $B_{MSY}(0.50)$.

This alternative sets MSST equal to one-half B_{MSY} regardless of the productivity of the stock. The specific MSST values defined by this alternative in accordance with the preferred MSY alternatives are presented for each stock or complex in Table 10 .

4.2.4.4 Alternative 4. Set MSST = B_{MSY}.

If all other factors remained constant, this alternative builds additional conservatism into the definition of MSST by eliminating the buffer between MSST and B_{MSY} so that a stock would never be permitted to fall below B_{MSY} without triggering an “overfished” determination and the need to develop a rebuilding plan within one year of that determination. The specific MSST values defined by this alternative in accordance with the preferred MSY alternatives are presented for each stock or complex in Table 10 .

4.2.4.5 Comparison of the environmental effects of alternative MSST definitions

Defining MSST does not directly affect the biological, ecological, social, or economic environment in a positive or negative way because this parameter simply provides fishery managers with a defined threshold to use in assessing the status of the stocks. However, defining this biomass threshold will indirectly affect the biological, ecological, social, and economic environment because the MSST adopted by the Council will prescribe the amount of each sub-unit that should be left in the water and this, in turn, will assist fishery managers in determining the amount of each sub-unit that can be harvested. In general, Alternative 2 establishes an MSST that is more conservative than Alternative 3, but less conservative than Alternative 4, which sets MSST equal to B_{MSY} and represents the most conservative alternative available to the Council. A decision to define (Alternatives 2-4) or not define (Alternative 1) MSST directlys affect the administrative environment. Alternative 2 appears to provide a compromise relative to the other alternatives in that it sets realistic goals for stock rebuilding without frequently (or unnecessarily) burdening the administrative environment. The MSST definition provided by Alternative 3 could make it more difficult to rebuild a stock from MSST to B_{MSY} within ten years while fishing at MFMT, particularly if the stock was not very productive. MSST Alternative 4 provides the greatest assurance of all the MSST alternatives that an overfished stock could be rebuilt to B_{MSY} within ten years, however, it could excessively burden the administrative environment by frequently triggering overfishing definitions and unnecessarily restricting fishing effort.

Therefore, the Council selected Alternative 2 as the preferred alternative for those FMUs and FMPs indicated as it represents a moderate management approach

4.2.5 Maximum fishing mortality threshold (MFMT), and limit and target control rules.

As discussed in Section 4.2, the MFMT represents the maximum fishing mortality rate that an FMU sub-unit can withstand while still producing MSY on a continuing basis. A fishery operating at a level that exceeds the MFMT is considered to be experiencing overfishing. The MFMT is defined by a MSY (limit) control rule – a predefined catch strategy that is designed to achieve MSY on a continuing basis. The catch levels calculated from the control rule represent the allowable biological catch (ABC) that is consistent with achieving MSY. The MFMT calculated from the control rule represents the fishing mortality rate (proportion of the existing population caught by the fishery) that would achieve the ABC.

The OY (target) control rule is used to calculate the level of catch that would be consistent with achieving OY on a continuing basis. Because OY cannot exceed MSY, the target control rule should not allow a level of catch exceeding the MFMT.

Alternative target control rules were combined with alternative MFMT/MSY control rules in this section to avoid the potential to select incompatible MFMT/MSY control rules and target control rules.

4.2.5.1 Alternative 1. No action. Do not define MFMT or control rules for FMU sub-units.

This alternative leaves MFMT and the control rules undefined. The MFMT and ABCs associated with this alternative are specified for each sub-unit in Tables 10 and 11 .

4.2.5.2 Alternative 2.

A) Specify an MSY control rule to define MFMT and ABC as follows: 1) If $B_{CURR}/B_{MSY} < B_{MIN}$, then ABC = 0; 2) If B_{CURR}/B_{MSY} 1, then ABC = MSY; and 3) If B_{CURR}/B_{MSY} is between B_{MIN} and 1, then ABC = $(MSY/(1-B_{MIN}))((B_{CURR}/B_{MSY})-B_{MIN})$; where $B_{MIN} = 0.25$; and

B) Specify an OY control rule to define target catch levels such that : 1) If $B_{CURR}/B_{MSY} < B_{MIN}$, then target catch levels = 0; 2) If B_{CURR}/B_{MSY} 1, then target catch levels = OY; and 3) If B_{CURR}/B_{MSY} is between B_{MIN} and 1, then target catch levels = $(OY/(1-B_{MIN}))(B_{CURR}/B_{MSY}-B_{MIN})$; where $B_{MIN} = 0.25$.

This alternative is based on a constant catch strategy. When stock biomass is at or above B_{MSY}, the limit control rule described by this alternative defines the level of catch that would trigger an overfishing determination to be equal to MSY. This rule does not allow the limit catch level to increase in response to an increase in stock biomass above the MSY level. If stock biomass decreased below B_{MSY}, this rule decreases the limit catch level proportionately. In other words, the further stock biomass declined below B_{MSY}, the further the limit catch level would be reduced from MSY. If stock biomass decreased below the identified threshold level defined as B_{MIN}, this rule requires that catches be reduced to zero. The B_{MIN} component of the rule is defined to equal 25% of the unfished abundance level, or about 10-15% of B_{MSY}.

The target control rule described by this alternative prescribes a harvest level equal to OY when stock biomass was at B_{MSY} or higher, and would reduce target catch levels proportionately when stock biomass decreased below B_{MSY}. This rule prohibits fishing entirely if stock biomass declined below 10-15% of B_{MSY}.

Table 10 details the specific ABC and target catch levels defined by this alternative, based on the stock status determinations of the SFA workgroup. Table 11 describes the reductions in catch that would be prescribed by each rule relative to average catches from 1997-2001. The MSY and OY rules described by this alternative are illustrated in Figure 2.

4.2.5.3 Alternative 3.

A) Specify an MSY control rule to define MFMT and ABC as 0; and

B) Specify an OY control rule to define target catch levels as 0.

This alternative is preferred for all species in the Coral FMP, excluding those species retained for data collection purposes.

This alternative defines overfishing as any fishing mortality rate above zero, and therefore, prohibits any catch.

4.2.5.4 Alternative 4.

A) Specify an MSY control rule to define MFMT and ABC as follows: 1) If $B_{CURR}/B_{MSY} < B_{MIN}$, then ABC = 0; 2) If B_{CURR}/B_{MSY} 1, then ABC = $F_{MSY}(B)$; and 3) If B_{CURR}/B_{MSY} is between B_{MIN} and 1, then ABC = $(F_{MSY}(B)/(1-B_{MIN}))((B_{CURR}/B_{MSY})-B_{MIN})$; where $B_{MIN} = 0.25$. If F_{MSY} cannot be estimated directly, use M as a proxy; and

B) Specify an OY control rule to define target catch levels such that: 1) If B_{CURR}/B_{MSY} is less than B_{MIN}, then target catch levels = 0; 2) If B_{CURR}/B_{MSY} is equal to or greater than 1, then target catch levels = $F_{OY}(B)$; and 3) If B_{CURR}/B_{MSY} is between B_{MIN} and 1, then target catch levels = $(F_{OY}(B)/(1-B_{MIN}))((B_{CURR}/B_{MSY})-B_{MIN})$; where $B_{MIN} = 0.25$. If F_{OY} cannot be estimated directly, use 0.5(M) as a proxy.

This alternative is similar to Alternative 2, but is based on a constant fishing mortality rate (F) strategy rather than on a constant catch strategy. When stock biomass is at or above B_{MSY}, the limit control rule described by this alternative defines the level of catch that would trigger an overfishing determination to be equal to the yield associated with fishing at F_{MSY}. As a result, this alternative allows the limit catch level to increase in response to an increase in stock biomass above the MSY level. If stock biomass decreased below B_{MSY}, this rule decreases the limit catch level proportionately. In other words, the further stock biomass declined below B_{MSY}, the further the limit catch level is reduced from MSY. If stock biomass decreased below the identified threshold level defined as B_{MIN}, this rule requires that catches be reduced to zero. The B_{MIN} component of the rule is defined to equal 25% of the unfished abundance level, or about 10-15% of B_{MSY}.

The target control rule described by this alternative prescribes a harvest level equal to the yield associated with fishing at F_{OY} when stock biomass was at B_{MSY} or higher, and reduces target catch levels proportionately when stock biomass decreased below B_{MSY}. This rule prohibits fishing entirely if stock biomass declined below 10-15% of B_{MSY}.

Table 10 details the specific ABC and target catch levels defined by this alternative, based on the stock status determinations of the SFA workgroup. Table 11 describes the reductions in catch that would be prescribed by each rule relative to average catches from 1997-2001. The MSY and OY rules described by this alternative are illustrated in Figure 3.

4.2.5.5 Alternative 5.

A) Specify an MSY control rule to define MFMT and ABC as follows: 1) If B_{CURR}/B_{MSY} < $MSST/B_{MSY}$, ABC = 0.33MSY; 2) If B_{CURR}/B_{MSY} 1, ABC = MSY; and 3) If B_{CURR}/B_{MSY} is between $MSST/B_{MSY}$ and 1, ABC = 0.67MSY; and

B) Specify an OY control rule to define target catch levels such that: 1) If B_{CURR}/B_{MSY} < $MSST/B_{MSY}$, target catch levels = 0.25MSY; 2) If B_{CURR}/B_{MSY} 1, target catch levels = 0.75MSY; and 3) If B_{CURR}/B_{MSY} is between $MSST/B_{MSY}$ and 1, target catch levels = 0.5MSY.

Alternative 5 defines the limit and target catch levels as MSY and 75% of MSY, respectively, when stock biomass is at or above B_{MSY}. If stock biomass decreased below B_{MSY}, but remained above the overfished threshold (i.e., MSST), this rule decreases the limit and target catch levels to 67% of MSY and to 50% of MSY, respectively. The limit and target catch levels are further reduced to 33% of MSY and to 25% of MSY, respectively, if stock biomass decreased below the overfished threshold.

Table 10 details the specific ABC and target catch levels defined by this alternative, based on the stock status determinations of the SFA workgroup. Table 11 describes the reductions in catch that would be prescribed by each rule relative to average catches from 1997-2001. The MSY and OY rules described by this alternative are illustrated in Figure 4.

4.2.5.6 Alternative 6.

A) Specify an MSY control rule to define ABC = F_{MSY}(B). When the data needed to determine F_{MSY} are not available, use natural mortality (M) as a proxy for F_{MSY}; and

B) Specify an OY control rule to define target catch limits such that they equal F_{OY}(B).

This alternative is preferred for Caribbean queen conch, spiny lobster, and reef fish, excluding those species retained for data collection purposes.

Alternative 6 defines the limit and target catch levels as the yield associated with fishing at F_{MSY} and F_{OY}, respectively, regardless of where stock biomass is in relation to B_{MSY} and to MSST.

This rule uses M and 0.75(F_{MSY}) as proxies for F_{MSY} and F_{OY}, respectively. The constant F strategy employed by this rule allows catches to increase in response to an increase in stock biomass, but requires that catches be reduced as stock biomass decreases. Table 10 details the specific ABC and target catch levels defined by this alternative, based on the stock status determinations of the SFA workgroup. Table 11 describes the reductions in catch that would be prescribed by each rule relative to average catches from 1997-2001. The MSY and OY rules described by this alternative are illustrated in Figure 5.

4.2.5.7 Alternative 7.

A) Specify an MSY control rule to define ABC = F_{MSY}(B). When the data needed to determine F_{MSY} are not available, use a proxy for F_{MSY} calculated as a fraction of the natural mortality rate (M) as follows: 1) Use 1.00(M) as a proxy for F_{MSY} for species that are not believed to be "at risk" based on the best available information; 2) Use 0.75(M) as a proxy for F_{MSY} for species for which no positive or negative determination can be made on the status of their condition; and 3) Use 0.50(M) as a proxy for F_{MSY} for species that are believed to be "at risk" based on the best available information; and

B) Specify an OY control rule to define target catch levels equal to F_{MSY}(B)(OY/MSY). When the data needed to determine F_{MSY} are not available, use a proxy for F_{MSY} calculated as a fraction of the natural mortality rate (M) as follows: 1) Use 0.75(M) as a proxy for F_{MSY} for species that are not believed to be "at risk" based on the best available information; 2) Use 0.50(M) as a proxy for F_{MSY} for species for which no positive or negative determination can be made on the status of their condition; and 3) Use 0.25(M) as a proxy for F_{MSY} for species that are believed to be "at risk" based on the best available information.

This alternative differs from Alternative 6 only in how it would define F_{MSY} and F_{OY} when those parameters have not been estimated. It states that for sub-units determined not to be "at risk," the MFMT should be set equal to M, such that ABC = M(B), and the target catch level should be set equal to 3/4 of M multiplied by B. For sub-units for which no determination can be made, MFMT should be set equal to 2/3 of M, resulting in an ABC = 2/3M(B), while the target catch level should be set equal to 1/2 of M multiplied by B. Finally for sub-units believed to be "at risk," MFMT should be set equal to 1/2 of M, resulting in an ABC = 1/2M(B), while the target catch level should be set equal to 1/4 of M multiplied by B. Table 10 details the specific ABC and target catch levels defined by this alternative, based on the stock status determinations of the SFA workgroup. Table 11 describes the reductions in catch that would be prescribed by each rule relative to average catches from 1997-2001. The MSY and OY rules described by this alternative are illustrated in Figure 6.

4.2.5.8 Comparison of the environmental effects of alternative MFMT definitions, and limit and target control rules

The selection of Alternative 3 would require a complete prohibition on catch for those species affected by the alternative (i.e., corals). This alternative is consistent with currently existing harvest prohibitions, and result in no net environmental effect for those species.

For species whose perceived status has been determined to be unknown by the SFA Working Group, the ABC for FMU sub-units under Alternatives 2 and 4-6 would be identical due to the default selection of 1.00 for the F and B ratios. For species to be considered “at risk,” Alternative 6 is the most liberal alternative, and allows fishing to continue at a higher level than all the other alternatives. Alternative 7 is the most conservative alternative (aside from Alternative 3), and results in a lower allowable catch than the other proposed options.

The potential adverse short-term socioeconomic effects associated with these alternatives range from no direct impact (Alternative 1), moderate (Alternatives 2 and 6), to significant adverse impacts (Alternatives 4 - 7). Impacts from Alternative 7 would exceed those associated with any other control rule alternative, with the exception of Alternative 3, which would require that the fishery be closed. A more conservative allowable catch could result in long-term biological benefits to species that are experiencing overfishing or are overfished. Conversely, a more liberal allowable catch could negatively impact the status of those species undergoing overfishing or that are overfished, and, in turn, lead to negative socioeconomic impacts over the long term.

Therefore, the Council selected Alternative 6 as the preferred alternative for those FMUs and FMPs indicated in order to minimize socioeconomic impacts, while still establishing effective control rule scenarios. Furthermore, the Council selected Alternative 1 as the preferred alternative for aquarium trade species retained for data collection in the Reef Fish and Coral Reef FMPs, as there is no need for conservation measures or active management of those species. Likewise, the Council selected Alternative 3 as the preferred alternative for coral species to reflect the importance of those species as EFH.

4.3 Regulating Fishing Mortality

The preferred definitions of FMUs and sub-units, biological reference points, stock status determination criteria, and control rules outlined in Sections 4.1 and 4.2 requires catches of select species to be reduced as follows to end overfishing: Grouper Unit 4 catches should be reduced by 30%, parrotfish catches by 27%, and Snapper Unit 1 catches by 23% (Limit Control Rule; Table 11). The preferred control rule alternatives require that catches of all species be reduced by 7%, on average, to achieve long-term average catches approximating OY (Target Control Rule; Table 11).

This section evaluates alternative management measures the Council could adopt to achieve various levels of reductions in fishing mortality rates in federal waters of the U.S. Caribbean.

The following alternatives are designed to achieve immediate reductions in fishing mortality, and could ultimately be replaced by, or supplemented with, other management strategies adopted in the future.

It is important to note that the reductions required by the alternative control rules evaluated in Section 4.2.5 (Table 11) reflect the amount that catches should be decreased in the entire U.S. Caribbean (e.g., in state and federal fisheries combined) to end overfishing and achieve OY as defined in this amendment. Consequently, assuming that catches are distributed evenly among fishable habitat, even a 100% reduction in fishing mortality rates in federal waters would not likely be sufficient to achieve the required reductions because only about 14% of the fishable habitat in the U.S. Caribbean occurs in federal waters (Figure 1). Recognizing this challenge, the Council is also considering administrative alternatives to promote the development of regulations in state waters compatible with the goals and objectives set forth in this amendment.

4.3.1 Alternative 1. No action. Do not adopt additional management measures.

This alternative maintains the status quo management regime, indicating that current regulations are adequate to achieve the goals and objectives adopted in Sections 4.1 and 4.2. Existing management measures regulating catches in the spiny lobster, queen conch, reef fish, and coral reef fisheries are summarized below, and are described more fully in Section 2.2.

The spiny lobster fishery is regulated by a minimum size limit, a prohibition on the retention of egg-bearing (berried) lobsters, a requirement to land lobsters whole, prohibitions on the type of gear that can be used to harvest lobster, and restrictions on the construction and use of traps.

The queen conch fishery is regulated by a minimum size limit, a requirement to land conch with meat and shell intact, a recreational bag limit, a commercial catch limit, an annual spawning season closure, and gear prohibitions.

The reef fish fishery is regulated by requirements for the construction and use of fish traps, prohibitions on some other types of gear to harvest reef fish, minimum size limits on the harvest of yellowtail snapper, a prohibition on the take or possession of Nassau and Goliath grouper, seahorses, and foureye, banded, and longsnout butterflyfishes, and seasonal and annual spawning closures.

The coral reef fishery is regulated by a prohibition on the take or possession of gorgonians, stony corals, and any species in the coral reef resource FMU if attached or existing upon live rock, a prohibition on the sale or possession of any prohibited coral unless fully documented as to point of origin, prohibitions on the type of gear that can be used to harvest coral reef resources, and a permit requirement. A year-round closure established through the Coral FMP prohibits all fishing in an area southwest of St. Thomas, USVI.

4.3.2 Alternative 2. Establish seasonal closures.

The following seasonal closure alternatives attempt to achieve any needed reductions in catches by prohibiting fishing for select species in federal waters during select months. Alternatives 2a - 2e are designed to eliminate directed fishing mortality on select snappers and groupers during their peak spawning periods, which are described in Section 5.2 and Table 12. Alternatives 2f - 2g are designed to eliminated directed fishing mortality on all Council-managed species for consecutively longer periods of time.

Generally, each alternative brackets the peak spawning periods of affected species (Table 12). Section 6.3.1.2 documents the actual impacts on affected FMU sub-unit landings based on Puerto Rico monthly landings, 1995 - 2002. The USVI does not differentiate species for snapper and grouper in their landings data, therefore, it is assumed for the purposes of the following alternatives that monthly landing patterns are similar between Puerto Rico and the USVI.

Alternative 2a (Preferred). Close the U.S. EEZ to the possession of all species except misty grouper in Grouper Unit 4 (i.e., red, black, tiger, yellowfin, and yellowedge grouper) from February 1 through April 30.

All species in Grouper Unit 4 spawn during at least a portion of the February - April closure proposed by this alternative. This captures the peak spawning period of the tiger and yellowfin groupers. Assuming that fishing pressure does not increase in the months preceding or following the closure, this alternative could reduce Grouper Unit 4 catches (excluding misty grouper) in federal waters by about 24% each year (Table 6.3.1.2a in Section 6.3.1.2.3). As misty grouper are caught in deep water (e.g., 300-400 m) beyond what is considered fishable habitat for the purposes of this document, the Council opted to exclude them from this seasonal closure. This alternative is intended to protect these species when they are spawning and likely vulnerable to fishing pressure.

Alternative 2b (Preferred). Close the U.S. EEZ off the west coast of Puerto Rico to the possession of red hind from December 1 through February 28.

For the purposes of this alternative, the delineation of the west coast of Puerto Rico would be those waters in the U.S. Caribbean EEZ west of 67° 10' W longitude. Peak spawning for red hind occurs from December - April (Table 12). Assuming that fishing pressure does not increase in the months preceding or following the closure, this alternative could reduce catches of red hind in federal waters by about 33% each year (Table 6.3.1.2b in Section 6.3.1.2.3). This alternative protects red hind spawning aggregations, which are vulnerable to fishing pressure.

Alternative 2c (Preferred). Close the U.S. EEZ to the possession of all species in Snapper Unit 1 (including the black, blackfin, vermilion, and silk snapper) from October 1 through December 31.

Species in Snapper Unit 1 have been documented to spawn throughout the year, and peak spawning appears to occur biannually for several species, such as silk, black, and blackfin snapper (Table 12). Assuming that fishing pressure does not increase in the months preceding or following the closure, this alternative could reduce Snapper Unit 1 catches in federal waters by about 23% each year (Table 6.3.1.2c in Section 6.3.1.2.3). This alternative protects these species when they are spawning and likely vulnerable to fishing pressure.

Alternative 2d. Close the U.S. EEZ to the possession of yellowtail snapper from April 1 through June 30.

The peak spawning period for yellowtail snapper occurs from March - July (Table 12). Assuming that fishing pressure does not increase in the months preceding or following the closure, this alternative would reduce catches of yellowtail snapper in federal waters by about 26% each year (Table 6.3.1.2d in Section 6.3.1.2.3). This alternative is intended to protect yellowtail snapper when they are spawning and likely vulnerable to fishing pressure.

Alternative 2e (Preferred). Close the U.S. EEZ to the possession of mutton snapper and lane snapper from April 1 through June 30.

The peak spawning period for mutton and lane snapper occurs from March - May and April - July, respectively (Table 12). Assuming that fishing pressure does not increase in the months preceding or following the closure, this alternative would reduce catches of mutton snapper and lane snapper in federal waters by about 29% each year (Table 6.3.1.2e in Section 6.3.1.2.3). This alternative protects these species when they are spawning and likely vulnerable to fishing pressure.

Alternative 2f. Close the U.S. EEZ to the possession of all Council-managed species each year from January 1 to March 31 (3-month closure).

Assuming that fishing pressure does not increase in the months preceding or following the closure, this alternative would reduce catches of all Council-managed species in federal waters by approximately 25%, and 28% specifically for reef fish species (Table 6.3.1.2f in Section 6.3.1.2.3). This period captures the peak spawning periods for many snapper, grouper, grunt, and parrotfish species, and for some goatfishes, porgies, squirrelfishes, jacks, surgeonfish, triggerfish, boxfish, and wrasses (Table 12).

Alternative 2g. Close the U.S. EEZ to the possession of all Council-managed species each year from January 1 to March 31 and from July 1 to September 30 (6-month closure).

Assuming that fishing pressure does not increase in the months preceding or following the closure, this alternative would reduce catches of all Council-managed species in federal waters by approximately 50%, and 52% specifically for reef fish species (Table 6.3.1.2f in Section 6.3.1.2.3). This seasonal closure alternative encompasses a portion of the spawning season of most reef fish species and covers many species during their peak spawning period (Table 12), and to spread out the socioeconomic effects of the closure over two different time periods.

Alternative 2h. Close the U.S. EEZ to the possession of all Council-managed species all year round (total closure).

This alternative would reduce catches of all Council-managed species in federal waters by 100% each year. This alternative is designed to achieve the maximum amount of reduction in fishing effort possible in federal waters.

4.3.3 Alternative 3. Establish area closures.

Alternatives 3a and 3b attempt to achieve any needed reductions in fishing mortality by prohibiting fishing for all Council-managed species year round in select areas of the U.S. EEZ. Alternatives 3c and 3d could supplement an area closure (i.e., Alternative 3a or 3b) by prohibiting the catch of species other than Council-managed species, or allowing the transit of fishing vessels with properly stowed gear and harvested catch.

Each alternative is described with respect to its potential to reduce total annual fishing mortality on affected species in federal waters, based on the assumption that catches in the U.S. EEZ are distributed equally over fishable habitat in the U.S. EEZ (e.g., a closed area that encompasses 10% of fishable habitat in the U.S. EEZ is presumed to result in a 10% reduction in fishing mortality for all Council-managed stocks). In reality, this assumption is not likely to hold true, as the distribution of fishing effort is affected by multiple factors, including the availability of fish and the redistribution of effort. However, state trip ticket programs do not collect data that would allow us to more precisely describe the spatial distribution of fishing effort. Assuming total landings are divided equally throughout the U.S. EEZ allows us to evaluate the potential impact of the alternatives relative to one another and to the goals and objectives established by the preferred limit (ABC) and target control rules. Calculations defining the total percentage of fishable habitat (i.e., waters 100 fathoms or shallower) in the U.S. EEZ that would be protected by each area closure alternative recognize recent protections to fishable habitat provided by the designation of the Hind Bank MCD, located south of St. Thomas, USVI. Implemented in December 1999, the Hind Bank MCD encompasses an area about 13 nm^2, which includes approximately 11 nm^2 (approximately 3%) of fishable habitat in EEZ waters off the USVI.

Alternative 3a. Establish one or more closed areas off Puerto Rico and the USVI as identified in Figures 7 - 9, and 12 - 15.

Coordinates for the proposed areas are as follows:

Alternative 3a(1). West of Puerto Rico (PRW)
A) 18° 13.50N, 67° 27.00W
B) 18° 13.50N, 67° 23.00W

C) 18° 00.00N, 67° 23.00W
D) 18° 00.00N, 67° 27.00W

PRW (Figure 7) creates a closed area of approximately 51.46 nm^2, with 31.98 nm^2 consisting of waters 100 fathoms or shallower. This area encompasses an existing red hind seasonal spawning closure off the west coast of Puerto Rico. It covers about 28% of the fishable habitat in EEZ waters off Puerto Rico, and about 9% of the total fishable habitat in the EEZ.

Alternative 3a(2). Northeast of Puerto Rico (PRN)
A) 18° 33.50N, 65° 17.00W
B) 18° 33.50N, 65° 10.00W
C) 18° 30.00N, 65° 10.00W
D) 18° 30.00N, 65° 17.00W

PRN (Figures 8 and 9) creates a closed area of approximately 23.14 nm^2, with 20.36 nm^2 consisting of waters 100 fathoms or shallower. This area covers about 12% of the fishable habitat in EEZ waters off Puerto Rico, and about 3% of the total fishable habitat in the EEZ.

Alternative 3a(3). East of St. Croix on Lang Bank (CRX)
A) 17° 50.50N, 64° 28.50W
B) 17° 50.50N, 64° 25.00W
C) 17° 47.00N, 64° 25.00W
D) 17° 47.00N, 64° 28.50W

CRX (Figure 8) creates a closed area of approximately 11.63 nm^2, with 7.47 nm^2 consisting of waters 100 fathoms or shallower. This area encompasses most of the area protected by the existing red hind seasonal spawning closure on Lang Bank. It covers about 3% of the fishable habitat in EEZ waters off the USVI, and about 2% of the total fishable habitat in the EEZ.

Alternative 3a(4). South of St. John (JOS)
A) 18° 14.50N, 64° 47.50W
B) 18° 14.50N, 64° 44.00W
C) 18° 10.00N, 64° 44.00W
D) 18° 10.00N, 64° 47.50W

JOS (Figure 8) creates a closed area of approximately 14.94 nm^2, with 13.01 nm^2 consisting of waters 100 fathoms or shallower. This area covers about 5% of the fishable habitat in EEZ waters off the USVI, and about 4% of the total fishable habitat in the EEZ.

Alternative 3a(5). North of St. Thomas (THN)
A) 18° 14.50N, 64° 47.50W
B) 18° 14.50N, 64° 44.00W
C) 18° 10.00N, 64° 44.00W
D) 18° 10.00N, 64° 47.50W

THN (Figures 8 and 9) would create a closed area of approximately 66.12 nm^2, with 55.21 nm^2 consisting of waters 100 fathoms or shallower. This area covers about 23% of the fishable habitat in EEZ waters off the USVI, and about 16% of the total fishable habitat in the EEZ.

Alternative 3a(6). West of Puerto Rico (PRW2)
A) 18° 12.12N, 67° 27.30W
B) 18° 12.12N, 67° 25.00W
C) 18° 05.00N, 67° 25.00W
D) 18° 05.00N, 67° 27.30W

PRW2 (Figure 13) creates a closed area of approximately 15.64 nm^2, with 10.60 nm^2 consisting of waters 100 fathoms or shallower. This area encompasses a portion of the area protected by the existing red hind seasonal spawning closure off the west coast of Puerto Rico. It covers about 9% of the fishable habitat in EEZ waters off Puerto Rico, and about 3% of the total fishable habitat in the EEZ.

Preferred Alternative 3a(7). West of Puerto Rico (PRW3)
A) 18° 12.00N, 67° 27.00W
B) 18° 12.00N, 67° 23.00W
C) 18° 03.50N, 67° 23.00W
D) 18° 03.50N, 67° 27.00W

PRW3 (Figures 12 and 13) creates a closed area of approximately 32.93 nm^2, with 28.40 nm^2 consisting of waters 100 fathoms or shallower. This area encompasses an existing red hind seasonal spawning closure off the west coast of Puerto Rico. It covers about 24% of the fishable habitat in EEZ waters off Puerto Rico, and about 8% of the total fishable habitat in the EEZ.

Preferred Alternative 3a(8). North of St. Thomas and Culebra (CARIB)
A) 18° 33.50N, 65° 17.00W
B) 18° 33.50N, 65° 05.00W
C) 18° 30.00N, 65° 05.00W
D) 18° 30.00N, 65° 17.50W

CARIB (Figures 14 and 15) creates a closed area of approximately 39.74 nm^2, of which 38.24 nm^2 consists of waters 100 fathoms or shallower (~13.73 nm^2 in Puerto Rico and ~24.44 nm^2 in USVI). This area covers about 12% and 10% of the fishable habitat in EEZ waters off Puerto Rico and the USVI, respectively, and about 11% of the total fishable habitat in the EEZ.

Alternative 3b. Close the EEZ off Puerto Rico, and establish a closed area off the USVI (e.g., Alternative 3a(5), THN, or Alternative 3a(8), CARIB), as indicated in Figure 8 or 15.

This alternative closes all federal waters off Puerto Rico, and a smaller portion of federal waters off the USVI. The delineation for the closed area off Puerto Rico would be seaward of the state boundary, and westward of 65° 15'W longitude. This 116 nm^2 area encompasses 100% of the fishable habitat in federal waters off Puerto Rico, and comprises about 33% of the fishable habitat in the U.S. EEZ. Additionally, this alternative closes one of two areas off the USVI: THN or CARIB. Both of these closed areas are described in Section 4.3.1.3.1. The total percentage of fishable habitat in the EEZ covered by this alternative is 49% if the THN alternative is selected, and 44% if the CARIB alternative is selected.

This alternative offers a different distribution of the social and economic burden associated with the implementation of closed areas. Puerto Rico has jurisdiction over marine waters extending nine nautical miles from shore while the USVI has jurisdiction over marine waters extending just three nautical miles from shore. Consequently, a greater percentage of the fishable habitat off the USVI is located in the U.S. EEZ, relative to the percentage of fishable habitat in the EEZ off Puerto Rico. Therefore, closing 40% of the fishable habitat in federal waters off the USVI would be more burdensome to fishermen in the USVI than closing 40% of the federal waters off Puerto Rico would be to fishermen in Puerto Rico.

Alternative 3c. Within any closed area alternative, prohibit all fishing for and possession of all species with the exception of HMS species.

This alternative supplements any preferred area closure (i.e., Alternatives 3a(7) and 3a(8)), and allow the harvest of HMS species such as tunas and sharks, but prohibit all other fishing activities. As with Alternatives 3a and 3b, there would be no transit provision for fishing vessels with this alternative.

Alternative 3d. Within any closed area alternative, prohibit all fishing for and possession of all species, but allow the transit of fishing vessels with properly stowed gear and catch.

This alternative supplements any preferred area closure (i.e., Alternatives 3a(7) and 3a(8)), but allow the transit of fishing vessels that have their gear and catch stowed.

4.3.4 Alternative 4. Eliminate the use of fish traps in the U.S. EEZ.

Alternative 4a. Implement an immediate prohibition on the use of fish traps in the U.S. EEZ.

Alternative 4b. Develop a program within two years of the implementation of this amendment that would phase out the use of fish traps in the U.S. EEZ over a period of (i) five years or (ii) ten years.

The alternatives attempt to achieve any needed reductions in fishing mortality by prohibiting the use of fish traps in federal waters of the U.S. Caribbean within various time limits. Theoretically, this results in an approximate reduction in fishing mortality of between 22-67%. This range is based on the fact that trap-based fisheries in Puerto Rico accounted for 22% of the overall catch in 2001 (Scharer *et al.* 2002), while 67% of USVI reef fish were landed by fish traps based on the proportion of reported/expanded landings by species category and gear type from 1994-2002 (Valle-Esquivel and Díaz 2003). In reality, the reductions achieved from such an action would be less because a large proportion of the fish trap harvest occurs within state waters, and because any reduction in fishing mortality due to a trap prohibition in federal waters is likely to be negated to some extent due to a transfer of effort by displaced fish trappers to another gear type. These issues are discussed in more detail in Section 6.3.1.4.

Sub-alternative 4a establishes a prohibition that would become effective with the implementation of this amendment. Sub-alternative 4b implements a program to phase out the use of fish traps over a five (4b(i)) or ten (4b(ii)) year period. If sub-alternative 4b(i) or 4b(ii) were adopted, the first step in that program would be the implementation of the federal permit program described in Section 4.6.1.

4.3.5 Alternative 5. Eliminate the use of gill and trammel nets in the U.S. EEZ.

Alternative 5a. Implement an immediate prohibition on the use of gill and trammel nets in the U.S. EEZ.

Alternative 5b. Develop a program within two years of the implementation of this amendment that would phase out the use of gill and trammel nets in the U.S. EEZ over a period of (i) five years or (ii) ten years.

Alternative 5c (Preferred). Implement an immediate prohibition on the use of gill and trammel nets in the U.S. 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.

The alternative attempts to achieve any needed reductions in catches by prohibiting or greatly restricting the use of gill and trammel nets in federal waters of the U.S. Caribbean. Theoretically, this results in a reduction in fishing mortality for managed reef fish species of approximately 6-20%, based on the proportion of reported/expanded landings by species category and gear type in the USVI from 1994-2002 (6%; Valle-Esquivel and Díaz 2003), and from the proportion of total reported Puerto Rican landings (potentially including many non-managed species) by nets from 1998-2001 (20%; Matos-Caraballo 2002). However, it must be pointed out that the net category for the Puerto Rico estimate includes not only gill and trammel nets, but beach seines and cast nets. Therefore, it is likely that the actual percentage would be somewhat lower than 20%, but it is not possible to determine that actual reduction with any precision.

In reality, the reductions achieved from such an action are likely to be less because a large proportion of the net harvest occurs within state waters, and because any reduction in fishing mortality due to a net prohibition in federal waters is likely to be negated to some extent due to a transfer of effort by displaced netters to another gear type. These issues are discussed in more detail in Section 6.3.1.5. Sub-alternative 5a would establish a prohibition effective with the implementation of this amendment. Sub-alternative 5b implements a program to phase out the use of gill and trammel nets over a five (5b(i)) or ten (5b(ii)) year period. If sub-alternative 5b(i) or 5b(ii) were adopted, the first step in that program would be the implementation of the federal permit program described in Section 4.6.1.

Alternative 5c allows the continued, but limited, use of gill nets to harvest non-managed species (e.g., flying fish) occurring in federal waters.

4.3.6 Alternative 6. Develop a memorandum of understanding (MOU) between NMFS and the state governments to develop compatible regulations to achieve the management objectives set forth in all Council FMPs in state and federal waters of the U.S. Caribbean

Because 86% of the fishable habitat in the U.S. Caribbean occurs in state waters (Figure 1), it is believed that most of the total catch in the U.S. Caribbean is taken in state waters. Therefore, any reductions in fishing mortality required by the implementation of the biological reference points, stock status determination criteria, and control rules selected in Section 4.2 should be applied consistently throughout the U.S. Caribbean, regardless of jurisdictional boundaries. The Council is considering this administrative alternative to initiate increased State-Federal cooperation.

The MOU would contain a defined set of actions that the state governments agree to implement within a prescribed time period to reduce fishing mortality in state waters to levels that would be consistent with achieving the goals and objectives set forth in the four Council FMPs, as amended, taking into consideration any recent state management actions that may have been implemented and that would result in reductions of fishing mortality. The MOU could parallel the same preferred management actions as implemented in the EEZ through this amendment. For example, the States could opt to ban gill and trammel nets within their jurisdiction; prohibit the filleting of fish at sea; implement, as necessary, additional area or seasonal closures to reduce fishing mortality on those species identified as overfished or undergoing overfishing; modify state (i.e., Puerto Rico) landings reports to include standardized bycatch reporting; and modify state (i.e., USVI) regulations to prohibit the harvest and possession of Nassau grouper within their jurisdiction. Development of the MOU's actual content would require subsequent discussions with the respective State's resource management representatives, Council staff, and NMFS.

4.3.7 Comparison of the environmental effects of alternative short-term management measures

Depending on the actual sub-alternatives that are selected, Alternative 3 would most likely be more conservative than Alternative 2, as it would prohibit all fishing within a specific area, while Alternative 2 would permit fishing activities to largely continue unabated and bycatch-associated mortality may impact its effectiveness. However, Alternative 3 is likely to result in more significant economic impacts than the species- or FMU-specific closures in Alternative 2. Sub-alternatives 3c would be more restrictive than 3a or 3b, as it would prohibit fishing for species other than those managed by the Council, which could provide additional ecological benefits to non-managed species and potentially facilitate enforcement. Sub-alternative 3d simply adds a transit provision to minimize the burden to fishermen. Overall, Alternative 4 would have a more significant effect in reducing fishing mortality than Alternative 5 since fish traps are a more predominant gear type in the U.S. Caribbean. It would also have a larger economic impact compared to other gear prohibitions (e.g., Alternative 5). Regardless, it is likely either of these gear prohibition alternatives would have a greater economic impact off the USVI than Puerto Rico due to the disparity in state boundaries (i.e., 3 nm versus 9 nm, respectively). Alternative 6, if successfully implemented, could have the greatest overall impact since the majority of fishing activity occurs in state waters.

The Council selected alternative 2, specifically 2a - 2c and 2e, and alternative 5c as the preferred alternatives to effectively reduce fishing mortality and minimize socio-economic impacts. Furthermore, the elimination of gill and trammel nets in alternative 5c will reduce bycatch to the extent that it occurs with this gear type in the EEZ.

4.4 Rebuilding Overfished Fisheries

The MSFCMA mandates that all FMPs shall, "…in the case of a fishery which the Council or the Secretary has determined is approaching an overfished condition or is overfished, contain conservation and management measures to prevent overfishing or end overfishing and rebuild the fishery" (MSFCMA §303(a)(10)).

Specifically, "Within one year of an identification…or notification…, the appropriate Council…shall prepare a fishery management plan, plan amendment, or proposed regulations for the fishery to which the identification or notice applies – (A) to end overfishing in the fishery and to rebuild affected stocks of fish; or (B) to prevent overfishing from occurring in the fishery whenever such fishery is identified as approaching an overfished condition" (MSFCMA §304(e)(3)).

The MSFCMA stipulates certain mandatory provisions when rebuilding an overfished fishery. The FMP or proposed regulations shall "(A) specify a time period for ending overfishing and rebuilding the fishery that shall -- (i) be as short as possible, taking into account the status and biology of any overfished stocks of fish, the needs of fishing communities, recommendations by international organizations in which the United States participates, and the interaction of the overfished stock of fish within the marine ecosystem; and (ii) not exceed 10 years, except in cases where the biology of the stock of fish, other environmental conditions, or management measures under an international agreement in which the United States participates dictates otherwise; (B) allocate both overfishing restrictions and recovery benefits fairly and equitably among sectors of the fishery" (MSFCMA §304(e)(4)).

Guidance at 50 CFR §600.310 specifies that the starting point in structuring a rebuilding program is the length of time in which a stock could be rebuilt in the absence of fishing mortality on that stock, described as T_{MIN}. If that period is less than ten years, the factors in §304(e)(4)(A)(i), including the needs of fishing communities, may be used to adjust the rebuilding period up to ten years. If the stock cannot be rebuilt within ten years because of the factors listed in §304(e)(4)(A)(ii), the factors in §304(e)(4)(A)(i) may be used to justify a schedule longer than the no-mortality period. To ensure that the rebuilding period is not indefinite, the outside limit of the rebuilding period is the no-mortality period plus one mean generation time (or equivalent period based on the species' life-history characteristics).

This section describes alternative schedules and measures that the Council is evaluating to rebuild five stocks or stock complexes, including Goliath grouper, Grouper Unit 4 (misty grouper, red grouper, tiger grouper, yellowedge grouper, and yellowfin grouper), Nassau grouper, and queen conch. Goliath grouper, Nassau grouper, and queen conch are classified as overfished in the most recent report to Congress on the status of fisheries of the United States (NMFS 2003a). Grouper Unit 4 would also be considered to be overfished if the Council's preferred definitions of FMU sub-units (Section 4.1) and stock status determination criteria (4.2) were adopted and implemented through this amendment

4.4.1 Nassau grouper

The biology and status of Nassau grouper is described in Section 5.2.1.3.33.9.

4.4.1.1 Rebuilding schedule

Fishery scientists do not have the data needed to calculate how quickly Nassau grouper could rebuild to B_{MSY} in the absence of fishing. The Council has specified a T_{MIN} proxy of ten years based on the conclusion of the NOAA SEFSC that it is unlikely that the stock could recover within ten years if all catches of this species were prohibited (CFMC 2001a). Estimates of generation time for this species range from 15 to 70 years (Porch and Scott 2001).

The rebuilding schedule alternatives the Council considered for Nassau grouper are based on the formula the National Standard Guidelines provides for stocks that cannot be rebuilt within 10 years: T_{MIN} + one mean generation time. The Council considered but eliminated from more detailed study an alternative that would have established a ten-year rebuilding schedule for this species. That schedule appears unrealistic based on the above-mentioned conclusion of the NOAA SEFSC and on the finding that Nassau grouper is still overfished more than ten years after the Council prohibited fishing for and possessing that species in federal waters. This is discussed in Section 11.2. The range of rebuilding schedule alternatives the Council considered for Nassau grouper were derived from the range of generation times estimated for this species.

4.4.1.1.1 Alternative 1. No action. Do not define a schedule/time frame for rebuilding Nassau grouper.

Although the Council has prohibited fishing for or possessing Nassau grouper since Amendment 1 to the Reef Fish FMP was implemented in December 1990, no formal rebuilding schedule has been established for this species. This alternative maintains the status quo, thus no rebuilding schedule would be defined for Nassau grouper.

4.4.1.1.2 Alternative 2 (Preferred). Rebuild Nassau grouper to B_{MSY} in 25 years, using the formula T_{MIN} (10 years) + one generation (15 years) = 25 years.

This alternative specifies a rebuilding schedule for Nassau grouper consistent with the longest rebuilding period advised by the National Standard Guidelines, and is based on the lowest value of the range of estimated generation times for this species.

4.4.1.1.3 Alternative 3. Rebuild Nassau grouper to B_{MSY} in 52.5 years, using the formula T_{MIN} (10 years) + one generation (42.5 years) = 52.5 years.

This alternative specifies a rebuilding schedule for Nassau grouper consistent with the longest rebuilding period advised by the National Standard Guidelines, and that is based on the middle value of the range of estimated generation times for this species.

4.4.1.1.4 Alternative 4. Rebuild Nassau grouper to B_{MSY} in 80 years, using the formula T_{MIN} (10 years) + one generation (70 years) = 80 years.

This alternative specifies a rebuilding schedule for Nassau grouper consistent with the longest rebuilding period advised by the National Standard Guidelines, and that is based on the highest value of the range of estimated generation times for this species.

4.4.1.1.5 Comparison of the environmental effects of alternative rebuilding schedules.

Defining a rebuilding schedule for Nassau grouper is an administrative action and, as such, would have no direct positive or negative impacts on the biological, ecological, social, or economic environment. However, determining the time period over which rebuilding efforts can be extended could have indirect environmental effects. Shorter schedules generally require that overfished stocks be provided a greater amount of (and more immediate) relief from fishing pressure. Conversely, longer schedules generally allow overfished stocks to be fished at higher rates of fishing mortality as they rebuild.

Alternative 1 adversely affects the administrative environment because the MSFCMA mandates the definition of rebuilding schedules for overfished stocks, and the lack of a rebuilding schedule would not provide fishery administrators with concrete, measurable objectives to use in assessing fishery and management performance. The indirect biological, ecological, social, and economic effects associated with this action also could be adverse if the current moratorium on harvest were rescinded in response. While permitting the harvest of Nassau grouper provides social and economic benefits in the short term, the net effect of such action are negative if the harvest of this species compromised rebuilding efforts. But the Council is unlikely to rescind the prohibition, which has been in effect for many years despite the specification of a formal rebuilding schedule.

Alternatives 2-4 directly benefit the administrative environment by helping fishery managers to fulfill legal administrative and conservation mandates. If the Council were to use the defined schedule to determine the amount of harvest of Nassau grouper that would be permitted, the indirect biological and ecological, and net social and economic, benefits associated with these alternatives would be expected to be greatest for Alternative 2, followed by Alternative 3, then Alternative 4. Extending rebuilding efforts over a longer time frame helps to mitigate the adverse social and economic effects of rebuilding. However, such an extension also increases the risk that environmental or other factors could prevent the stock from recovering. Therefore, the Council selected Alternative 2 as the preferred alternative.

4.4.1.2 Rebuilding strategy

4.4.1.2.1 Alternative 1. No action. Rely on current regulations to rebuild the stock to B_{MSY} within the required time frame.

Current regulations in federal waters that impact the recovery of this stock are described more fully in Section 2.2.3, and include:

- A control rule of ABC = 0 (prohibition on catch in place since 1990);
- Gear construction requirements (e.g., 2-inch minimum mesh size; 2 escape panels);
- Gear prohibitions (e.g., prohibition on use of powerheads, explosives, poisons, drugs and other chemicals); and
- Area closures (e.g., a year-round area closure of the Hind Bank MCD).

4.4.1.2.2 Alternative 2 (Preferred). 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.

Anecdotal information suggests that Nassau grouper is still being harvested in federal waters and filleted at sea, thereby complicating the enforcement of the prohibition on catch and possession of these species. This action would prevent fishermen from landing Nassau grouper, as well as other species, in an unidentifiable form.

4.4.1.2.3 Alternative 3. Establish a seasonal or area closure to protect spawning stock.

This alternative would prohibit fishing in known Nassau grouper spawning sites either during a portion of the year or year-round. Fishery managers do not know of any unprotected sites in federal waters where Nassau grouper aggregate to spawn. The Council included this alternative in the amendment to solicit public input on this subject.

4.4.1.2.4 Alternative 4 (Preferred). 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 Caribbean

Fishery Management Council's Reef Fish FMP in USVI and federal waters of the U.S. Caribbean.

The USVI does not currently regulate the take of Nassau grouper. Since much of the habitat that supports this species is located in state waters, its recovery likely depends on the implementation of more protective regulations in state waters. For this reason, the Council is considering this administrative alternative in addition to the regulatory alternatives described above.

The MOU would define one or more actions, such as working to prohibit the catch and possession of Nassau grouper in USVI waters, that the USVI government would agree to implement within a prescribed time period to assist federal fishery managers in achieving the rebuilding goal and schedule adopted for Nassau grouper in this amendment. At the 117th Council meeting, representatives from the USVI stated that they would pursue the prohibition of Nassau grouper harvest and possession in state waters.

4.4.1.2.5 Comparison of the environmental effects of alternative rebuilding measures

Alternative 1 offers no additional protections to Nassau grouper beyond current regulations, which are not believed to have improved the status of the stock. This failure to rebuild the stock despite a 14-year prohibition on harvest is attributed primarily to the lack of compatible regulations in state waters. Puerto Rico recently implemented regulations that would prohibit the harvest and possession of this species in state waters.

Alternatives 2 and 3 could directly benefit Nassau grouper, the surrounding ecosystem, and fishing communities if they served to further reduce overall mortality of the stock and if this reduction in mortality assisted in rebuilding stock biomass to a sustainable level. The prohibition on filleting fish at sea proposed in Alternative 2 is expected to reduce directed fishing mortality by curbing illegal fishing activities. The seasonal or annual spawning area closure proposed in Alternative 3 could reduce bycatch mortality of Nassau grouper if one or more spawning areas could be reliably defined.

Alternative 4 directly benefits the administrative environment. Although developing the MOU would present an administrative burden, the net administrative effects of coordinating state and federal management are expected to be positive. The MOU would be expected to provide indirect biological, ecological, social, and economic benefits by facilitating the implementation of a harvest prohibition in USVI waters, as well as other conservative measures, such as prohibiting the filleting of fish at sea throughout state and federal waters in the U.S. Caribbean. Therefore, the Council selected Alternatives 2 and 4 as preferred alternatives, in order to rebuild the species.

4.4.2 Goliath grouper

The biology and status of Goliath grouper is described in Section 5.2.1.3.33.6.

4.4.2.1 Rebuilding schedule

Fishery scientists do not have the data needed to calculate how quickly Goliath grouper could rebuild to B_{MSY} in the absence of fishing. The Council has specified a T_{MIN} proxy of ten years based on the conclusion of the NOAA SEFSC that it is unlikely that the stock could recover within ten years if all catches of this species were prohibited (CFMC 2001a). Estimates of generation time for this species range from 20 to 95 years (Porch and Scott 2001).

The rebuilding schedule alternatives the Council considered for Goliath grouper are based on the formula the National Standard Guidelines provides for stocks that cannot be rebuilt within 10 years: T_{MIN} + one mean generation time. The Council considered but eliminated from more detailed study an alternative that would have established a ten-year rebuilding schedule for this species. That schedule appears unrealistic based on the above-mentioned conclusion of the NOAA SEFSC and on the finding that Goliath grouper is still overfished ten years after the Council prohibited fishing for and possessing that species in federal waters. This is discussed in Section 11.2. The range of rebuilding schedule alternatives the Council considered for Goliath grouper were derived from the range of generation times estimated for this species.

4.4.2.1.1 Alternative 1. No action. Do not define a schedule/time frame for rebuilding Goliath grouper.

Although the Council has prohibited fishing for or possessing Goliath grouper since Amendment 2 to the Reef Fish FMP was implemented in November 1993, no formal rebuilding schedule has been established for this species. This alternative maintains the status quo, thus no rebuilding schedule would be defined for Goliath grouper.

4.4.2.1.2 Alternative 2 (Preferred). Rebuild Goliath grouper to B_{MSY} in 30 years, using the formula T_{MIN} (10 years) + one generation (20 years) = 30 years.

This alternative specifies a rebuilding schedule for Goliath grouper consistent with the longest rebuilding period advised by the National Standard Guidelines, and is based on the lowest value of the range of estimated generation times for this species.

4.4.2.1.3 Alternative 3. Rebuild Goliath grouper to B_{MSY} in 67.5 years, using the formula T_{MIN} (10 years) + one generation (57.5 years) = 67.5 years.

This alternative specifies a rebuilding schedule for Goliath grouper consistent with the longest rebuilding period advised by the National Standard Guidelines, and is based on the middle value of the range of estimated generation times for this species.

4.4.2.1.4 Alternative 4. Rebuild Goliath grouper to B_{MSY} in 105 years, using the formula T_{MIN} (10 years) + one generation (95 years) = 105 years.

This alternative specifies a rebuilding schedule for Goliath grouper consistent with the longest rebuilding period advised by the National Standard Guidelines, and is based on the highest value of the range of estimated generation times for this species.

4.4.2.1.5 Comparison of the environmental effects of alternative rebuilding schedules

Defining a rebuilding schedule for goliath grouper is an administrative action and, as such, would have no direct positive or negative impacts on the biological, ecological, social, or economic environment. However, determining the time period over which rebuilding efforts can be extended could have indirect environmental effects. Shorter schedules generally require that overfished stocks be provided a greater amount of (and more immediate) relief from fishing pressure. Conversely, longer schedules generally allow overfished stocks to be fished at higher rates of fishing mortality as they rebuild.

Alternative 1 adversely affects the administrative environment because the MSFCMA mandates the definition of rebuilding schedules for overfished stocks, and the lack of rebuilding schedules would not provide fishery administrators with concrete, measurable objectives to use in assessing fishery and management performance. The indirect biological, ecological, social, and economic effects associated with this action also could be adverse if the current moratorium on harvest were rescinded in response. While permitting the harvest of goliath grouper would provide social and economic benefits in the short term, the net effect of such action would be negative if the harvest of this species compromised rebuilding efforts. But the Council is unlikely to rescind the prohibition, which has been in effect for many years despite the specification of a formal rebuilding schedule.

Alternatives 2-4 would directly benefit the administrative environment by helping fishery managers to fulfill legal administrative and conservation mandates. If the Council were to use the defined schedule to determine the amount of harvest of goliath grouper that would be permitted, the indirect biological and ecological, and net social and economic, benefits associated with these alternatives would be expected to be greatest for Alternative 2, followed by Alternative 3, then Alternative 4. Extending rebuilding efforts over a longer time frame helps to mitigate the adverse social and economic effects of rebuilding. However, such an extension also increases the risk that environmental or other factors could prevent the stock from recovering. Therefore, the Council selected Alternative 2 as the preferred alternative.

4.4.2.2 Rebuilding strategy

4.4.2.2.1 Alternative 1. No action. Rely on current regulations to rebuild the stock to B_{MSY} within the required time frame.

Current regulations in federal waters that impact the recovery of this stock are described in full in Section 2.2.3, and include:

- A control rule of ABC = 0 (prohibition on catch in place since 1993);
- Gear construction requirements (e.g., 2-inch minimum mesh size; 2 escape panels);
- Gear prohibitions (e.g., prohibition on use of powerheads, explosives, poisons, drugs and other chemicals); and
- Area closures (e.g., a year-round area closure of the Hind Bank MCD).

4.4.2.2.2 Alternative 2 (Preferred). 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.

Anecdotal information suggests that Goliath grouper may still be harvested in federal waters and filleted at sea, thereby complicating the enforcement of the prohibition on catch and possession of these species. This action prevents fishermen from landing Goliath grouper, as well as other species, in an unidentifiable form.

4.4.2.2.3 Alternative 3. Establish a seasonal or area closure to protect spawning stock.

This alternative prohibits fishing in known goliath grouper spawning sites either during a portion of the year or year-round. Fishery managers do not know of any unprotected sites in federal waters where Goliath grouper aggregate to spawn. The Council included this alternative to solicit public input on this subject.

4.4.2.2.4 Comparison of the environmental effects of alternative rebuilding measures

Alternative 1 offers no additional protections to Goliath grouper beyond current regulations, which are not believed to have improved the status of the stock. This failure to rebuild the stock despite an 11-year prohibition on harvest is attributed primarily to the lack of compatible regulations in state waters in the past. Following recent rulemaking in Puerto Rico, the harvest and possession of this species is now prohibited in all state and federal waters throughout the U.S. Caribbean; harvest of Goliath grouper in USVI is prohibited.

Alternatives 2 and 3 could directly benefit Goliath grouper, the surrounding ecosystem, and fishing communities if they served to further reduce overall mortality of the stock and if this reduction in mortality assisted in rebuilding stock biomass to a sustainable level. The prohibition on filleting fish at sea proposed in Alternative 2 is expected to reduce directed fishing mortality by curbing illegal fishing activities. The seasonal or annual spawning area closure proposed in

Alternative 3 could reduce bycatch mortality of Goliath grouper if one or more spawning areas could be reliably defined. Therefore, the Council selected Alternative 2 as the preferred alternative, in order to rebuild the species.

4.4.3 Queen Conch

The biology and status of queen conch is described in Section 5.2.1.2.1.

4.4.3.1 Rebuilding schedule

Fishery scientists do not have the data needed to calculate how quickly queen conch could rebuild to B_{MSY} in the absence of fishing. However, the NOAA SEFSC has concluded that it is unlikely the stock can recover within ten years, even if all catches of this species were prohibited (CFMC 2001a). Employing two different models, Valle-Esquivel estimates a mean generation time for queen conch ranging from 4.6 years to 4.9 years (personal communication). This resulted in the specification of a generation time for that species of five years.

The rebuilding schedule alternatives the Council considered for queen conch are based on the formula the National Standard Guidelines provides for stocks that cannot be rebuilt within 10 years: T_{MIN} + one mean generation time. The Council considered but eliminated from more detailed study an alternative that would have established a rebuilding schedule for this species. Such a schedule appears unrealistic based on the above-mentioned conclusion of the NOAA SEFSC, and on the finding that queen conch fisheries closed in Florida and Bermuda since 1986 have shown little or no sign of improvement (CFMC 2001a; Deluca 2002). This is discussed in Section 11.2. The range of rebuilding schedule alternatives the Council is considering for queen conch derives from two alternative definitions of T_{MIN}.

4.4.3.1.1 Alternative 1. No action. Do not define a schedule/time frame for rebuilding queen conch.

This alternative maintains the status quo, thus no rebuilding schedule would be defined for queen conch.

4.4.3.1.2 Alternative 2 (Preferred). Rebuild queen conch to B_{MSY} in 15 years, using the formula T_{MIN} (10 years) + one generation (5 years) = 15 years.

This alternative specifies a rebuilding schedule for queen conch consistent with the longest rebuilding period advised by the National Standard Guidelines, and is based on a T_{MIN} proxy of ten years.

4.4.3.1.3 Alternative 3. Rebuild queen conch to B_{MSY} in 20 years, using the formula T_{MIN} (15 years) + one generation (5 years) = 20 years.

This alternative specifies a rebuilding schedule for queen conch consistent with the longest rebuilding period advised by the National Standard Guidelines, and is based on a T_{MIN} proxy of 15 years.

4.4.3.1.4 Comparison of the environmental effects of alternative rebuilding schedules

Defining a rebuilding schedule for queen conch is an administrative action and, as such, would have no direct positive or negative impacts on the biological, ecological, social, or economic environment. However, determining the time period over which rebuilding efforts can be extended could have indirect environmental effects. Shorter schedules generally require that overfished stocks be provided a greater amount of (and more immediate) relief from fishing pressure. Conversely, longer schedules generally allow overfished stocks to be fished at higher rates of fishing mortality as they rebuild.

Alternative 1 would adversely affect the administrative environment because the MSFCMA mandates the definition of rebuilding schedules for overfished stocks, and the lack of a rebuilding schedule would not provide fishery administrators with concrete, measurable objectives to use in assessing fishery and management performance. The indirect biological, ecological, social, and economic effects associated with this action also could be adverse if current management measures regulating the take of queen conch were rescinded in response. Allowing unregulated harvest of queen conch could provide social and economic benefits in the short term. However, the net effect of such action would be expected to be negative because unregulated harvest would likely compromise rebuilding efforts.

Alternatives 2-4 would directly benefit the administrative environment by helping fishery managers to fulfill legal administrative and conservation mandates. Using the defined schedules to determine the amount of harvest of queen conch that would be permitted, the indirect biological and ecological benefits, and adverse social and economic effects, associated with these alternatives would be expected to decrease progressively from Alternative 2 to Alternative 3. Extending rebuilding efforts over a longer time frame helps to mitigate the adverse social and economic effects of rebuilding. However, such an extension also increases the risk that environmental or other factors could prevent the stock from recovering. Therefore, the Council selected Alternative 2 as the preferred alternative.

4.4.3.2 Rebuilding strategy

4.4.3.2.1 Alternative 1. No action (maintain status quo). Rely on current regulations to rebuild the stock to B_{MSY} within the required time frame.

Current regulations in federal waters that impact the recovery of this stock are described in full in Section 2.2.2, and include:

- A nine-inch (22.9 cm) overall minimum size limit or 3/8-inch (9.5 mm) shell-lip thickness limitation on the possession of queen conch;
- A requirement that all species in the management unit be landed in the shell;
- A prohibition on the sale of undersized queen conch and queen conch shells;
- A bag limit of three queen conch/day for recreational fishermen, not to exceed 12 per boat, and 150 queen conch/day for licensed commercial fishermen;
- A July 1 through September 30 closed season;
- A prohibition on the use of HOOKAH gear to harvest queen conch; and
- Additional seasonal and area closures implemented to protect alternate species.

4.4.3.2.2 Alternative 2. Prohibit commercial and recreational catch and possession of queen conch in federal waters of the U.S. Caribbean.

This alternative prohibits commercial and fishermen from taking or possessing queen conch in the U.S. EEZ.

4.4.3.2.3 Alternative 3 (Preferred). 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.

This alternative prohibits commercial and recreational fishermen from taking or possessing queen conch throughout the U.S. EEZ, with the exception of Lang Bank. For the purposes of this alternative, Lang Bank consists of federal waters east of 64° 34' W longitude.

4.4.3.2.4 Alternative 4 (Preferred). Develop a memorandum of understanding (MOU) between NMFS and the state governments to develop compatible regulations to achieve the management objectives set forth in the Caribbean Fishery Management Council's Queen Conch FMP in state and federal waters of the U.S. Caribbean.

Since much of the queen conch habitat, in particular juvenile habitat, is located in state waters, the recovery of this species is likely dependent on the implementation of compatible protective regulations in state waters.

Currently, both Puerto Rico and the USVI have consistent minimum size regulations with those in the EEZ; however, Puerto Rico does not require that conch be landed whole in the shell, as in USVI or federal waters. Both Puerto Rico and the USVI have closed seasons July 1 - September 30.

This alternative would require the Council to request the Secretary of Commerce/NMFS formalize, through an MOU, an agreement to work together to rebuild queen conch in the U.S. Caribbean. The MOU would define specific actions the state governments agree to implement, or maintain, over a prescribed time period to assist federal fishery managers in achieving the rebuilding goal and schedule adopted for queen conch in this amendment.

4.4.3.2.5 Comparison of the environmental effects of alternative rebuilding measures

Alternative 1 offers no additional protections to queen conch beyond current regulations, which have not been effective in sustaining the stock. As a result, this alternative is expected to result in the continued overexploitation of this species, which would directly adversely affect the biological, ecological, social, economic, and administrative environments. Alternatives 2 and 3 are expected to directly benefit queen conch, the surrounding ecosystem, and fishing communities by protecting the breeding populations of queen conch believed to exist in EEZ waters.

The total prohibition on queen conch harvest proposed in Alternative 2 is expected to provide greater biological and ecological benefits relative to the limited prohibition on queen conch harvest proposed in Alternative 3. However, the superiority of Alternative 2 relative to Alternative 3 is more uncertain in terms of social and economic benefits. St. Croix is relatively isolated geographically and oceanographically, and scientists do not fully understand how (if at all) the status of conch populations in that area affects (or is affected by) the overall status of the queen conch stock. Alternative 3 would provide greater net social and economic benefits relative to Alternative 2 if continued harvest in that area did not compromise stock rebuilding efforts.

Alternative 4 directly benefits the administrative environment. Although developing the MOU presents an administrative burden, the net administrative effects of coordinating state and federal management are expected to be positive. The MOU would be expected to provide indirect biological, ecological, social, and economic benefits by facilitating the implementation of compatible rebuilding goals and strategies.

Therefore, the Council selected Alternatives 2 and 4 as preferred alternatives to rebuild the species.

4.4.4 Grouper Unit 4

Grouper Unit 4 is composed of misty grouper, red grouper, tiger grouper, yellowedge grouper, and yellowfin grouper. The biology and status of these species is described in Section 5.2.1.3.33. This complex will be considered overfished if the preferred biological reference points and stock status determination criteria described in Section 4.2 are adopted. For this reason, the Council evaluated alternative rebuilding schedules and measures for this complex in this amendment.

4.4.4.1 Rebuilding schedule

Scientists have not estimated the parameters needed to calculate alternative rebuilding schedules for the Grouper Unit 4. Therefore, we used the theoretical dynamics of a population under the logistic (Graham-Schaefer) surplus-production model to calculate T_{MIN} for this stock based on the definition of the B ratio and F_{MSY} estimate that would be established by the preferred alternatives in Section 4.2 and on the assumption that the intrinsic rate of population growth, r, equals 0.25. Using these definitions, T_{MIN} is equal to about 1.1 years. We rounded the T_{MIN} estimate to 2 years, rather than 1 year, because it is impossible to rebuild the stock in 1 year if T_{MIN} represents a zero-mortality scenario and is defined as 1.1. The range of alternative rebuilding schedules considered for Grouper Unit 4 is consistent with the guidance provided in the National Standard Guidelines, such that the shortest schedule evaluated is bounded by T_{MIN}, and the longest rebuilding schedule evaluated is bounded by ten years, since T_{MIN} is less than 10 years. The recovery plot is illustrated in Figure 10. A detailed description of the theory and equations used to generate the plot is provided in Prager (1994).

4.4.4.1.1 Alternative 1. No action. Do not define a schedule/time frame for rebuilding Grouper Unit 4.

This alternative maintains the status quo, thus no rebuilding schedule would be defined for the Grouper Unit 4 Complex.

4.4.4.1.2 Alternative 2 (Preferred). Rebuild grouper unit 4 to B_{MSY} in 10 years.

This alternative specifies a rebuilding schedule for the Grouper Unit 4 Complex that is consistent with the longest rebuilding period advised by the National Standard Guidelines: 10 years, if T_{MIN} is less than 10 years.

4.4.4.1.3 Alternative 3. Rebuild grouper unit 4 to B_{MSY} in 2 years.

This alternative requires the Council to rebuild the Grouper Unit 4 Complex in as short a time period as possible, defined as T_{MIN}, or the time the stock could rebuild to B_{MSY} in the absence of fishing.

4.4.4.1.4 Alternative 4. Rebuild grouper unit 4 to B_{MSY} in 6 years.

This alternative specifies a rebuilding schedule for the Grouper Unit 4 Complex that reflects the mid-point between T_{MIN} and the longest advisable rebuilding period of 10 years.

4.4.4.1.5 Comparison of the environmental effects of alternative rebuilding schedules

Defining a rebuilding schedule for the Grouper Unit 4 is an administrative action and, as such, would have no direct positive or negative impacts on the biological, ecological, social, or economic environment. However, determining the time period over which rebuilding efforts can be extended could have indirect environmental effects. Shorter schedules generally require that overfished stocks be provided a greater amount of (and more immediate) relief from fishing pressure. Conversely, longer schedules generally allow overfished stocks to be fished at higher rates of fishing mortality as they rebuild.

Alternative 1 adversely affect the administrative environment because the MSFCMA mandates the definition of rebuilding schedules for overfished stocks, and the lack of rebuilding schedules would not provide fishery administrators with concrete, measurable objectives to use in assessing fishery and management performance. The indirect biological, ecological, social, and economic effects associated with this alternative also could be adverse if it resulted in continued overfishing of the Grouper Unit 4 Complex.

Alternatives 2-4 directly benefit the administrative environment by helping fishery managers to fulfill legal administrative and conservation mandates. The indirect biological and ecological benefits associated with these alternatives are expected to be greatest for Alternative 3, followed by Alternative 4, then Alternative 2. Conversely, adverse social and economic effects are expected to be least for Alternative 3, followed by Alternative 4, then Alternative 2. Extending rebuilding efforts over a longer time frame potentially increases the adverse social and economic effects of rebuilding depending on the rebuilding strategy, as the rebuilding alternatives would potentially be in effect for a longer time period, unless the species or FMU sub-unit recovered sooner than expected. However, such an extension also increases the risk that environmental or other factors could prevent the stock from recovering.

4.4.4.2 Rebuilding strategy

The management measures described in Section 4.3 are designed to reduce fishing mortality rates to levels that are equal to or less than those prescribed by the Preferred MSY Control Rule described in Section 4.2.5. A preferred alternative in Section 4.3 would prohibit the possession of species in Grouper Unit 4 from February 1 - April 30, to reduce fishing mortality and protect spawning aggregations. It is expected to result in a 24% reduction in fishing mortality, which should be sufficient to end overfishing and rebuild the FMU sub-unit within the preferred rebuilding schedule. Because the Grouper Unit 4 Complex would be considered to be just slightly overfished (B_{CURR} is 91% of MSST) upon implementatin of the preferred alternatives in Section 4.2, ending overfishing should allow Grouper Unit 4 to rebuild to B_{MSY} within any of the alternative schedules evaluated above. Therefore, no additional rebuilding measures are considered in this section.

4.5 Conserving and Protecting Yellowfin Grouper

The Council considered the following regulatory measures in addition to those described in Section 4.3 to protect an identified yellowfin grouper spawning aggregation on Grammanik Bank, south of St. Thomas. These alternatives were originally being developed and evaluated in a separate amendment to the Reef Fish FMP, but were transferred to this amendment to streamline the administrative process and to reduce the amount of time before they were brought before the Council for final consideration.

4.5.1 Alternative 1. No action. Do not establish a seasonal closure of the Grammanik Bank.

This alternative leaves the Grammanik Bank open to fishing year round. Fishing in that area would continue to be managed by the regulations set forth in the four Council FMPs and described in Section 2.2.

4.5.2 Alternative 2. Close the Grammanik Bank to all fishing from February 1 to April 30 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18º 12.40' N, 64º 59.00' W; 18º 10.00' N, 64º 59.00' W; 18º 10.00' N, 64º 56.10' W; and 18º 12.40' N, 64º 56.10' W.

This alternative defines an area of approximately 4.63 km (2.5 nm) by 5.09 km (2.75 nm), resulting in a 23.57 km^2 (6.88 nm^2) area in which fishing would be prohibited from February through April. The reported spawning aggregation would be positioned slightly northeast of the closed area's center.

4.5.3 Alternative 3. Close the Grammanik Bank to all fishing from February 1 to April 15 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18º 13.20' N, 64º 59.00' W; 18º 13.20' N, 64º 54.00' W; 18º 09.50' N, 64º 59.00' W; and 18º 09.50' N, 64º 54.00' W.

This alternative defines an area of approximately 6.48 km (3.5 nm) by 9.26 km (5 nm), resulting in a 60 km^2 (17.5 nm^2) area in which fishing would be prohibited from February through April 15. The reported spawning aggregation would be centered within this closed area.

4.5.4 Alternative 4. Close the Grammanik Bank to all fishing from February 1 to April 15 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18º 12.00' N, 64º 58.00' W; 18º 12.00' N, 64º 57.00' W; 18º 11.00' N, 64º 57.00' W; and 18º 11.00' N, 64º 58.00' W.

This alternative defines an area of approximately 1.85 km (1.0 nm) by 1.85 km (1.0 nm), resulting in a 3.42 km^2 (1.0 nm^2) area in which fishing would be prohibited from February through April 15. The reported spawning aggregation would be centered within this closed area.

4.5.5 Alternative 5. Close the Grammanik Bank to all fishing from February 1 to May 31 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18º 13.20' N, 64º 59.00' W; 18º 13.20' N, 64º 54.00' W; 18º 09.50' N, 64º 59.00' W; and 18º 09.50' N, 64º 54.00' W.

This alternative defines an area of approximately 4.63 km (2.5 nm) by 3.70 km (2.0 nm), resulting in a 17.13 km^2 (5 nm^2) area in which fishing would be prohibited from February through May. The reported spawning aggregation would be centered within this closed area.

4.5.6 Alternative 6. Close the Grammanik Bank to all fishing from February 1 to May 31 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18º 12.00' N, 64º 58.00' W; 18º 12.00' N, 64º 57.00' W; 18º 11.00' N, 64º 57.00' W; and 18º 11.00' N, 64º 58.00' W.

This alternative defines an area of approximately 1.85 km (1.0 nm) by 1.85 km (1.0 nm), resulting in a 3.42 km^2 (1.0 nm^2) area in which fishing would be prohibited from February through May. The reported spawning aggregation would be centered within this closed area.

4.5.7 Alternative 7 (Preferred). Close the Grammanik Bank to all fishing from February 1 to April 30 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18º 11.898' N, 64º 56.328' W; 18º 11.645' N, 64º 56.225' W; 18º 11.058' N, 64º 57.810' W; and 18º 11.311' N, 64º 57.913' W.

This alternative defines an area of approximately 3.0 km (1.62 nm) by 0.5 km (0.27 nm), resulting in a 1.50 km^2 (0.44 nm^2) area in which fishing would be prohibited from February through April. The reported spawning aggregation would be centered within this closed area.

4.5.8 Alternative 8. Prohibit the harvest and possession of yellowfin grouper in the U.S. EEZ, in conjunction with the closure of the Grammanik Bank.

This alternative is encompassed by Preferred Alternative 2a proposed in Section 4.3.2.

4.5.9 Comparison of the environmental effects of alternatives

Alternatives 2-8 would all have a direct effect on the biological, socioeconomic, and administrative environment. Alternatives 2-7 all afford protection of a documented spawning aggregation, which are typically targeted by fishermen due to the fact that large spawning fish can be harvested in abundant numbers in a fairly discrete area and during a fairly predictable timeframe. Since a closed area prohibits all harvest and possession of Council-managed species within the specified coordinates, other species, including those species in the Coral FMP that are considered EFH, would benefit from the closure as well. However, as with any closed area or season, there could be negative effects associated with the proposed action. Intensified fishing before and after a closed season could reduce or negate benefits accrued during the closure. Likewise, displaced fishing activities could increase pressure on juveniles in USVI waters, or impair EFH through intensified fishing activities in waters outside the closed area. Finally, there may be some short-term economic impacts associated with the proposed action. The actual size and length of the closure would ultimately determine the extent of any socioeconomic impact. Generally, the larger the closed area (e.g., Alternative 3 versus Alternative 7) and the longer the duration (e.g., Alternative 4 versus Alternative 6), the greater the economic impact. However, there should be economic benefits in the long term, due to the rebuilding of yellowfin grouper and the establishment of a sustainable fishery.

Of the various closed area alternatives, Alternative 2 is the most conservative. It closes a sufficiently large area to protect yellowfin grouper and other species, as well as an area large enough to facilitate enforcement, and it would be closed throughout the complete duration of the yellowfin grouper spawning period. Alternative 1 (no-action) obviously not prevent exploitation of the spawning aggregation, and would not fulfill the purpose and need of this action. Alternative 5 has a longer time period as Alternative 2, but is slightly smaller in area; even though Alternative 5 is longer in duration that Alternative 2, since yellowfin grouper are not documented to spawn in May, the benefit to the species is questionable. While Alternative 3 closes a larger area, its duration does not encompass the full spawning period of yellowfin grouper, nor does it prohibit fishing for other species for as long as a time period as Alternative 2. Alternative 7 is the smallest in size, which may not provide enough of a buffer around Grammanik Bank and the spawning aggregations, in turn potentially complicating enforcement. However, significant comment during Council meetings indicated there would be significant economic impact to other fisheries (e.g., yellowtail snapper) that are conducted near Grammanik Bank that could be prohibited if a large closed area were selected. Additionally, the Council wanted to ensure that the area pertinent to the year-round gear closure on Grammanik Bank to protect EFH (i.e., Section 4.7) would be consistent with the Grammanik Bank spawning aggregation closure. Alternative 8 further protects yellowfin grouper by prohibiting their harvest and possession during their documented spawning period, in conjunction with the closed area. This would protect undocumented spawning aggregations in federal waters of the U.S. Caribbean, as well as facilitate at-sea enforcement. However, since the Council opted to implement a seasonal closure for all species in Grouper Unit 4 during the entire yellowfin grouper spawning period, Alternative 8 would be redundant. Therefore, the Council selected Alternative 7 as the preferred alternative to further protect and conserve yellowfin grouper, which would be considered overfished based on the preferred stock status criteria alternatives in Section 4.2.

4.6 Achieving the MSFCMA Bycatch Mandates

The MSFCMA mandates that all FMPs shall "...establish a standardized reporting methodology to assess the amount and type of bycatch occurring in the fishery, and include conservation and management measures that, to the extent practicable and in the following priority – (A) minimize bycatch; and (B) minimize the mortality of bycatch which cannot be avoided" (MSFCMA §303(a)(11)). This section describes the alternatives the Council is considering to meet these two bycatch mandates.

The MSFCMA 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" (MSFCMA §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 a 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.

4.6.1 Bycatch reporting

4.6.1.1 Alternative 1. No action. Do not establish a standardized bycatch reporting methodology program in the U.S. Caribbean.

This alternative maintains the status quo. Currently, there is no program in place in the U.S. Caribbean to collect bycatch data.

4.6.1.2 Alternative 2. Develop and implement a federal permit system for commercial and charter boat fishermen participating in Council-managed fisheries, with an associated mandatory monthly reporting requirement.

Under this alternative, permits would be implemented for each fishery (e.g., conch permit, spiny lobster permit, reef fish permit). Permit renewal would be dependent upon submission of monthly catch reports, similar to what is currently required of USVI fishery participants. Permits would be issued to specific vessels. Initially, there would be no specific eligibility criteria required, so as to encourage issuance of permits to all vessels fishing in the EEZ.

The federal permit system for the U.S. Caribbean would be administered by NMFS SERO, or the SEFSC, or at a facility in Puerto Rico or the USVI. Although permits are typically issued on an annual basis, a renewal application is required every two years. In the interim year, renewal is automatic (without application) for a vessel owner or dealer who has met the specific requirements for the requested permit, license, or endorsement; who has submitted all reports required under the MSFCMA; and who is not subject to a sanction or denial.

The application and permitting process can be briefly summarized as follows: 1) initial mail out of applications; 2) application receipt; 3) permit data entry and issuance; 4) telephone correspondence regarding status of permits; 5) data request and questions following implementation, and 6) automatic renewal processes. Most permits are issued on the month of incorporation, or birth month of the individual, which spreads the permitting administrative workload throughout the calendar year.

A permit requirement (regardless of where that system is administered) allows implementation of a separate catch reporting requirement. Without a permit to identify and locate participating vessels, logbooks cannot easily be distributed. Permit holders will have to maintain a logbook to record their fishing activity. Logbook format and data reporting methods will be determined during the agency approval process. However, any permit-specific requirements are in addition to the following basic requirements. The permit holder must report catch, effort, and discards by species, location, time, and other factors as specified by the Council; report protected species observations; report any lost gear or damage to coral reef habitat (with no penalty); complete a daily logbook within 24 hours after completion of the fishing day; and submit reports within 30 days of returning to port. Reports would most likely be transmitted to the SEFSC for data management.

For an example permit application, see Appendix C.

4.6.1.3 Alternative 3 (Preferred). Utilize the MRFSS database to provide additional bycatch information on the recreational and subsistence sectors.

This alternative provides fishery managers a means to monitor the bycatch of individual recreational anglers and subsistence fishermen in Puerto Rico, and, if expanded, in the USVI.

4.6.1.4 Alternative 4 (Preferred). Consult with Puerto Rico and the USVI in an effort to modify the trip ticket system currently in place in the U.S. Caribbean to require standardized collection of bycatch data.

This alternative intends to implement standardized bycatch data reporting through the current trip ticket systems, which are managed at the state level. These systems were established in 1967 and 1974 in Puerto Rico and the USVI, respectively. Both programs have experienced a series of periodic lapses over the years, as well as significant under and/or misreporting, and changes in the type of data collected (Valle-Esquivel 2002). Landings in the USVI were historically reported by gear group (e.g., pot fish, net fish), while those in Puerto Rico were reported by species or species groups (e.g., Nassau grouper, grouper).

Presently, landings in both territories are recorded at the species or species-group level. Monthly commercial catch reporting is mandatory in both Puerto Rico and the USVI. Fishermen report landings in Puerto Rico and the USVI to the Puerto Rico DNER and the USVI DFW, respectively. Both state agencies are supported by NMFS through the State/Federal Cooperative Fisheries Statistics Program. Currently, Puerto Rico does not collect bycatch data, but the USVI initiated rudimentary bycatch reporting (i.e., pounds of bycatch by gear type) in 2004. Therefore, effort would be directed on modifying Puerto Rican landings reports to include consistent and standardized bycatch data.

Monthly landings data for Puerto Rico are collected from fishermen, fish buyers, and fishing associations by DNER port agents (four at the moment) and the program's principal investigator at 88 fishing centers in 42 coastal municipalities, including the islands of Vieques and Culebra. Prior to 2004, participation in the data collection program was voluntary. Currently, fishermen are required to submit monthly catch reports. Data fields on Puerto Rico's trip ticket form include fishing date; name of fish buyer, fisherman and/or helper; fishing license number; municipality; fishing center (landing area); number of trips reported; gear type; fishing effort (hours fishing); weight in pounds by species or taxonomic family; market value; depth; and fishing area (less than or greater than 10 miles from shore). Tickets use numeric codes for common names and species identification. Data are computerized by DNER and submitted to NMFS in raw form on an annual basis (Valle-Esquivel 2002).

Landings data for the USVI fisheries are mailed or delivered to DFW on a monthly basis. DFW requires that all reports for a 12-month period (July to June) be submitted before renewing a commercial fishing license. The current trip ticket form, which was expanded to the entire territory between 1997 and 2000, requests data on family or species group harvested; gear type (hook and line, net, pot/trap, and dive); an estimate of fishing effort (the number of gear and the estimated time in hours fished during the trip); and area fished (including distance from shore (i.e., less than 3 miles, 3-200 miles, or greater than 200 miles) and location). The DFW computerizes and verifies data, and submits datasets to NMFS on an annual basis. Landings in St. Croix and St. Thomas/St. John are maintained in separate datasets (Valle-Esquivel 2002).

Both the specificity and accuracy of the data collected through the trip ticket systems is believed to have been improving in recent years. However, fishermen seldom complete the data fields that indicate what portion, if any, of their catches was taken from the U.S. EEZ. Consequently, fishery managers generally cannot distinguish between catches taken from federal and state waters (Valle-Esquivel, pers. comm.).

4.6.1.5 Comparison of the environmental effects of alternative bycatch reporting programs

Alternatives 1-4 would have a direct effect on the administrative and socioeconomic environment, and an indirect effect on the biological environment. Alternative 1 adversely affects the administrative environment because the MSFCMA mandates that a standardized reporting methodology to assess the amount and type of bycatch occurring in the fishery be established. The indirect biological, socioeconomic effects associated with this alternative also could be adverse if excessive and unreported bycatch jeopardized the sustainability of managed fisheries.

Alternatives 2-4 offer direct benefit to the administrative environment by helping fishery managers to fulfill legal administrative and conservation mandates. However, there would also be indirect negative administrative and socioeconomic impacts associated with Alternatives 2 and Alternative 3, in that a new permit system would have to be funded and established for Alternative 2, and that MRFSS would have to be expanded, which would require funding and personnel, under Alternative 3. Yet, the impacts associated with expanding the MRFSS survey to the USVI under Alternative 3 are expected to be overshadowed by the benefits provided by better recreational data, which can improve management of that fishery. The indirect biological benefits, and adverse socioeconomic effects, associated with these alternatives are expected to be greatest for Alternative 2, followed by Alternative 4, then Alternative 3. Because the USVI recently implemented mandatory bycatch reporting, Alternative 4 presents the most likely alternative that could produce beneficial commercial bycatch information within the U.S. Caribbean. Therefore, the Council selected Alternatives 3 and 4 as the preferred alternatives to establish a standardized bycatch reporting system in the U.S. Caribbean.

4.6.2 Minimizing bycatch and bycatch mortality to the extent practicable

There are scant data on commercial and recreational bycatch in the U.S. Caribbean region. Rosario (1993) estimated, based on fishery-independent data from the SEAMAP-Caribbean program collected off the west coast of Puerto Rico, that about 14% by number and 17% by weight of the fish caught in the commercial hook and line fishery are species with low market value, including squirrel fishes, butterfly fishes, doctor fishes, puffers, filefish, and scorpion fish. However, anecdotal information suggests that the vast majority of fish harvested in the U.S. Caribbean are retained for the market or for personal use – including species with low market value. With the exception of species that are commonly believed to be ciguatoxic, economic discards in this region appear to be minimal.

Regulatory discards may potentially include the following species:

- Nassau grouper. Federal law requires that Nassau grouper landed in the U.S. EEZ be returned to the water (catches of Nassau grouper in the state waters of the USVI are not regulated);
- Goliath grouper. Federal law requires that Goliath grouper landed in the U.S. EEZ be returned to the water;
- Butterfly fish. The harvest of some species of butterfly fish (*Chaetodon spp.*) is prohibited in federal waters (butterfly fish are also a prohibited species in the state waters of Puerto Rico. The USVI has permitted the catch of a small number of these species for scientific research/educational purposes);
- Sub-adult yellowtail snapper. Federal law requires that catches of yellowtail snapper under 12 inches in fork length be returned to the water (yellowtail snapper are not regulated in the state waters of the USVI, and the minimum size in Puerto Rico waters is 10.5 inches); and
- Sub-adult and berried spiny lobster. Federal law prohibits the retention of spiny lobster under 3.5 inches in carapace length and berried spiny lobsters (similar regulations are in place in state waters of Puerto Rico and the USVI).

The extent of these regulatory discards is unknown. 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. So, for example, the captain/crew of a boat boarded in the U.S. EEZ could claim that any prohibited and/or undersized species onboard were captured in state waters. The mortality rates associated with commercial and recreational bycatch also are unknown, but generally increase with depth (e.g., finfish taken from deeper water generally have a lower survival rate when returned to the water).

In determining the practicability of minimizing bycatch and bycatch mortality, the National Standards provides the following guidance: "(i) A determination of whether a conservation and management measure minimizes bycatch or bycatch mortality to the extent practicable, consistent with other national standards and maximization of net benefits to the Nation, should consider the following factors:

(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 nonconsumptive uses of fishery resources;
(I) Changes in the distribution of benefits and costs; and
(J) Social effects.

(ii) The Councils should 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 any of the factors listed in this paragraph (d)(3)" (50 CFR §600.350(d)(3)).

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.

This section describes alternatives considered by the Council to further minimize bycatch and bycatch mortality in federal fisheries of the Caribbean. The analysis of the practicability of these measures is provided in Section 6.6.2.

4.6.2.1 Alternative 1. No action. Rely on current management measures to minimize bycatch and bycatch mortality.

Current management measures that impact regulatory discards and discard mortality include minimum mesh size and escape vent requirements for traps. These apply primarily to species managed with minimum size limits (e.g. yellowtail snapper and spiny lobster), and do not reduce incidental catches of prohibited species (e.g., Nassau and Goliath grouper, and some species of butterfly fish), with the exception of those that are small enough to escape through the two-inch mesh. Some portion of the populations of prohibited species is likely protected by seasonal and area closures established by the Council primarily to protect mutton snapper and red hind spawning aggregations.

4.6.2.2 Alternative 2. Increase the minimum allowable mesh size for fish traps.

This alternative increases the minimum size of the mesh used in the construction of fish traps to provide for the increased escapement of juvenile fish and tropical species.

4.6.2.3 Alternative 3. Establish a minimum mesh size of two inches and a maximum mesh size of six inches, stretched mesh, for gill and trammel nets. Additionally, gill and trammel nets must be tended at all times.

This alternative establishes requirements for the construction and use of nets to increase the escapement of juvenile fishes and to decrease the occurrence of incidental catches.

4.6.2.4 Alternative 4 (Preferred). Amend current requirements for trap construction such that only one escape panel be required, which could be the door.

This alternative modifies the regulation implemented through a 1991 regulatory amendment to the Reef Fish FMP, which requires that each fish trap contains two degradable (escape) panels in addition to a self-destruct door fastening. Under this alternative, each fish trap must contain at least one degradable panel, which could be a self-destruct door fastening if the door was positioned on the side of the trap.

4.6.2.5 Comparison of the environmental effects and practicability of alternative bycatch reduction measures

It is unlikely that any of the alternatives would significantly reduce bycatch due to the nature of the Caribbean fisheries. Due to the fact that most Caribbean fishermen utilize much of what they catch, and due to the absence of fisheries that are noted for producing large amounts of bycatch (e.g., trawling), bycatch is not as a significant issue in the 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 here. Such discards will likely be further reduced if preferred alternatives identified in other sections of this amendment are retained and implemented (e.g., area closures, prohibition on filleting fish at sea). Therefore, the direct effects to the biological environment from any of these alternatives would be minimal.

Alternatives 2-4 result in direct, but relatively minor, effects to the socioeconomic and administrative environment, due to the required modifications of fishing gear. In general, the socioeconomic and administrative effect of Alternative 2 would be greater than those experienced by Alternatives 3-4. A larger mesh size in fish traps in Alternative 2 will likely result in reduced catch, and therefore reduced income for fishermen. 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 only employ one escape panel door. Regardless, the Council also opted to prohibit the use of gill and trammel nets in the 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.

4.7 Achieving the MSFCMA EFH mandates

The MSFCMA mandates that all FMPs shall "...describe and identify essential fish habitat for the fishery based on the guidelines established by the Secretary under section 305(b)(1)(A), minimizing to the extent practicable adverse effects on such habitat caused by fishing...." (MSFCMA §303(a)(7)). This section describes the preferred alternatives the Council is considering to meet these EFH mandates, which were developed in the EFH EIS.

4.7.1 Describe and identify EFH

4.7.1.1 Alternative 1. No action.

4.7.1.2 Alternative 2 (Preferred). Describe and identify EFH according to functional relationships between life history stages of Federally-managed species and Caribbean marine and estuarine habitats.

This alternative specifies functional relationships for life stages and habitat types that might be regarded as meriting special attention for their importance to managed species. The MSFCMA defined EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." These are the functions that marine and estuarine habitats support. Under this alternative, the distribution of species and life stages is inferred from information on these functional relationships. In particular, EFH is defined as:

- EFH for the spiny lobster fishery in the U.S. Caribbean consists of all waters from mean high water to the outer boundary of the EEZ – habitats used by phyllosome larvae – (Figure 2.2; EFH EIS) and seagrass, benthic algae, mangrove, coral, and live/hard bottom substrates from mean high water to 100 fathoms depth – used by other life stages – (Figure 2.38; EFH EIS), shown in the aggregate as Figure 2.39 (EFH EIS);
- EFH for the queen conch fishery in the U.S. Caribbean consists of all waters from mean high water to the outer boundary of the EEZ – habitats used by eggs and larvae – (Figure 2.2; EFH EIS) and seagrass, benthic algae, coral, live/hard bottom and sand/shell substrates from mean high water to 100 fathoms depth – used by other life stages – (Figure 2.40; EFH EIS), shown in the aggregate as Figure 2.39 (EFH EIS);
- EFH for the reef fish fishery in the U.S. Caribbean consists of all waters from mean high water to the outer boundary of the EEZ – habitats used by eggs and larvae – (Figure 2.2; EFH EIS) and all substrates from mean high water to 100 fathoms depth – used by other life stages – (Figure 2.41; EFH EIS), shown in the aggregate as Figure 2.39 (EFH EIS); and
- EFH for the coral fishery in the U.S. Caribbean consists of all waters from mean low water to the outer boundary of the EEZ – habitats used by larvae – (Figure 2.2; EFH EIS) and coral and hard bottom substrates from mean low water to 100

fathoms depth – used by other life stages – (Figure 2.42; EFH EIS), shown in the aggregate as Figure 2.39 (EFH EIS).

4.7.1.3 Alternative 3 (Preferred). Designate 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.

The EFH regulations encourage regional Fishery Management Councils to designate these HAPCs within areas identified as EFH in order to focus conservation priorities on specific habitat areas that play a particularly important role in the life cycles of federally managed fish species. The following HAPCs would be designated for the various FMPs:

Alternative 3a. Designate HAPCs in the Reef Fish FMP at the following areas based on the occurrence of confirmed spawning locations:

I. Puerto Rico
  A. Tourmaline Bank/Buoy 8 (Figure 2.29; EFH FSEIS) (50 CFR 622.33(a));
  B. Abrir La Sierra Bank/Buoy 6 (Figure 2.29; EFH FSEIS) (50 CFR 622.33(a));
  C. Bajo de Sico (Figure 2.29; EFH FSEIS) (50 CFR 622.33(a)); and
  D. Vieques, El Seco (Figure 2.30; EFH FSEIS).
II. St. Croix
  A. Mutton snapper spawning aggregation area (Figure 2.29; EFH FSEIS) (50 CFR 622.33(a));
  B. East of St. Croix (Lang Bank) (Figure 2.29; EFH FSEIS) (50 CFR 622.33(a)).
III. St. Thomas
  A. Hind Bank MCD (Figure 2.29; EFH FSEIS) (50 CFR 622.33(b)); and
  B. Grammanik Bank (Figure 2.29; EFH FSEIS).

Alternative 3b. Designate HAPC for the Reef Fish FMP as those EFH habitat areas or sites identified as having particular ecological importance to Caribbean reef fish species:

I. Puerto Rico
  A. Hacienda la Esperanza, Manití (Figure 2.31; EFH FSEIS);
  B. Bajuras and Tiberones, Isabela (Figure 2.31; EFH FSEIS);
  C. Cabezas de San Juan, Fajardo (Figure 2.31; EFH FSEIS);
  D. JOBANNERR, Jobos Bay (Figure 2.31; EFH FSEIS);
  E. Bioluminescent Bays, Vieques (Figure 2.31; EFH FSEIS);
  F. Boquerón State Forest (Figure 2.32; EFH FSEIS);
  G. Pantano Cibuco, Vega Baja (Figure 2.31; EFH FSEIS);
  H. Piñones State Forest (Figure 2.31; EFH FSEIS);
  I. Río Espiritu Santo, Río Grande (Figure 2.31; EFH FSEIS);

J. Seagrass beds of Culebra Island (nine sites designated as Resource Category 1 and two additional sites) (Figure 2.31; EFH FSEIS); and

K. Northwest Vieques seagrass west of Mosquito Pier, Vieques (Figure 2.33; EFH FSEIS).

II. St. Thomas

A. Southeastern St. Thomas, including Cas Key and the mangrove lagoon in Great St. James Bay (Figure 2.34; EFH FSEIS); and

B. Saba Island/Perseverance Bay, including Flat Key and Black Point Reef (Figure 2.34; EFH FSEIS).

III. St. Croix

A. Salt River Bay National Historical Park and Ecological Preserve and Marine Reserve and Wildlife Sanctuary (Figure 2.36; EFH FSEIS);

B. Altona Lagoon (Figure 2.36; EFH FSEIS);

C. Great Pond (Figure 2.36; EFH FSEIS);

D. South Shore Industrial Area (Figure 2.36; EFH FSEIS); and

E. Sandy Point National Wildlife Refuge (Figure 2.36; EFH FSEIS)

Alternative 3c. Designate HAPC for the Coral FMP as those EFH habitat areas or sites identified as having particular ecological importance to Caribbean coral species:

I. Puerto Rico

A. Luis Peña Channel, Culebra (Figure 2.31; EFH FSEIS);

B. Mona/Monito (Figure 2.31; EFH FSEIS);

C. La Parguera, Lajas (Figure 2.32; EFH FSEIS);

D. Caja de Muertos, Ponce (Figure 2.32; EFH FSEIS);

E. Tourmaline Reef (Figure 2.32; EFH FSEIS);

F. Guánica State Forest (Figure 2.32; EFH FSEIS);

G. Punta Petrona, Santa Isabel (Figure 2.31; EFH FSEIS);

H. Ceiba State Forest (Figure 2.31; EFH FSEIS);

I. La Cordillera, Fajardo (Figure 2.31; EFH FSEIS);

J. Guayama Reefs (Figure 2.31; EFH FSEIS);

K. Steps and Tres Palmas, Rincon (Figure 2.31; EFH FSEIS);

L. Los Corchos Reef, Culebra (Figure 2.31; EFH FSEIS); and

M. Desecheo Reefs, Desecheo (Figure 2.31; EFH FSEIS)

II. St. Croix

A. St. Croix Coral Reef Area of Particular Concern, including the East End Marine Park (Figure 2.36; EFH FSEIS);

B. Buck Island Reef National Monument (Figure 2.36; EFH FSEIS);

C. South Shore Industrial Area Patch Reef and Deep Reef System (Figure 2.36; EFH FSEIS);

D. Frederiksted Reef System (Figure 2.36; EFH FSEIS);

E. Cane Bay (Figure 2.36; EFH FSEIS); and

F. Green Cay Wildlife Refuge (Figure 2.36; EFH FSEIS).

4.7.1.4 Comparison of the environmental effects and practicability of EFH identification measures

Please refer to Sections 2, 4.3, and 4.5 of the EFH EIS. To summarize, identification and designation of EFH will not have a direct effect on the biological or physical environment, but is likely to present indirect effects to the administrative environment due to consultation requirements, and result in controversy within the social environment due to differences in desired methodologies for designating EFH and HAPCs. It is expected that the identification and description of EFH and HAPCs will indirectly benefit the biological and physical environments, due to the EFH consultation requirements.

4.7.2 Minimize adverse effects on EFH

4.7.2.1 Alternative 1. No action.

4.7.2.2 Alternative 2 (Preferred). Establish modifications to anchoring techniques; establish 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.

The measures include the following:

- Require at least one buoy that floats on the surface on all individual traps/pots;
- Require at least one buoy at each end of trap lines linking traps/pots for all fishing vessels that fish for or possess Caribbean spiny lobster or Caribbean reef fish species in or from the EEZ under the Spiny Lobster and Reef Fish FMPs;
- Require an anchor retrieval system that insures the anchor is recovered by its crown in order to prevent 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 towards the crown. For a fluke or plow-type anchor (e.g., Danforth, Delta, Fortress, etc.), a trip line consisting of a line from the crown of the anchor to a surface buoy (Figure 2.43; EFH EIS) would be required. This would apply to all commercial and recreational fishing vessels that fish for or possess Caribbean reef species in or from the EEZ; and
- Prohibit 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 (as defined by the preferred alternative in Section 4.5) in the EEZ under the Spiny Lobster and Reef Fish FMPs.

4.7.2.3 Comparison of the environmental effects and practicability of measures to minimize adverse effects on EFH

Please refer to Sections 2 and 4 of the EFH EIS. To summarize, this alternative may result in small benefits to the biological and physical environment by increasing biodiversity of coral through the reduction of continuous, but low-level impacts to coral. This alternative is expected to have a small effect on the biological environment due to the fact that only about 14% of fishable habitat consisting of coral reef species exists in the EEZ, where the Council and NMFS have jurisdiction. The alternative will have a direct effect on the socioeconomic environment, by requiring gear modification and changes in fisheries practices. Indirect administrative impacts are expected to be small, but in large part should be beneficial, as this alternative will allow managers to comply with MSFCMA and other conservation requirements. Additionally, the gear requirements will require enforcement to insure compliance in some cases. Alternative 2 introduces significant administrative effects due to potential difficulties in enforcement of such a small closed area specific to only certain types of gear (similar to those outlined in Section 4.5).

5 Description of the fishery/affected environment

5.1 Physical environment

The U.S. Caribbean is located in the eastern extreme of the Caribbean archipelago, about 1,100 mi east-southeast of Miami, Florida (Figure 1) (Olcott 1999). It comprises the Commonwealth of Puerto Rico in the Greater Antilles and the Territory of the USVI in the Lesser Antilles island chain, both of which separate the Caribbean Sea from the western central Atlantic Ocean.

The rectangular-shaped island of Puerto Rico is the smallest and the most eastern island of the Greater Antilles (CFMC 2002c), and is located between the North Atlantic Ocean and the Caribbean Sea. The island measures about 110 mi from east to west; 40 mi from north to south. The overall area of Puerto Rico, including its principal offshore islands of Vieques, Culebra, and Mona, is estimated at 3,471 mi^2 (Olcott 1999); the combined length of its coasts, 700 mi (CFMC 2002c).

The USVI are part of the Virgin Islands chain, which lies about 50 mi east of Puerto Rico and consist of about 80 islands and cays (Olcott 1999). The USVI include the largest and most important islands of the Virgin Islands chain: St. Croix, St. Thomas, and St. John. Together, their coastlines extend about 175 mi. St. Croix is located about 40 nm (74 km) south of St. Thomas and St. John (CFMC 2002c). Covering about 84 mi^2, that island is entirely surrounded by the Caribbean Sea. The islands of St. Thomas and St. John are bordered by the Atlantic Ocean to the north and the Caribbean Sea to the south. Their respective areas are about 32 and 19 mi^2 (Olcott 1999).

More detailed information on the physical environment can be found in Section 3.1 of the EFH FSEIS (CFMC 2004).

5.1.1 Geology

The nearshore waters of Puerto Rico range from 0-20 m in depth and outer shelf waters range from 20-30 m in depth at the depth of the shelf break. The north coast of Puerto Rico is marked by a narrow insular shelf that is only 2-3 km wide. Depths extend to over 1,200 ft (400 m) beyond the shelf break (CFMC 2002c); the deepest point in the Atlantic Ocean, the Milwaukee Depth, lies at a depth of 27,493 feet (8,380 m) in the western end of the Puerto Rico Trench, about 100 miles (160 km) northwest of the island. Mona Passage, measuring about 75 mi (120 km) wide and more than 3,300 ft (1,000 m) deep, separates Puerto Rico from Hispaniola to the west. The southeast coast has a narrow shelf approximately 8 km wide (CFMC 2002c), after which the sea bottom descends to the 16,400 ft (5,000 m) deep Venezuelan Basin of the Caribbean Sea. The east coast lies on the same geological platform as the USVI of St. Thomas and St. John. Waters in that area extend to depths of less than 240 ft (73 m) throughout (CFMC 2002c).

The shelf shared by the islands of St. Thomas and St. John is about 12.9 km wide on the south and 32.2 km wide on the north (Goenaga and Boulon 1992). St. Croix, which lies on a different geological platform, is separated from the other islands by a 4,000 m-deep trench (CFMC 2002c). The St. Croix shelf is much narrower and shallower than that of the northern islands (Goenaga and Boulon 1992), extending only 4 km wide in the south, less than 0.2 km wide on the northwest, though up to several km wide in the northeast and out on Lang Bank (CFMC 2002c).

5.1.2 Oceanography and climate

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 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 2002c). 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 100 km south of the U.S. Caribbean islands at an average speed of 0.5 to 1 knots (CFMC 2002c). The current is characterized by large cyclonic and anticyclonic gyres. Its flow exits the Caribbean through the Yucatan Strait into the Gulf of Mexico and, to the northwest, into the North Atlantic (Kjerfve 1998). Its strength is influenced by changes in the position of the inter-tropical convergence zone (ITCZ). It increases in strength during the winter when the thermal equator is farthest south. It decreases in strength during the summer when the thermal equator shifts north, and surface waters in the Caribbean are influenced by increasing precipitation. This is the time of year when the North Equatorial Counter Current is established and surface waters of the equatorial Atlantic are displaced to the east (Kjerfve 1998).

Fluctuations in the water mass transport of the Gulf Stream are influenced by seasonal changes in Caribbean surface salinity transport and to wind speed changes in the tropical-subtropical trade wind zone (Kjerfve 1998). Westerly trade wind circulations to the north are responsible for the major wind and wave patterns. High winds occur in the winter; hurricanes in the autumn (CFMC 2002c).

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 (Kjerfve 1998), generally in the late winter to spring (Kjerfve 1998; Olcott 1999). The wet season occurs when the ITCZ is at its most northerly position in the Caribbean, generally in the late summer into late fall (Kjerfve 1998; Olcott 1999); about 50 % of the annual rainfall occurs during this wet season. Average annual precipitation in Puerto Rico ranges from less than 40 in (101.6 cm) on the southern coastal plain, to greater than 200 in (512 cm) in the mountains. Along the coasts, average annual precipitation ranges from about 30 in (76.2 cm) on the lee side of the island along the southwestern coast to about 75 in (190.5 cm) on the windward north coast. Average annual precipitation ranges from less than 30 in (76.2 cm) to greater than 55 in (139.7 cm) in the USVI. Most of the precipitation in this region is returned to the atmosphere by evapotranspiration – evaporation from the land and water surfaces and transpiration by plants (Olcott 1999).

Surface water salinity changes along with the seasonal change in precipitation. But precipitation affects salinity only indirectly. The discharge from the Amazon, Orinoco, and Magdalena rivers is the main contribution to buoyancy in the Caribbean, increasing silica concentrations, decreasing salinity and chlorophyll pigments, and increasing the input of terrestrial materials (Kjerfve 1998). The plume of the Orinoco River, as tracked by satellite imagery, seasonally penetrates across the Caribbean Basin, potentially exerting a region-wide influence (Kjerfve 1998). It could be responsible for events of high turbidity and algal blooms that often occur in the Caribbean Basin in October (CFMC 2002c).

Locally, Puerto Rico's rivers influence the nearshore environment by discharging silt, nutrients, various chemicals and, of course, freshwater. The USVI has no permanent streams, and outflows only occur during periods of heavy rainfall. But these are sometimes sufficient to muddy coastal surface waters up to one half mile (0.8 km) from shore (CFMC 1985).

Sea surface temperature ranges from a minimum of 25 degrees Celsius in February-March to a maximum of about 28.5 degrees Celsius in August-September. Inshore temperatures may be higher (e.g., 30 degrees Celsius) due to shallower depths or, in some cases, to thermal plumes from generator plants (CFMC 2002c).

Tidal regimes differ between the north and south coasts. The fluctuations range from a diurnal tide of about 10 cm in the south coast to a semi-diurnal regime of between 60-100 cm along the north coast, where waves are larger (CFMC 2002c). But the astronomical tidal range is slight (20-30 cm) (Kjerfve 1998).

5.1.3 Major habitat types

The coastal-marine environment of Puerto Rico and the USVI is characterized by a wide variety of habitat types. NOAA's National Ocean Service has mapped 21 distinct benthic nearshore habitat types using aerial photographs acquired in 1999. Those maps display 49 km^2 of unconsolidated sediment, 721 km^2 of submerged vegetation, 73 km^2 of mangroves, and 756 km^2 of coral reef and colonized hard bottom over an area of 1600 km^2 in Puerto Rico. They document 24 km^2 of unconsolidated sediment, 161 km^2 of submerged vegetation, 2 km^2 of mangroves, and 300 km^2 of coral reef and hard bottom over an area of 490 km^2 in the USVI. Coral reefs, seagrass beds, and mangrove wetlands are the most productive marine habitat areas (CFMC 2002c). CFMC (2002c) provides an in-depth description of the distribution of these habitats, along with information on their ecological functions and condition. A summary of the habitat-life history associations of Caribbean Council-managed species is provided in Section 5.2 (Biological Environment).

Generally, the north coast of Puerto Rico is characterized by a mixture of coral and rock reefs. The east coast is characterized by a sandy bottom, which commonly contains algal and sponge communities. The southern shelf is characterized by hard or sand-algal bottoms with emergent coral reefs, seagrass beds, and shelf edge. A small seamount known as Grappler Bank lies 70 m below the surface waters about 25 mi (40.3 km) off the southeast coast of the island. An extensive seagrass bed extends 9 km off the central south coast to Caja de Muertos Island. Habitats along the southern portion of the west coast are similar to those of the south coast (CFMC 2002c).

A general description of the marine environments of the USVI is given in Island Resources Foundation (1977). The fringing reefs on St. John are said to be poorly developed (Randall 1963). Outside this area, in Coral Bay, a more-mature reef profile is found at Lagoon Point. St. Croix has the most extensive reefs, with many miles of bank-barrier reefs, often with algal ridges, extending in an almost unbroken line from Coakley Bay on the north coast, around the eastern tip to Great Pond Bay on the south coast. There are also numerous fringing and patch reefs. On the north coast, the eastern shelf is up to several kilometers wide and is rimmed by emergent Holocene reefs, considered to be the best developed on the island. The western portion is less than 0.2 km wide and is traversed by two small submarine canyons; in the Salt River and Cane Bay areas, the edge of the shelf drops precipitously into great depths and the reefs form a vertical wall supporting abundant growths of black coral. The south shore has a shelf up to 4 km wide (Hubbard *et al.* 1981). The reef zonation of the entire island has been mapped from aerial photographs for the Bureau of Land Management.

These environments are threatened by human activities, such as coastal development and fishing activities, but also by natural factors, such as El Niño Southern Oscillation events and hurricanes, which leave habitats more vulnerable to human disturbance. Climate changes resulting from global warming are also a threat. Bryant *et al.* (1998) reports that almost two-thirds of the mapped coral reefs in the Caribbean are at risk, and one-third are at high risk of impact resulting from increasing water temperatures.

Once the amendment is submitted for review by the Secretary, NMFS' Office of Sustainable Fisheries will request initiation of an EFH consultation from the Office of Habitat Conservation to determine whether the actions proposed in this amendment would adversely affect essential fish habitat.

Additional information on regional habitat types can be found in Section 3.2 of the EFH FSEIS (CFMC 2004).

5.2 Biological environment

5.2.1 Caribbean Council-managed species

This section summarizes the available information on the biology, life history, and status of Caribbean Council-managed species. NMFS' 2001 report to Congress on the status of U.S. fisheries classifies most stocks in the U.S. Caribbean as "unknown" (NMFS 2002). Because information on the status of stocks is required to calculate the biological parameters and stock status determination criteria proposed in this amendment, the SFA Working Group established by the Caribbean Council was required to make determinations on the status of those stocks for which no formal determination has been made. As stated in Restrepo *et al.* (1998), "in cases of severe data limitations, qualitative approaches may be necessary, including expert opinion and consensus-building methods."

The status determinations of the Working Group reported in the following sub-sections are based on best professional judgement, informed by available scientific and anecdotal information on a variety of factors, including the anecdotal observations of fishermen as reported by fishery managers, life history information, and the status of individual species as evaluated in other regions. The discussion resulting in these determinations took place at the 23-24 October 2002 meeting of the SFA Working Group in Carolina, Puerto Rico. Notice of the meeting location, date, and agenda was provided in the *Federal Register* (67 FR 63622). The minutes of that meeting are available by request from the Caribbean Council.

Detailed identification and description of EFH for managed species can be found in the EFH FSEIS (CFMC 2004).

5.2.1.1 Caribbean spiny lobster, *Panulirus argus*

The Caribbean spiny lobster belongs to the Palinuridae family, which contains about 50 different species of spiny lobsters in 8 genera. 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). This species is taken in commercial, subsistence, and recreational fisheries.

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). 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. Kanciruk (1980) estimates maximum age as 20 years.

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 year-round, 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. And it appears most likely that larvae spawned in the Caribbean could, for example, settle at Bermuda (Munro 1974a).

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).

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).

Tagging experiments indicate that, with few exceptions, adult spiny lobsters do not usually undertake extensive movements. But some studies show evidence of seasonal inshore-offshore movements, and of extensive mass migrations. 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. And 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).

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).

5.2.1.2 Caribbean conch resource

The term "conch" usually refers to gastropods of the family Strombidae (Genus *Strombus*), but is often applied to large, usually edible, gastropods in other families as well. As defined by the Caribbean Council's Queen Conch FMP, the Caribbean conch resource comprises 13 species of gastropods within the families Strombidae, Cymatiidae, Cassidae, Turbinellidae, Fasciolariidae, and Trochidae. But only one species, the queen conch (*Strombus gigas*), has been the focus of fishery management measures defined in that FMP.

5.2.1.2.1 Queen conch, *Strombus gigas*

A member of the Strombidae family, 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 is taken in both commercial and recreational fisheries.

The Queen Conch FMP (CFMC 1996a) provides a detailed description of the biology and life history of the queen conch. This species generally occurs on expanses of shelf to about 76 m (250 ft) 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. This species also occurs on gravel, coral rubble, smooth hard coral or beach rock bottoms, and sandy algal beds (CFMC 1996a).

The adult queen conch grows to 15-30.5 cm (6-12 in) in length (CFMC 1996a), weighs about 2 kg (4.4 lb), on average, and generally lives 6 to 7 years; although it may survive as many as 26 (Rhines 2000), or even 40 (CFMC 1996a) 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). Rhines (2000) reports age at maturation as 3.5 - 4 years. The average age of maturation of queen conch off Puerto Rico is 3.2 years (about 4 years for 100% maturation); off St. John, USVI, 3 years. This species reaches an acceptable market size at 17.8 cm (7 in), which translates to about 2.5 years of age (CFMC 1996a). Estimated natural mortality rate is 0.30 annually (Appeldoorn, pers. comm.).

Sexes are separate and fertilization is internal. Copulation can precede spawning events by several weeks (CFMC 1996a). Rhine (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. Spawning occurs in aggregations (CFMC 1996a).

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 1996a). 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 1996a).

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 43 km (26 mi) per day, or 900 km (540 mi) during the 3-week larval period. Eggs hatched off Puerto Rico and the USVI may supply conch to areas located downstream, such as Haiti, Dominican Republic, and Cuba. Conversely, islands situated upstream in the Caribbean arc may provide conch that settle in Puerto Rico and the USVI

(CFMC 1996a). However, the evidence of local retainment of larvae would suggest that it is important to focus primarily on management of the local conch stock.

Juveniles settle in shallow, subtidal habitats where they spend much of their first year buried in sediment (CFMC 1996a; CFMC, CFRAMP 1999; Rhines 2000). At shell lengths ranging from 5-10 cm (2-3.9 in), 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. Conch exhibit two migrational patterns. The first is an ontogenetic migration into deeper water, which generally becomes more pronounced in large juveniles, who leave nursery areas and move into deeper water (CFMC, CFRAMP 1999). Aggregations of over 100,000 juveniles have been reported in the Bahamas (CFMC 1996a). The second migration is related to spawning. Conch generally move inshore to spawn as temperatures start to increase in March, and return to deeper water in October. This migration is manifest 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).

Queen conch larvae feed on plankton (Rhine 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), and on hard bottomed 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 dogenes*) expropriates the shell of the queen conch after consuming the animal. The conchfish (*Astrapogon stellatus*), and possibly a *procellanid* crab, has a commensal relationship with the queen conch; the former spends the day within the conch's mantle cavity, emerging at night to feed (Colin 1978).

5.2.1.2.2 Other Caribbean conch resources

Less is known about the biology and status of the 12 other Caribbean conch species. The Council included these species in the management unit because they are occasionally marketed, but they are not generally of economic importance to U.S. Caribbean fisheries. Some, such as the milk conch (*Strombus costatus*) and West Indian fighting conch (*Strombus pugilis*), are used for food, but to a lesser extent than queen conch. Others, such as the Atlantic triton's trumpet (*Charonia variegata*) and the flame helmet (*Cassis flammea*) are collected for the ornamental trade (CFMC 1996a).

This section summarizes the available information on the biology and life history of these species. The status of the other Caribbean conch resources is unknown. No definition of overfished or overfishing has been developed for these species (NMFS 2002). The SFA

Working Group did not make a determination on their status, as the preferred alternative in Section 4 is to move them to a monitoring-only category.

5.2.1.2.2.1 Atlantic triton's trumpet, *Charonia variegata*

A member of the Cymatiidae family, the Atlantic triton's trumpet occurs in the Western Atlantic, from North Carolina (USA) to the northern coast of South America, including the Gulf of Mexico and Caribbean Sea (The Academy of Natural Sciences of Philadelphia 2002). This species has also been recorded in the eastern Mediterranean Sea, off the Cape Verde Islands, and off St. Helena (Colin 1978). In the U.S. Caribbean, it has been reported off Mona Island, Puerto Rico, and off St. Thomas and St. Croix, USVI (The Academy of Natural Sciences of Philadelphia 2002).

One of the largest and highly prized Caribbean snails (Colin 1978; Sefton and Webster 1986), this species is generally found on sandy bottoms near reef habitat. It most commonly occurs to depths of about 10 m (Colin 1978) but, apparently, can be found to depths of 45 m (The Academy of Natural Sciences of Philadelphia 2002). Maximum reported length is 45 cm (Sefton and Webster 1986). This species is most active at night (Colin 1978), when it has been observed to feed on sea cucumbers (Colin 1978; Sefton and Webster 1986). It seeks shelter in holes and caves during the day (Sefton and Webster 1986).

5.2.1.2.2.2 Cameo helmet, *Cassis madagascarensis*

A member of the Cassidae family, the cameo helmet has been reported to depths of 27 m, from North Carolina (USA) to the northern coast of South America, including the Gulf of Mexico and Caribbean Sea. In the U.S. Caribbean, it has been reported off St. Thomas and St. Croix, USVI. Maximum reported length is 35 cm (The Academy of Natural Sciences of Philadelphia 2002).

5.2.1.2.2.3 Caribbean helmet, *Cassis tuberosa*

The Caribbean helmet is a member of the Cassidae family. Also known as the "king helmet," this species occurs to depths of about 20 m (Colin 1978), from North Carolina (USA) to the northern coast of South America, including the Gulf of Mexico and Caribbean. In the U.S. Caribbean, it has been reported off all three islands in the USVI (The Academy of Natural Sciences of Philadelphia 2002). This species most commonly occurs in seagrass beds, but can also be encountered on the sandy margins of reefs (Colin 1978). Maximum reported length is about 30 cm (The Academy of Natural Sciences of Philadelphia 2002). It has been observed to feed on sea urchins (Colin 1978).

5.2.1.2.2.4 Caribbean vase, *Vasum muricatum*

A member of the Turbinellidae family, the Caribbean vase has been reported to depths of 15 m, from Florida (USA) to the northern coast of South America, including the Gulf of Mexico and

Caribbean Sea. In the U.S. Caribbean, it has been reported off Puerto Rico and all three of the USVI. Maximum reported length is 12.5 cm (The Academy of Natural Sciences of Philadelphia 2002).

5.2.1.2.2.5 Flame helmet, *Cassis flammea*

A member of the Cassidae family, the flame helmet has been reported in depths to about 20 m (Colin 1978), from Florida (USA) to the northern coast of South America, including the Gulf of Mexico and Caribbean Sea. In the U.S. Caribbean, it has been reported off Puerto Rico and all three of the USVI. Maximum reported length is 15.4 cm (The Academy of Natural Sciences of Philadelphia 2002).

5.2.1.2.2.6 Green star shell, *Astrea tuber*

The green star shell is a small mollusc that ranges from South Florida throughout the West Indies. This species is typically found in shallow water. Average length is approximately 5.1 cm (Morris 1975).

5.2.1.2.2.7 Hawkwing conch, *Strombus raninus*

A member of the Strombidae family, the hawkwing conch has been reported in depths to 6 m from North Carolina (USA) to the northern coast of South America, including the Gulf of Mexico and Caribbean Sea. In the U.S. Caribbean, it has been reported off St. Thomas and St. Croix, USVI (The Academy of Natural Sciences of Philadelphia 2002). Usually found in seagrass meadows and sand flats, this species generally reaches 6.4-8.9 cm in length (CFMC 1996a). Maximum reported length is 12.1 cm (The Academy of Natural Sciences of Philadelphia 2002).

5.2.1.2.2.8 Milk conch, *Strombus costatus*

The milk conch is a member of the Strombidae family. Also known as the harbor conch (CFMC 1996a), this species has been reported in depths to 27 m, from North Carolina (USA) to the northern coast of South America, including the Gulf of Mexico and Caribbean Sea. In the U.S. Caribbean, it has been reported off St. Croix, USVI (The Academy of Natural Sciences of Philadelphia 2002). Usually found in seagrass meadows and sand flats, this species generally reaches 10-15 cm in length (CFMC 1996a). Maximum reported length is 23.1 cm (The Academy of Natural Sciences of Philadelphia 2002).

5.2.1.2.2.9 Roostertail conch, *Strombus gallus*

A member of the Strombidae family, the roostertail conch has been reported in depths to 48 m, from Florida (USA) to the northern coast of South America, including the Caribbean Sea. In the U.S. Caribbean, it has been reported off St. John, USVI (The Academy of Natural Sciences of

Philadelphia 2002). Usually found in seagrass meadows and sand flats, this species generally reaches 8.9-12.7 cm in length (CFMC 1996a). Maximum reported length is 19.7 cm (The Academy of Natural Sciences of Philadelphia 2002).

5.2.1.2.2.10 True tulip, *Fasciolaria tulipa*

A member of the Fasciolariidae family, the true tulip has been reported in depths to 37 m, from North Carolina (USA) to the northern coast of South America, including the Gulf of Mexico and Caribbean Sea. In the U.S. Caribbean, it has been reported off St. Croix, USVI. Maximum reported length is 25 cm (The Academy of Natural Sciences of Philadelphia 2002). The true tulip is a carnivorous snail, commonly found in shallow grassy areas and often stranded by the receding tide (Zeiller 1974).

5.2.1.2.2.11 West Indian fighting conch, *Strombus Pugilis*

A member of the Strombidae family, the West Indian fighting conch has been reported in depths to 55 m, from Florida (USA) to the northern coast of South America, including the Caribbean Sea. In the U.S. Caribbean, it has been reported off St. Croix, USVI (The Academy of Natural Sciences of Philadelphia 2002). Usually found in seagrass meadows and sand flats, this species generally reaches 5-7.6 cm in length (CFMC 1996a). Maximum reported length is 11 cm (The Academy of Natural Sciences of Philadelphia 2002).

5.2.1.2.2.12 Whelk (West Indian top shell), *Cittarium pica*

A member of the Trochidae family, the whelk has been reported in depths to 2 m, from the Florida Keys (USA) to the northern coast of South America, including the Caribbean Sea. In the U.S. Caribbean, it has been reported off St. Croix, USVI. Maximum reported length is 13.6 cm (The Academy of Natural Sciences of Philadelphia 2002).

5.2.1.3 Caribbean reef fish

The Caribbean reef fish fishery management unit comprises 140 species. Of these, 80 are taken primarily in commercial, subsistence, and/or recreational fisheries; the remainder are utilized primarily in the commercial aquarium trade and for private (recreational harvest) aquariums. This section summarizes the available information on the biology, life history, and status of these species. The status of these stocks has not been evaluated in a formal stock assessment. But Appeldoorn *et al.* (1992) reported on the reef fish fishery in 1992 based on an examination of available fishery landings and biostatistical data. At that time, the authors noted that, although insufficient data were available to measure overfishing, there was reasonable direct and anecdotal evidence to suggest that many species had been, and continued to be overexploited.

They reported that total landings in Puerto Rico had declined about 25% from 1931 to 1989, despite an estimated 30% and 55% increase in the respective number of fishermen and fishing vessels employed in the fishery during that same period of time. They also noted that several families comprised a smaller proportion of the total demersal catch, and that the composition of snapper catches had shifted from mostly shallow water to deeper water species. They concluded that total finfish landings for the USVI appeared reasonably stable between 1975 and 1989, the longest time period for which data were available, but that catch per unit effort based on fish traps had declined in both the USVI and Puerto Rico. And landings of larger individuals of common grouper species, such as coney and red hind, had decreased. They indicated that growth overfishing appeared to be a major problem, but that it could not be quantified because of the lack of essential biological data specifically tuned to Puerto Rico and the USVI (Appeldoorn *et al.* 1992).

The authors identified a number of means to improve the status of knowledge about this group. They recommended continuing efforts to standardize and improve data collection, entry, and storage, and to gather data on reef fish growth and fecundity necessary to produce yield-per-recruit models and calculate spawning potential ratios. The authors also identified the need to improve compliance and to secure compatible regulations between the Caribbean Council and the state governments, noting that, "without compatible regulations and cooperation to increase compliance, particularly by the Commonwealth of Puerto Rico, no improvements for the fishery can be anticipated because so little reef habitat is under direct Council control" (Appeldoorn *et al.* 1992).

5.2.1.3.1 Surgeonfishes, Acanthuridae

The Acanthuridae family contains about 75 species of surgeonfishes in 6 genera, distributed in most tropical waters across the globe. These species are commonly found in small groups, or larger aggregations, usually in association with coral reef habitat. Only three species are included in the Caribbean reef fish fishery management unit, and all belong to the genus *Acanthurus*. These fishes occur in both the Western and Eastern Atlantic, and have been observed to associate with larger mixed-species aggregations of other reef fishes, including parrotfishes, grunts, goatfishes, and wrasses. Almost entirely herbivorous, they compete with parrotfishes, various damselfishes, filefishes, and others for algae and plants. Sharks, rays, barracuda, the mutton hamlet, coney, groupers, snappers, and jacks have all been identified as predators of both juvenile and adult surgeonfishes. Surgeonfish larvae have been observed in the stomachs of skipjack, yellowfin, and blackfin tuna (Reeson 1975a). The spines on the caudal peduncle of these fishes are capable of inflicting painful wounds (Robins and Ray 1986 in Froese and Pauly 2002). The biology, life history, and status information specific to each species is described below.

5.2.1.3.1.1 Ocean surgeonfish, *Acanthurus bahianus*

In the Western Atlantic, the ocean surgeonfish ranges from Massachusetts (USA), southward to Brazil, including the Gulf of Mexico and Caribbean Sea. This species is fished for food and for bait, but is believed to be of minor importance to commercial fisheries. It also is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

The ocean surgeonfish inhabits 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).

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. 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).

No estimate of approximate life span or natural mortality is available. 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).

5.2.1.3.1.1.1 Doctorfish, *Acanthurus chirurgus*

In the Western Atlantic, the doctorfish ranges from Massachusetts (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. This species is considered to be of minor importance to commercial fisheries (Robins and Ray 1986 in Froese and Pauly 2002).

The doctorfish is 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).

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). 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). The approximate life span of the doctorfish is 10.9 years. Estimated natural mortality rate is 0.64 (Froese and Pauly 2002). 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).

5.2.1.3.1.2 Blue tang, *Acanthurus coeruleus*

In the Western Atlantic, the blue tang ranges from New York (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. This species is marketed fresh, and is occasionally used as bait. But it is considered to be of minor importance to commercial fisheries. It also is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

The blue tang is generally encountered in coral reef, or inshore grassy or rocky habitat, 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. 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).

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). The blue tang feeds almost entirely on algae (Robins and Ray 1986 in Froese and Pauly 2002), but also consumes organic detritus and seagrasses (Reeson 1975a).

5.2.1.3.2 Frogfishes, Antennariidae

The Frogfish family contains 41 species in 12 genera, distributed in most tropical waters around the globe (Pietsch and Grobecker 1987). Only the Genus *Antennarius* is represented in the Caribbean reef fish fishery management unit. Those species reported in Caribbean waters include the striated frogfish (*A. striatus*) (Pietsch and Grobecker 1987 in Froese and Pauly 2002), the island frogfish (*A. bermudensis*) (Böhlke and Chaplin 1993 in Froese and Pauly 2002), the ocellated frogfish (*A. ocellatus*), the dwarf frogfish (*A. pauciradiatus*), and the longlure frogfish (*A. multiocellatus*) (Robins and Ray 1986 in Froese and Pauly 2002). All are utilized primarily in the aquarium trade (Pietsch and Grobecker 1987 in Froese and Pauly 2002).

Both juvenile and adult frogfishes are benthic (Pietsch and Grobecker 1987 in Froese and Pauly 2002), often living in association with sponges on which they can be highly cryptic. Reported depth ranges are 4-30 m (island frogfish) (Böhlke and Chaplin 1993 in Froese and Pauly 2002), 0-66 m (longlure frogfish), 6-73 m (dwarf frogfish), up to 150 m (ocellated frogfish) (Robins and Ray 1986 in Froese and Pauly 2002), and 10-219 m (striated frogfish) (Pietsch and Grobecker 1987 in Froese and Pauly 2002). Maximum reported sizes range from 6.3 cm total length (TL) (dwarf frogfish) to 38 cm TL (ocellated frogfish) (Robins and Ray 1986 in Froese and Pauly 2002). These fishes feed voraciously on other fishes and crustaceans. Females produce thousands of eggs. Some, such as the striated frogfish, lay their eggs in a ribbon-like sheath or mass of gelatinous mass, called an "egg raft," or "veil;" others attach their eggs to their body (Pietsch and Grobecker 1987 in Froese and Pauly 2002).

5.2.1.3.3 Cardinalfishes, Apogonidae

The Cardinalfish family contains 207 species in 22 genera, distributed in the Atlantic, Indian, and Pacific Oceans (Nelson 1994 in Froese and Pauly 2002). The two species included in the Caribbean reef fish fishery management unit belong to the generas *Apogon* and *Astrapogen*. Both species are utilized primarily in the aquarium trade (Nelson 1994 in Froese and Pauly 2002).

5.2.1.3.3.1 Flamefish, *Apogon maculatus*

The flamefish occurs in the Western Atlantic, ranging from Massachusetts (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea (Robins and Ray 1986 in Froese and Pauly 2002).

The flamefish is found to 128 m depth, commonly along sea walls and pilings, in harbors, and in coral reef habitats. It is nocturnal, hiding in cracks and crevices during the day. Maximum reported size is 11.1 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at first maturity is estimated as 7.7 cm TL. Estimated natural mortality rate is 1.98 (Froese and Pauly 2002). Males brood eggs in their mouths, and have been observed with eggs in the Bahamas in the months of June and July. The diet of the flamefish is not described, but most known members of the cardinalfish family feed on zooplankton and benthic invertebrates (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.3.2 Conchfish, *Astrapogen stellatus*

The conchfish occurs in the Western Central Atlantic, ranging from Florida (USA) to northern South America, including the Caribbean Sea (Robins and Ray 1986 in Froese and Pauly 2002).

A demersal species, the conchfish is encountered to 40 m depth. It prefers the clear insular waters of oceanic islands. Maximum reported size is 8 cm SL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at first maturity is estimated as 5.8 cm standard length (SL) (Froese and Pauly 2002). No estimate of natural mortality rate is available. Males brood eggs in their mouths. This species has a commensal relationship with the queen conch, *Strombus gigas*, and with the stiff penshell , *Atrina rigida*, a bivalve. It occupies the mantle cavity of the former, emerging at night to feed on small crustaceans (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.4 Trumpetfishes, Aulostomidae

The Trumpetfish family contains three species within the genus *Aulostomus* (Nelson 1984 in Froese and Pauly 2002). Only one species, the trumpetfish (*A. maculatus*), is included in the Caribbean reef fish fishery management unit.

5.2.1.3.4.1 Trumpetfish, *Aulostomus maculatus*

The trumpetfish occurs in both the Western and Eastern Atlantic. In the Western Atlantic, its range extends from southern Florida (USA) to northern South America, including the Caribbean Sea. This species is marketed locally, but is considered to be of minor importance to commercial fisheries. It also is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

The trumpetfish is commonly found from depths of 2-25 m, in weedy areas and particularly around reefs, where it often swims among sea whips (gorgonians). Maximum reported size is 100 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at first maturity is estimated as 53.5 cm TL. Estimated natural mortality rate is 0.29 (Froese and Pauly 2002). This fish feeds on small fishes and crustaceans, often ambushing its prey from behind the bodies of large herbivorous fishes. It is capable of opening its mouth to the full diameter of its body to suck in prey items (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.5 Leatherjackets or Triggerfish, *Balistidae*

The Balistidae family contains 40 species in 11 genera, distributed in the Atlantic, Indian, and Pacific Oceans (Nelson 1994 in Froese and Pauly 2002). Only 4 genera are represented in the Caribbean reef fish fishery management unit: *Balistes*, *Canthidermes*, *Melichthys*, and *Xanthicthys*. These fish are popular and hardy aquarium trade species, but are often aggressive (Nelson 1994 in Froese and Pauly 2002). They are also a popular target of subsistence fishing on many islands.

5.2.1.3.5.1 Queen triggerfish, *Balistes vetula*

The queen triggerfish occurs in both the Eastern and Western Atlantic. In the Western Atlantic, its range extends 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. It is considered to be an excellent food fish, but its liver is poisonous (Robins and Ray 1986 in Froese and Pauly 2002). According to Robins and Ray (1986), in Froese and Pauly (2002), the queen triggerfish is of minor importance to commercial fisheries, but also is taken recreationally and utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002). It is often one of the most popular fishes to be taken artisanally and used for subsistence or local commerce.

The queen triggerfish is 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).

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. And 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). Approximate life span is 12.5 years. Estimated natural mortality rate is 0.48 (Froese and Pauly 2002). This fish primarily feeds on benthic invertebrates, such as sea urchins (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.5.2 Ocean triggerfish, *Canthidermis sufflamen*

The ocean triggerfish occurs in both the Western and Eastern Atlantic. In the Western Atlantic, it ranges from Massachusetts (USA) to South America, including the Gulf of Mexico and Caribbean Sea. This species is taken in both commercial and recreational fisheries, and also is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

The ocean triggerfish occurs 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. It is sometimes seen in association with the black durgon (Aiken 1975b).

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 4 individuals taken from Jamaican waters averaged 217 eggs per gram body weight. 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). Estimated natural mortality rate is 0.57 (Froese and Pauly 2002). 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).

5.2.1.3.5.3 Black durgon, *Melichthys niger*

The black durgon is widely distributed around the globe, occurring in the Western and Eastern Pacific, the Western and Eastern Atlantic, and the Western Indian Oceans. In the Western Atlantic, its range extends from Florida (USA) to Brazil, including the Caribbean Sea. It is apparently absent in the Gulf of Mexico. This species, known as the "black triggerfish" in some areas, is marketed fresh, but is considered to be of minor importance to commercial fisheries. It also is utilized in the aquarium trade (Matsuura 2001 in Froese and Pauly 2002).

Although present in many of the world's oceans, the black durgon commonly occurs only around isolated oceanic islands where it generally inhabits clear seaward reefs to 75 m depth (Matsuura 2001 in Froese and Pauly 2002). Individuals may be observed inshore, on occasion, in as little as 3-4 m of water. Like the ocean triggerfish, the black durgon usually occupies the mid-water column, and these two species are sometimes observed in association with one another (Aiken 1975b). Maximum reported size is 50 cm TL (male) (Matsuura 2001 in Froese and Pauly 2002). Size at maturity is estimated as 29 cm TL. Estimated natural mortality rate is 0.47 (Froese and Pauly 2002). Ripe fishes were observed in a Jamaican study during the month of March, and from August to November (Aiken 1975b). In the northeastern Caribbean, individuals in spawning condition have been observed in April (Erdman 1976). This species feeds primarily on calcareous algae and zooplankton, but also on phytoplankton (Matsuura 2001 in Froese and Pauly 2002). It may compete with the gray and French angelfishes, as these species feed mainly on sponges (Aiken 1975b).

5.2.1.3.5.4 Sargassum triggerfish, *Xanthichthys ringens*

The Sargassum triggerfish occurs in the Western Atlantic, ranging from North Carolina (USA), southward to Brazil, including the Caribbean Sea. This species is utilized primarily in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

The sargassum triggerfish occurs from 25-80 m depth, and is sometimes the most common fish on seaward reef slopes, usually well below 30 m depth (Robins and Ray 1986 in Froese and Pauly 2002). Juveniles often live among floating *Sargassum* (Aiken 1975b; Robins and Ray 1986 in Froese and Pauly 2002). Adults also may be found beneath *Sargassum* or other floating objects (Aiken 1975b). This fish is sometimes solitary; other times forms small groups. Maximum reported size is 25 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at first maturity is estimated as 15.7 cm TL. Estimated natural mortality rate is 1.11 (Froese and Pauly 2002). Spawning occurs in deep water (Robins and Ray 1986 in Froese and Pauly 2002). A Jamaican study, based on a small sample size, reported the occurrence of ripe fishes in March and November (Aiken 1975b). Prey items include crabs and sea urchins (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.6 Filefishes, *Monacanthidae*

The Monacanthidae family contains 95 species in 31 genera, distributed in the Atlantic, Indian, and Pacific Oceans (Nelson 1994 in Froese and Pauly 2002). Genera represented in the Caribbean reef fish fishery management unit include *Aluterus* and *Cantherhines*.

5.2.1.3.6.1 Scrawled filefish, *Aluterus scriptus*

The scrawled filefish occurs in the Western and Eastern Atlantic, and in the Eastern Pacific Oceans. Within the Western Atlantic, its range extends from Nova Scotia, Canada to Brazil, including the Gulf of Mexico and Caribbean Sea. This species is taken in commercial and recreational fisheries, and is also utilized in the aquarium trade (Hutchins 1986 in Froese and Pauly 2002). Halstead *et al.* (1990), in Froese and Pauly (2002), report that it can be ciguatoxic.

The scrawled filefish can be found from 4-120 m depth, in lagoons, seaward reef habitats and, on occasion, under floating objects. Maximum reported size is 110 cm TL (male); maximum weight, 2,500 g (Hutchins 1986 in Froese and Pauly 2002). Size at first maturity is estimated as 58.3 cm TL. Estimated natural mortality rate is 0.27 (Froese and Pauly 2002). The diet of this fish is composed of algae, seagrass, hydrozoans, gorgonians, colonial anemones, and tunicates (Hutchins 1986 in Froese and Pauly 2002).

5.2.1.3.6.2 Whitespotted filefish, *Cantherhines macrocerus*

Also known as the "American whitespotted filefish," this species occurs in both the Western and Eastern Atlantic Oceans. In the Western Atlantic, it ranges from Florida (USA) to Brazil, including the Caribbean Sea (Robins and Ray 1986 in Froese and Pauly 2002). It is taken in commercial and recreational fisheries, and also is utilized in the aquarium trade.

The whitespotted filefish inhabits coral reef or rocky bottom habitats, occurring from 5-25 m depth. It is often found among gorgonians, and generally occurs in pairs. Maximum reported size is 46 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 27 cm TL; natural mortality rate, as 0.72 (Froese and Pauly 2002). Its diet is composed primarily of sponges, gorgonians, and algae. But it also consumes hydroids and stinging coral (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.7 Combtooth blennies, Blenniidae

The Blennidae family contains 345 species in 53 genera, distributed in the Atlantic, Pacific, and Indian Oceans. Only one of these species, the redlip blenny (*Ophioblennius atlanticus*), is included in the Caribbean reef fish fishery management unit (Nelson 1994 in Froese and Pauly 2002).

5.2.1.3.7.1 Redlip blenny, *Ophioblennius atlanticus*

The redlip blenny occurs in both the Eastern and Western Atlantic. In the Western Atlantic, it ranges from North Carolina (USA) to Brazil, including the Caribbean Sea. It is reportedly rare in the northern Gulf of Mexico (Bath 1990 in Froese and Pauly 2002). This species is utilized primarily in the aquarium trade. Its bite can cause severe injuries (Bath 1990, and Jenyns 1842, in Froese and Pauly 2002).

Adults are restricted to shallow waters, generally less than 8 m in depth, and dwell among rocks and coral reefs, where there is considerable wave action. Maximum reported size is 19 cm TL (male) (Bath 1990 in Froese and Pauly 2002). Size at maturity is estimated as 12.4 cm TL; natural mortality rate, as 1.35 (Froese and Pauly 2002). In the northeastern Caribbean, individuals in spawning condition have been observed in June and July (Erdman 1976). Females deposit eggs in small holes, crevices, or empty bivalve shells, and nests are guarded by males or by both parents (Nelson 1994 in Froese and Pauly 2002). Larvae are pelagic. Filamentous algae is the primary food item (Bath 1990 in Froese and Pauly 2002).

5.2.1.3.8 Lefteye flounders, Bothidae

The Bothidae family contains 116 species in 13 genera, distributed in tropical and temperate waters of the Atlantic, Indian, and Pacific Oceans. Only one species, the peacock flounder (*Bothus lunatus*), is included in the Caribbean reef fish fishery management unit (Nelson 1994 in Froese and Pauly 2002).

5.2.1.3.8.1 Peacock flounder, *Bothus lunatus*

The peacock flounder occurs in both the Western and Eastern Atlantic. In the Western Atlantic, it ranges from Florida (USA) to Brazil, including the Caribbean Sea. It is reportedly absent in the Gulf of Mexico. This species is marketed fresh, but is considered to be of minor importance to commercial fisheries. It also is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

A demersal species, the peacock flounder is found to depths of 100 m in clear sandy areas near mangroves, among seagrass, coral, and rubble. It is the most common flounder species found in association with coral reefs (Robins and Ray 1986 in Froese and Pauly 2002). Maximum size is estimated as 46 cm TL; size at maturity, 27 cm TL. Estimated natural mortality rate is 0.72 (Froese and Pauly 2002). This fish is a pelagic spawner (Nelson 1994 in Froese and Pauly 2002). In the northeastern Caribbean, individuals in spawning condition have been observed in April (Erdman 1976). It feeds primarily on small fishes, but also on crustaceans and octopuses (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.9 Jacks, Carangidae

The Carangidae family contains 140 species in 33 genera, distributed in the Atlantic, Indian, and Pacific Oceans. Jacks are some of the most important tropical marine fishes for commercial, subsistence, and recreational fisheries (Nelson 1984 in Froese and Pauly 2002). Only two genera are represented in the Caribbean reef fish fishery management unit: *Caranx* and *Seriola*.

5.2.1.3.9.1 Yellow jack, *Caranx bartholomaei*

The yellow jack occurs in both the Western and Eastern Atlantic Oceans. In the Western Atlantic, its range extends from Massachusetts (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. This species is taken in both commercial and recreational fisheries (Cervigón 1993 in Froese and Pauly 2002). Dammann (1969), in Froese and Pauly (2002), reports that it can be ciguatoxic.

The yellow jack is generally found in offshore reef and open marine water habitat to 50 m depth. This fish is generally solitary, but also has been observed to occur in small groups. Juveniles are often found near the shore on seagrass beds (Cervigón 1993 in Froese and Pauly 2002), but are thought to move to the outer margins of the shelf at or before maturity (Thompson and Munro 1974c). They often occur in association with jellyfish or floating *Sargassum* (Cervigón 1993 in Froese and Pauly 2002).

Maximum reported size is 100 cm TL (male); maximum weight, 14 kg (Cervigón 1993 in Froese and Pauly 2002). Size at maturity is estimated as 53.5 cm TL; natural mortality rate, as 0.29 (Froese and Pauly 2002). Fecundity, as measured in a Jamaican study, is estimated at over one million eggs per ovary for large individuals (Thompson and Munro 1974c). According to Cervigón (1993), in Froese and Pauly (2002), this species spawns offshore from February to October. Thompson and Munro (1974c) report that ripe fishes have been collected in November over the oceanic banks off Jamaica. This species feeds on small fishes (Cervigón 1993 in Froese and Pauly 2002).

5.2.1.3.9.2 Blue runner, *Caranx crysos*

The blue runner occurs in both the Eastern and Western Atlantic. In the Western Atlantic, it ranges as far north as Nova Scotia, Canada, south to Brazil, including the Gulf of Mexico and throughout the Caribbean Sea. In the tropical Eastern Pacific, it is replaced by the green jack, *Caranx caballus*, which may be conspecific. An excellent food fish, the blue runner is taken in both commercial and recreational fisheries. It also is used for bait, and in the aquarium trade (Smith-Vaniz *et al.* 1990 in Froese and Pauly 2002). Dammann (1969), in Froese and Pauly (2002), reports that it can be ciguatoxic.

A pelagic species, the blue runner is found to 100 m depth, but generally stays close to the coast. Juveniles often occur in association with floating *Sargassum*. This species is highly resilient, with a minimum population doubling time of less than 15 months (K=0.32-0.38; tmax=11; Fec=41,000). Maximum reported size is 70 cm TL (male); maximum weight, 5,050 g (Smith-Vaniz *et al.* 1990 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated as 39.1 cm TL and 2.5 years, respectively (Froese and Pauly 2002). Maximum reported age is 11 years (Smith-Vaniz *et al.* 1990 in Froese and Pauly 2002). Estimated natural mortality rate is 0.49 (Froese and Pauly 2002). This fish is thought to form spawning aggregations (Thompson and Munro 1974c). Spawning period is protracted (Erdman 1976). Some studies suggest that spawning activity peaks from January through August. One estimated that the spawning season extends from February to September (Thompson and Munro 1974c). Erdman reported in 1976 that, historically, more adults captured off La Parguera were in spawning condition from March through May than at other times of the year. Prey items include fishes, shrimps, and other invertebrates (Smith-Vaniz *et al.* 1990 in Froese and Pauly 2002).

5.2.1.3.9.3 Horse-eye jack, *Caranx latus*

The horse-eye jack occurs in both the Western and Eastern Atlantic. In the Western Atlantic, it ranges from New Jersey (USA) to Brazil, including the Gulf of Mexico and throughout the Caribbean Sea. This species is considered to be of minor commercial importance, but also is targeted in recreational fisheries. It can be ciguatoxic (Robins and Ray 1986 in Froese and Pauly 2002).

The horse-eye jack is a pelagic schooling species, usually found in offshore reefs, where it often approaches divers. Its depth range is 60-140 m. Some individuals may penetrate into brackish water, and even ascend rivers. Juveniles are encountered along shores of sandy beaches; also over muddy bottoms. Maximum reported size is 101 cm FL (male); maximum weight is 13.4 kg (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated in Froese and Pauly (2002) as 54.1 cm FL. A study conducted in Jamaican waters reports that most fishes are probably mature by about 42.5 cm FL. Fecundity, as measured in that study, was estimated as over one million eggs per ovary for large individuals (Thompson and Munro 1974c). Erdman (1976) reports that the spawning period of this species is protracted. Thompson and Munro (1974c) report that spawning activity is believed to peak in or around February-April and September-October. Spawning is reported to occur June through August off Cuba (Garcia-Cagide *et al.* 1994). Natural mortality rate has not been estimated for this species. Prey items include fishes, shrimp, and other invertebrates (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.9.4 Black jack, *Caranx lugubris*

The black jack is widely distributed around the globe, occurring in the Western Indian, the Western and East Central Pacific, and the Western and Eastern Atlantic Oceans. In the Western Atlantic, it ranges from Bermuda to Brazil, including the Gulf of Mexico and Caribbean Sea. Commercial fisheries for this species are believed to be minor. But the black jack also is fished recreationally, and is cultured commercially (Paxton *et al.* 1989 in Froese and Pauly 2002). Lieske and Myers (1994), in Froese and Pauly (2002), report that it can be ciguatoxic.

A pelagic species, the black jack occurs in clear oceanic waters from 12-354 m depth. It is sometimes observed near drop-offs at the outer edge of reefs and, less commonly, over shallow banks. It occasionally forms schools. This species is of low resilience, with a minimum population doubling time of 4.5 - 14 years (K=0.12). Maximum reported size is 100 cm TL (male); maximum weight is 17.9 kg (Paxton *et al.* 1989 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated as 51.3 cm TL and 5.1 years, respectively. Approximate life span is 24 years. Estimated natural mortality rate is 0.27 (Froese and Pauly 2002). The spawning period of this species is protracted (Erdman 1976). This fish feeds at night, primarily on fishes (Paxton *et al.* 1989 in Froese and Pauly 2002).

5.2.1.3.9.5 Bar jack, *Caranx ruber*

The bar jack occurs in the Western Atlantic, ranging from New Jersey (USA) to southern Brazil, including the Gulf of Mexico and throughout the Caribbean Sea. This species is taken in both commercial and recreational fisheries. Large individuals can be ciguatoxic (Berry and Smith-Vaniz 1978 in Froese and Pauly 2002).

The bar jack is commonly found in clear insular areas or coral reef habitats off mainland coasts, from depths of 3-35 m. Juveniles frequent areas with *Sargassum* (Berry and Smith-Vaniz 1978 in Froese and Pauly 2002) and appear to be common in shallow water (0-15 m) reef habitats, but are thought to move to the outer margins of the shelf at or before maturity (Thompson and Munro 1974c). This fish is generally easily approached. It is sometimes solitary, but usually forms schools, possibly associated with spawning events (Berry and Smith-Vaniz 1978 in Froese and Pauly 2002). In the Bahamas, the bar jack has been observed to school near the surface in July and August. But the general movement and destination of these schools is unknown (Thompson and Munro 1974c).

This species is moderately resilient, with a minimum population doubling time of 1.4 - 4.4 years (K=0.14-0.24; tm=3; Fec=800,000). Maximum reported size is 59 cm FL and 69 cm TL for males and females, respectively. Maximum reported weight is 8,200 g (Berry and Smith-Vaniz 1978 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated in Froese and Pauly (2002) as 37.9 cm TL and 4.6 years, respectively. A study conducted in Jamaican waters reported minimum size of maturity for both males and females as 22-23.9 cm FL, mean length at maturity as about 24 cm TL for both sexes, and indicates that most fishes probably mature by 26-27 cm FL. The ovaries of three specimens measuring 25 cm, 28 cm, and 31 cm FL, were estimated to contain 131,917, 67,750, and 230,690 eggs, respectively. The authors of that study reported the occurrence of ripe fishes in all months of the year and suggested that, based on high proportions of ripe fishes seen in April and October, these might be the peak spawning months for this species (Thompson and Munro 1974c). Erdman (1976) agrees that the spawning period of this species is protracted. Garcia-Cagide *et al.* (1994) reported that peak spawning off Cuba occurrs during April and July. Estimated natural mortality rate is 0.33 (Froese and Pauly 2002). Prey items include fishes, shrimps and other invertebrates (Berry and Smith-Vaniz 1978 in Froese and Pauly 2002).

5.2.1.3.9.6 Greater amberjack, *Seriola dumerili*

The greater amberjack occurs in the Indo-West Pacific, and in the Western and Eastern Atlantic Oceans. In the Western Atlantic, it ranges as far north as Nova Scotia, Canada, southward to Brazil, including the Gulf of Mexico and the Caribbean Sea. This species is believed to be of minor importance to commercial fisheries. But it also is fished recreationally, and is utilized in the aquarium trade. It has been reported to be ciguatoxic in some areas (Paxton *et al.* 1989 in Froese and Pauly 2002).

The greater amberjack is found to depths of 360 m, inhabiting deep seaward reefs and, occasionally, coastal bays. Juveniles occur singly or in small schools in association with floating plants or debris in oceanic and offshore waters. This species is moderately resilient, with a minimum population doubling time of 1.4 - 4.4 years (K=0.18; tm=4). Maximum reported size is 190 cm TL (male); maximum weight, 80.6 kg (Paxton *et al.* 1989 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated as 78.8 cm TL and 2.3 years, respectively (Froese and Pauly 2002). Fecundity, as measured in a Jamaican study, is estimated at over one million eggs per ovary for large individuals. That study observed ripe individuals offshore in the months of August and November (Thompson and Munro 1974c). Off the Florida Keys, greater amberjack spawn from January through June with a peak occurring during February through April (MARMAP unpublished data). Approximate life span is 11.6 years. Estimated natural mortality rate is 0.40 (Froese and Pauly 2002). The greater amberjack feeds primarily on fishes such as the bigeye scad, but also on invertebrates (Paxton *et al.* 1989 in Froese and Pauly 2002).

5.2.1.3.9.7 Almaco jack, *Seriola rivoliana*

The almaco jack is widely distributed in waters around the globe. It occurs in the Indo-West Pacific, the Eastern Pacific, and the Western Atlantic, where it ranges from Cape Cod (USA) to northern Argentina. This species is thought to occur in the Eastern Atlantic as well. But the extent of its distribution there is not well established. The almaco jack is taken in both commercial and recreational fisheries (Myers 1991 in Froese and Pauly 2002). It may cause ciguatera poisoning, particularly those individuals taken in coral reef areas (Cervigón *et al.* 1992 in Froese and Pauly 2002; Myers 1991 in Froese and Pauly 2002).

A benthopelagic species, the almaco jack inhabits outer reef slopes and offshore banks; generally from 15-160 m depth, but possibly to deeper depths. It has been observed to occur in small groups. Juveniles are often seen around floating objects. Maximum reported size is 160 cm FL (male); maximum weight, 59.9 kg (Myers 1991 in Froese and Pauly 2002). Size at maturity is estimated as 81.1 cm FL (Froese and Pauly 2002). No estimate of natural mortality rate is available for this species. Fishes serve as its primary prey. But invertebrates also make up a portion of its diet (Myers 1991 in Froese and Pauly 2002).

5.2.1.3.10 Butterflyfishes, Chaetodontidae

The Chaetodontidae family contains 114 species of butterflyfishes in 10 genera, distributed in the tropical Atlantic, Indian, and Pacific Oceans (Nelson 1994 in Froese and Pauly 2002). Burgess (1978) reports that these residential fishes occur as individuals, commonly as pairs strongly or loosely bound together, as small groups of three or more, and as relatively large aggregations for feeding and, possibly, for spawning. But a study conducted in Jamaican waters noted that no schooling behavior has been reported for the four *Chaetodon* species included in the Caribbean reef fish fishery management unit, rather they tend to occur in smaller groups (Aiken 1975a). The authors of that study report that butterflyfishes of this genus usually occur in pairs; generally male and female. This is supported by reports that butterflyfish enter fish traps in pairs in the Virgin Islands (Aiken 1975a). It is suspected that these pairs form early in life, but stay together for purposes of spawning (Burgess 1978). Butterflyfishes are highly fecund (one gonad count showed 3000-4000 eggs) (Burgess 1978), producing many more eggs/g body weight than the angelfishes (Aiken 1975a). Eggs (Nelson 1994 in Froese and Pauly 2002) and, possibly, early juveniles (Aiken 1975a), are pelagic.

These fishes are typically diurnal (Nelson 1994 in Froese and Pauly 2002), and have been observed to feed on small invertebrates, including coral polyps and planktonic copepods, and, to a lesser extent, algae (Burgess 1978). They also ingest inorganic material such as sand and coral fragments and thus play a direct role in the transport of calcareous fragments by reef fishes (Aiken 1975a). Juveniles of many species have been observed removing parasites from other fishes. But, it is believed that the bulk of their food is obtained from other sources, and that parasite-picking behavior is only exhibited on occasion (Burgess 1978). These fishes show no direct evidence of competition among themselves (Aiken 1975a). They are preyed on by the same predators as other reef fishes, including moray eels, snappers, scorpionfishes, and groupers. Their diurnal behavior makes them easy prey to night-hunting predators such as moray eels, since they are comatose during the evening hours. Butterflyfish larvae are frequently found among stomach contents of large pelagic fishes; major predators appear to be tunas and dolphins (Burgess 1978).

CFMC (1985) reports that butterflyfishes in the U.S. Caribbean are consumed in the USVI, but not in Puerto Rico. They are of primary importance to the aquarium trade (CFMC 1985).

5.2.1.3.10.1 Longsnout butterflyfish, *Chaetodon aculeatus*

The longsnout butterflyfish occurs in the Western Atlantic, from southern Florida to northern South America and in the Gulf of Mexico and Caribbean Sea (Allen 1985 in Froese and Pauly 2002).

The longsnout butterflyfish occurs from 1-91 m depth (Allen 1985 in Froese and Pauly 2002; Burgess 1978), but is most commonly found on reefs (Allen 1985 in Froese and Pauly 2002) from 5-55 m depth (Burgess 1978). Maximum reported size is about 9 cm TL (male) (Aiken

1975a; Allen 1985 in Froese and Pauly 2002). Size at maturity is estimated as 6.4 cm TL; natural mortality rate, 2.29 (Froese and Pauly 2002). This fish feeds on small invertebrates (Allen 1985 in Froese and Pauly 2002; Burgess 1978) and is often seen nibbling on the tubefeet of sea urchins or the tentacles of tubeworms (Allen 1985 in Froese and Pauly 2002). It appears to be one of the butterflyfishes that does not pick parasites from the bodies of other fishes (Allen 1985 in Froese and Pauly 2002; Burgess 1978).

5.2.1.3.10.2 Foureye butterflyfish, *Chaetodon capistratus*

The foureye butterflyfish occurs in the Western Atlantic, ranging from Massachusetts (USA) to northern South America, including the Gulf of Mexico and Caribbean Sea (Allen 1985 in Froese and Pauly 2002). This species is common in the Caribbean and, in 1902, was reported as the most abundant butterflyfish in Puerto Rican waters (Burgess 1978). Olsen *et al.* (1984), in Froese and Pauly (2002), report that it can be ciguatoxic.

The foureye butterflyfish can be found in rocky and reef areas, and in seagrass (e.g., *Thalassia*) beds. One study indicates that juveniles are more apt to be taken in grass flats, the adults being reef fishes (Burgess 1978). This species occurs from2-20 m depth, generally singly or in pairs (Allen 1985 in Froese and Pauly 2002). It is generally easily approached (Allen 1985 in Froese and Pauly 2002). Allen (1985), in Froese and Pauly (2002), report maximum size as 7.5 cm TL (male). But the largest male captured in a study off Jamaican measured 14 cm TL; the largest female, 13 cm TL (Aiken 1975a).

Size at maturity, as estimated by Froese and Pauly (2002) is 5.4 cm TL; natural mortality rate, 1.81. The smallest mature specimens captured off Jamaica measured 7 cm TL (female) and 9 cm TL (male). Eggs per gram body weight calculated ranged from 181 for a specimen of 8 cm TL weighing 16 g (2,900 eggs total), to 478 for a specimen of 10.4 cm TL, weighing 27 g (12,900 eggs total) (Aiken 1975a). Data collected in Jamaican waters between September 1969 and February 1973 indicate that ripe fishes occur in every month except April (no data were collected for the month of October). Spawning peaks occurred between December and March (Aiken 1975a). In the northeastern Caribbean, individuals in spawning condition have been observed in April (Erdman 1976). The foureye butterflyfish feeds primarily on zoantharians, polychaete worms, gorgonians, and tunicates (Allen 1985 in Froese and Pauly 2002).

5.2.1.3.10.3 Spotfin butterflyfish, *Chaetodon ocellatus*

The spotfin butterflyfish occurs in the Western Atlantic; generally along the coast from Florida (USA) to Brazil, but also in the Gulf of Mexico and Caribbean Sea. Larvae, sometimes swept northward, probably accounts for the sighting of juvenile specimens off Massachusetts (USA) during the summer months, and even as far north as Nova Scotia (Canada) (Randall 1996 in Froese and Pauly 2002). Burgess (1978) reports the occurrence of juveniles in seines operated in eel grass at Wood's Hole. He also notes that they are fairly common off the New Jersey coast in the late summer months; but absent the rest of the year (Randall 1996 in Froese and Pauly 2002).

According to Randall (1996), in Froese and Pauly (2002), the spotfin butterflyfish can be found to 30 m depth. But Burgess (1978) reports that this species has been encountered rather frequently at depths of 40-80 m. These fishes are frequently observed in pairs and, sometimes, in small groups of four or five. They are reportedly more apt to swim and feed over comparatively bare and sandy areas than other species of butterflyfishes (Burgess 1978). Maximum reported size is 20 cm TL (male) (Randall 1996 in Froese and Pauly 2002).

Size at maturity is estimated as 12.9 cm TL; natural mortality rate, 1.30 (Froese and Pauly 2002). The smallest mature specimen observed in a study conducted in Caribbean waters was 11 cm TL (female). Number of eggs per gram body weight ranged from 110 for a specimen of 13.4 cm TL weighing 110 g (total of 12,500 eggs), to 464 for a specimen of 15.5 cm TL weighing 138 g (total of 64,000 eggs). Data collected in Jamaican waters from September 1969 to February 1973 indicate that small numbers of ripe fishes can be found year-round, but no data were collected for the months of March, April, and June. The greatest proportions of ripe fishes were found in January and May (Aiken 1975a). In the northeastern Caribbean, individuals in spawning condition have been observed in May (Erdman 1976).

5.2.1.3.10.4 Banded butterflyfish, *Chaetodon striatus*

The banded butterflyfish occurs in both the Western and Eastern Central Atlantic Oceans. In the Western Atlantic, it ranges from Massachusetts (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea (Allen 1985 in Froese and Pauly 2002).

The banded butterflyfish is usually found in association with reef habitat (Allen 1985 in Froese and Pauly 2002), but can also be found in tidal pools and in eel grass beds, where its barred pattern affords it some protective coloration. Coral rubble bottom only sparsely covered with algae has been reported to be a preferred habitat (Burgess 1978). Its known depth range extends from 3-55 m. These fishes generally occurs singly or in pairs. But adults may form plankton-feeding aggregations of up to 20 individuals, and occasionally clean other reef fishes which join the group, such as grunts, parrotfishes, and surgeonfishes (Allen 1985 in Froese and Pauly 2002).

Maximum reported size is 17 cm TL (male) (Allen 1985 in Froese and Pauly 2002). Size at maturity is estimated as 10.6 cm TL; natural mortality rate, 1.53 (Froese and Pauly 2002). The smallest mature fish captured in a study conducted in Caribbean waters was 13 cm TL (male). Number of eggs per gram body weight ranged from 220 for a specimen of 13.9 cm TL weighing 52 g (total of 11,450 eggs), to 600 for a smaller specimen of 11.7 cm TL weighing 42 g (total of 25,200 eggs). A study collected in Jamaican waters from September 1969 to February 1973 reported that the greatest proportion of ripe fishes was collected in January-February, but more than 40% of the fishes were ripe in all months (Aiken 1975a). In the northeastern Caribbean, individuals in spawning condition have been observed in April (Erdman 1976). Prey items include polychaete worms, coral polyps, crustaceans, and mollusk eggs (Allen 1985 in Froese and Pauly 2002).

5.2.1.3.11 Hawkfishes, Cirrhitidae

The Cirrhitidae family contains 32 species in 9 genera, distributed in the tropical Western and Eastern Atlantic, Indian, and Pacific (mainly Indo-Pacific) Oceans. Only one species, the redspotted hawkfish (*Amblycirrhitus pinos*) is included in the Caribbean reef fish fishery management unit (Nelson 1994 in Froese and Pauly 2002). It is utilized primarily in the aquarium trade.

5.2.1.3.11.1 Redspotted hawkfish, *Amblycirrhitus pinos*

The redspotted hawkfish occurs in the Western Atlantic, ranging from southern Florida (USA) to northern South America, including the Gulf of Mexico and Caribbean Sea. One observation in the Eastern Atlantic has also been reported (Robins and Ray 1986 in Froese and Pauly 2002).

The redspotted hawkfish is moderately common in rocky areas and among rubble, often in crevices and shallow caves, from depths of 2-46 m. Maximum reported size is 9.5 cm SL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 6.7 cm SL (Froese and Pauly 2002). No estimate of natural mortality rate is available for this species. This fish is a protogynous hermaphrodite, with few dominant males. Spawning takes place in open water near the surface (Nelson 1994 in Froese and Pauly 2002). It feeds mainly on small crustaceans, particularly copepods, shrimps and shrimp larvae, crabs, and crab larvae as well as polychaetes (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.12 Flying gurnards, Dactylopteridae

The Dactylopteridae family contains 7 species in 2 genera, distributed in the tropical Indo-Pacific and Atlantic Oceans. Only one species, the flying gurnard (*Dactylopterus volitans*) is included in the Caribbean reef fish fishery management unit (Nelson 1994 in Froese and Pauly 2002). This fish is taken in commercial and recreational fisheries, and also is utilized in the aquarium trade (Eschmeyer and Dempster 1990 in Froese and Pauly 2002). In the U.S. Caribbean, it is utilized primarily in the aquarium trade.

5.2.1.3.12.1 Flying gurnard, *Dactylopterus volitans*

The flying gurnard occurs in both the Western and Eastern Atlantic Oceans. In the Western Atlantic, it ranges from Massachusetts (USA) to Argentina, including the Gulf of Mexico (Eschmeyer and Dempster 1990 in Froese and Pauly 2002) and Caribbean Sea.

A benthic species (Nelson 1994 in Froese and Pauly 2002), the flying gurnard is found over reefs, on sand, mud, or over rocks in sandy areas, to 100 m depth. It exhibits a “walking” movement on the sea floor, accomplished by an alternate movement of the pelvic fins. Maximum reported size is 90 cm TL (male); maximum weight, 1,810 g. Size at maturity is estimated as 48.8 cm TL; natural mortality rate, 0.31 (Froese and Pauly 2002). Primary prey items include benthic crustaceans, especially crabs, as well as clams and small fishes (Eschmeyer and Dempster 1990 in Froese and Pauly 2002).

5.2.1.3.13 Spadefishes, Ephippidae

The Ephippidae family contains 20 species in 7 genera, distributed in the Atlantic, Indian, and Pacific Oceans (Nelson 1994 in Froese and Pauly 2002). Only one species, the Atlantic spadefish *(Chaetodipterus faber*) is included in the Caribbean reef fish fishery management unit. This fish is taken in commercial and recreational fisheries, is utilized in the aquarium trade, and has been reared in captivity (Robins and Ray 1986 in Froese and Pauly 2002). In the U.S. Caribbean, it is utilized primary in the aquarium trade. Olsen *et al.* (1984), in Froese and Pauly (2002), report that it can be ciguatoxic.

5.2.1.3.13.1 Atlantic spadefish, *Chaetodipterus faber*

The Atlantic spadefish occurs in the Western Atlantic, from Massachusetts (USA) to southeastern Brazil, including the Gulf of Mexico (Robins and Ray 1986 in Froese and Pauly 2002) and Caribbean Sea.

A demersal species, the Atlantic spadefish is found in depths of 3-35 m, and is abundant in shallow coastal waters, from mangroves and sandy beaches, to wrecks and harbors. It often circles divers. Juveniles (black phase) are common in estuaries and are often found in very shallow water swimming at an angle resembling dead leaves or as infertile red mangrove pods and other debris. Adults often occur in very large schools of up to 500 individuals. Maximum reported size is 91 cm TL (male); maximum weight, 9,000 g (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 49.3 cm TL; natural mortality rate, 0.31 (Froese and Pauly 2002). All members of the spadefish family are thought to be pelagic spawners (Nelson 1994 in Froese and Pauly 2002). In the northeastern Caribbean, individuals in spawning condition have been observed in May and September (Erdman 1976). This fish feeds on benthic invertebrates like crustaceans, mollusks, annelids, cnidarians, as well as on plankton (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.14 Gobies, Gobiidae

The largest family of marine fishes, the Gobiidae family contains at least 1,800 species in 212 genera, mostly distributed in tropical and subtropical areas (Nelson 1994 in Froese and Pauly 2002). The two species included in the Caribbean reef fish fishery management unit fall under the genera *Gobiosoma* and *Priolepis*. Both are utilized primarily in the aquarium trade.

5.2.1.3.14.1 Neon goby, *Gobiosoma oceanops*

The neon goby occurs in the Western Atlantic, from southern Florida (USA) to Belize, including the Gulf of Mexico (Robins and Ray 1986 in Froese and Pauly 2002) and Caribbean Sea. It has also been reared in captivity (Robins and Ray 1986 in Froese and Pauly 2002).

This fish is found in to 45 m depth, usually associated with coral heads. Maximum reported size is 5 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 3.8 cm TL; natural mortality rate, 3.39 (Froese and Pauly 2002). It removes ecto-parasites from other fishes (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.14.2 Rusty goby, *Priolepis hipoliti*

The rusty goby occurs in the Western Atlantic, ranging from southern Florida (USA) to northern South America, including the Caribbean Sea (Robins *et al.* 1991 in Froese and Pauly 2002).

This fish occurs to depths of 130 m. It is commonly found on shallow bottoms of coral reefs with clear water, usually on the undersides of ledges and roofs of caves. Maximum reported size is 4 cm TL (male) (Robins *et al.* 1991 in Froese and Pauly 2002). Size at maturity is estimated as 3.1 cm TL; natural mortality rate, 4.08 (Froese and Pauly 2002). It is generally sedentary and feeds on minute crustaceans (Robins *et al.* 1991 in Froese and Pauly 2002).

5.2.1.3.15 Basslets, Grammatidae

The Grammatidae family contains 9 species in 2 genera, distributed in the Western Atlantic and Western Pacific Oceans (Nelson 1984 in Froese and Pauly 2002). Only one species, the royal gramma (*Gramma loreto*) is included in the Caribbean reef fish fishery management unit. It is utilized primarily in the aquarium trade, and has been reared in captivity (Asoh and Yoshikawa 1996 in Froese and Pauly 2002).

5.2.1.3.15.1 Royal gramma, *Gramma loreto*

The royal gramma occurs in the Western Central Atlantic, from Bermuda, the Bahamas, and Central America, to northern South America (Asoh and Yoshikawa 1996 in Froese and Pauly 2002).

The royal gramma is found to 60 m depth, and is commonly observed in caves or under ledges, retreating into recesses when alarmed. Maximum reported size is 8 cm TL (male) (Asoh and Yoshikawa 1996 in Froese and Pauly 2002). Size at maturity is estimated as 5.8 cm TL; natural mortality rate, 2.43 (Froese and Pauly 2002). Males exhibit various types of nest care behavior. This fish feeds on the ecto-parasites of other fishes (Asoh and Yoshikawa 1996 in Froese and Pauly 2002).

5.2.1.3.16 Grunts, Haemulidae

The Haemulidae family contains 150 species in 17 genera, distributed in the Atlantic, Indian, and Pacific Oceans (Nelson 1994 in Froese and Pauly 2002). Genera represented in the Caribbean reef fish fishery management unit include *Anisotremus* and *Haemulon*. These species are considered to be important food fishes (Nelson 1994 in Froese and Pauly 2002). But Olsen *et al.* (1984), in Froese and Pauly (2002), report that all can be ciguatoxic.

The grunts are pelagic spawners (Nelson 1994 in Froese and Pauly 2002). Some species are thought to spawn two or more times each year for some species; others may spawn more or less continuously throughout the year. Several species are believed to form spawning aggregations. Both eggs and larvae are thought to be pelagic. Settlement takes place in shallow water, and the young of many species school on nursery grounds, such as shallow back-reef areas or grass beds, until reaching maturity when they join the adult schools. Adults of most species typically form schools of a few to several hundred fishes on coral reefs by day, and feed in adjacent areas by night. This schooling behavior is an important factor in trap fishing, as one study has shown that, when a few white grunts entered a trap, conspecific attraction tended to draw in more individuals. Schools of mixed species of grunts are common (Gaut and Munro 1974).

All grunts are carnivores, feeding largely on invertebrates, although some supplement their diet with small fishes. Both the wide variety of food items taken and apparent differences in preferred foods probably reduces the amount of interspecific competition for food. But the grunts do compete for food with many other reef fishes, including porgies (*Sparidae*), goatfishes (*Mullidae*), wrasses and hogfishes (*Labridae*), and mojarras (*Gerreidae*). Predators include groupers (*Serranidae*), snappers (*Lutjanidae*), and jacks (*Carangidae*) (Gaut and Munro 1974).

5.2.1.3.16.1 Porkfish, *Anisotremus virginicus*

The porkfish occurs in the Western Atlantic, ranging from Florida (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. It is not indigenous to waters off Bermuda. This species is fished commercially and also is utilized in the aquarium trade. It has been reared in captivity (Robins and Ray 1986 in Froese and Pauly 2002).

The porkfish inhabits reef and rocky bottom habitats from 2-20 m depth. Maximum reported size is 40.6 cm TL (male); maximum weight, 930 g (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 24.2 cm TL; natural mortality rate, 0.428 (Ault *et al.* 1998). Peak breeding season appears to be between January and April in Jamaican waters, and spawning probably occurs offshore (Gaut and Munro 1974). In the northeastern Caribbean, individuals in spawning condition have been observed in April, July, October, and December (Erdman 1976). This species feeds at night on mollusks, echinoderms, annelids, and crustaceans. Juveniles pick parasites from the bodies of larger fishes (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.16.2 Margate, *Haemulon album*

Also known as the "white margate," this species occurs in the Western Atlantic, from the Florida Keys (USA) to Brazil, including the Caribbean Sea. It is taken in commercial and recreational fisheries, and also is utilized in the aquarium trade (Cervigón 1993 in Froese and Pauly 2002).

The margate is found in pairs or larger schools, over seagrass beds, sand flats, coral reefs, and wrecks from 20-60 m depth. This fish is moderately resilient, with a minimum population doubling time of 1.4 - 4.4 years (K=0.19-0.20; tm=3.5; Fec=800,000). Maximum reported size is 79 cm TL (male); maximum weight, 7,140 g (Cervigón 1993 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated in Froese and Pauly (2002) as 40.2 cm TL and 3.2 years, respectively. A Jamaican study reports mean size at maturity as about 24 cm FL, and size of full mature as 26-27.98 cm FL (Gaut and Munro 1974). Approximate life span is 14.3 years. Estimated natural mortality rate is 0.374 (Ault *et al.* 1998). Peak breeding season appears to be between January and April in Jamaican waters, with a secondary, minor peak in September-November. But spawning is not necessarily synchronous in different localities (Gaut and Munro 1974). In the northeastern Caribbean, individuals in spawning condition have been observed in February, March, April, and September (Erdman 1976). Garcia-Cagide *et al.* (1994) have reported that margate off Cuba are in spawning condition throughout the year with a peak occurring during March and April. This fish feeds on benthic invertebrates, and has been observed to nose into the sand to eat such subsurface invertebrates as peanut worms and heart urchins (Cervigón 1993 in Froese and Pauly 2002).

5.2.1.3.16.3 Tomtate, *Haemulon aurolineatum*

The tomtate occurs in the Western Atlantic, ranging from Massachusetts (USA) to Brazil, including the Gulf of Mexico (Robins and Ray 1986 in Froese and Pauly 2002) and Caribbean Sea. This species is taken for food and for bait and is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

The tomtate inhabits seagrass beds, sand flats, patch reefs (Robins and Ray 1986 in Froese and Pauly 2002), and even muddy bottom habitat, to depths of 45 m. It has been observed to form schools or small groups near coral (Gaut and Munro 1974). This fish is moderately resilient, with a minimum population doubling time of 1.4 - 4.4 years (K=0.18-0.35; tmax=9; Fec=29,000). Maximum reported size is 25 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated as 19 cm TL and 3.4 years, respectively. Approximate life span is 13.5 years; natural mortality rate, 0.333 (Ault *et al.* 1998). Based on a small sample size, a Jamaican study reported a mean length of 15.4 cm, mean weight of 69 g, and a mean fecundity of 30,000. Peak breeding season appeared to be between January and April (Gaut and Munro 1974). In the northeastern Caribbean, individuals in spawning condition have been observed from January through May, and in July and August (Erdman 1976). Prey items include small crustaceans, mollusks, other benthic invertebrates, plankton, and algae (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.16.4 French grunt, *Haemulon flavolineatum*

The French grunt occurs in the Western Atlantic, ranging from Bermuda, South Carolina (USA), and the northern Gulf of Mexico, to Brazil, including the Caribbean Sea. This species is taken for food and for bait, and is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

The French grunt occurs in large schools on rocky and coral reefs to 60 m depth. It is often found under ledges or in association with elkhorn coral. Juveniles are abundant in nearshore seagrass beds. This fish is moderately resilient, with a minimum population doubling time of 1.4 - 4.4 years (K=0.24). Maximum reported size is 30 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 16.9 cm TL and 2.1 years, respectively. But a Jamaican study reports that individuals might often mature at lengths of 12 cm FL or less. The mean length of a small number of individuals captured in that study was 16.9 cm; mean weight was 109 g; and mean fecundity was 31,000 (Gaut and Munro 1974). Approximate life spawn is 8.1 years; natural mortality rate, 0.333 (Ault *et al.* 1998). It appears that breeding of this species probably is continuous at a low level throughout the year (Gaut and Munro 1974). In the northeastern Caribbean, individuals in spawning condition have been observed in March and September (Erdman 1976). Small crustaceans serve as the primary prey (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.16.5 White grunt, *Haemulon plumieri*

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. This fish supports commercial and recreational fisheries, is utilized in the aquarium trade, and has been reared in captivity (Courtenay and Sahlman 1978 in Froese and Pauly 2002).

The white grunt is 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. 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). 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). The white grunt feeds on crustaceans, small mollusks, and small fishes, and 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).

5.2.1.3.16.6 Bluestriped grunt, *Haemulon sciurus*

The bluestriped grunt occurs in the Western Atlantic, ranging from Florida (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. This species is generally considered to be of minor importance to commercial fisheries. But it also is utilized in the aquarium trade (Courtenay and Sahlman 1978 in Froese and Pauly 2002).

The bluestriped grunt is found in small groups over coral and rocky reefs to 30 m depth. Juveniles are abundant in seagrass (*Thalassia*) beds. This species is moderately resilient, with a minimum population doubling time of 1.4 - 4.4 years (K=0.22-0.30; tm=2; Fec=47,000). Maximum reported size is 46 cm TL (male); maximum reported weight, 750 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 23.6 cm TL and 2.3 years, respectively. A Jamaican study reported, based on a small sample size, that few fishes mature before 18 cm FL and that full maturity is probably at about 22 cm FL. For a sample size of just 3, mean length was 24.2 cm, mean weight was 283 g, and mean fecundity was 32,000 (Gaut and Munro 1974). Approximate life span is 9.5 years; natural mortality rate, 0.50 (Ault *et al.* 1998). Peak breeding season in Jamaican waters appears to be between January and April, with a secondary, minor peak in September-November (Gaut and Munro 1974). In the northeastern Caribbean, individuals in spawning condition have been observed in January and March (Erdman 1976). Off Cuba, bluestriped grunt are reported to be in spawning condition during October through April with a peak during December and January (Garcia-Cagide *et al.* 1994). The blue-striped grunt feeds on crustaceans, bivalves and, occasionally, on small fishes (Courtenay and Sahlman 1978 in Froese and Pauly 2002).

5.2.1.3.17 Squirrelfishes and Soldierfishes, Holocentridae

The Holocentridae family contains 65 species in 8 genera, distributed in the tropical Atlantic, Indian, and Pacific Oceans. Most members of this family are nocturnal, and hide during the day in crevices or beneath reef ledges, along with cardinalfishes, bigeyes, and sweepers. These fish are hardy aquarium trade species, and also important subsistence food fishes in many areas (Nelson 1994 in Froese and Pauly 2002). Genera represented in the Caribbean reef fish fishery management unit include *Myripristis*, *Holocentrus*, and *Plectrypops*.

5.2.1.3.17.1 Squirrelfish, *Holocentrus adscensionis*

The squirrelfish occurs in both the Western and Eastern Atlantic Oceans. In the Western Atlantic, it ranges from North Carolina (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. This species is considered to be of minor importance to commercial fisheries. But it is also utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002). Wyatt (1976) indicates that it appears to be a hardy fish, having been found to survive for several days in traps, and believed to be somewhat tolerant to pollution. Olsen *et al.* (1984), in Froese and Pauly (2002), report that it can be ciguatoxic.

The squirrelfish is found in shallow coral reefs and in deeper offshore waters, to 180 m depth (Robins and Ray 1986 in Froese and Pauly 2002). Wyatt (1976) reports that it is commonly found from 12-30 m depth in the Caribbean, whereas further north in American waters, it is more usually found at 8-12 m. Adults are demersal; juveniles, planktonic. Maximum reported size is 61 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 34.6 cm TL; natural mortality rate, 0.64 (Froese and Pauly 2002). The mean lengths of fishes captured in traps set in an inshore reef area off Jamaica were 19.5 cm FL and 16.5 cm FL for males and females, respectively. Most spawning in that area appears to occur from January to March, with a slightly smaller peak in October (Wyatt 1976). In the northeastern Caribbean, individuals in spawning condition have been observed in February, April, and September (Erdman 1976). The squirrelfish is a nocturnal species, hiding in deep crevices or under coral ledges during the day, and moving to sand and grass beds at night to feed (Robins and Ray 1986 in Froese and Pauly 2002) primarily on crabs and shrimp. Probable predators include sharks, snappers, and groupers (Wyatt 1976).

5.2.1.3.17.2 Longspine squirrelfish, *Holocentrus rufus*

The longspine squirrelfish occurs in the Western Atlantic Ocean, ranging from southern Florida (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. This species is considered to be of minor importance to commercial fisheries, but also is utilized in the aquarium trade. It is marketed fresh, but is not popular as a food fish (Robins and Ray 1986 in Froese and Pauly 2002). Wyatt (1976) indicates it appears to be a hardy fish, having been found to survive for several days in traps, and believed to be somewhat tolerant to pollution. Olsen *et al.* (1984), in Froese and Pauly (2002), report that it can be ciguatoxic.

The longspine squirrelfish is generally found to 32 m depth, near the mouths of caves and holes (Robins and Ray 1986 in Froese and Pauly 2002). Young are planktonic (Wyatt 1976). 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, 0.96 (Froese and Pauly 2002). Wyatt (1976) reports the mean length of males and females captured in offshore Jamaican waters was 17.5 cm. Spawning activity in Jamaican waters is believed to be similar to that of the squirrelfish, with the greatest proportion of ripe fishes observed in October and in February (Wyatt 1976). Wyatt (1983) reported that spawning of longspine squirrelfish occurred during August through June off Jamaica, In the northeastern Caribbean, individuals in spawning condition have been observed from February through March, in June, and from August through October (Erdman 1976). This species is nocturnal, and usually moves to sandy areas and grass beds at night to feed on crabs, shrimps, gastropods, and brittle stars (Robins and Ray 1986 in Froese and Pauly 2002). Probable predators include sharks, snappers, and groupers (Wyatt 1976).

5.2.1.3.17.3 Blackbar soldierfish, *Myripristis jacobus*

The blackbar soldierfish occurs in both the Western and Eastern Atlantic Oceans. In the Western

Atlantic, it ranges from North Carolina (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. This species is considered to be of minor importance to commercial fisheries, but also is utilized in the aquarium trade. It is marketed fresh, but is not popular as a food fish (Robins and Ray 1986 in Froese and Pauly 2002).

The blackbar soldierfish is a demersal species, commonly found aggregating around coral and deeper rocky reefs (Robins and Ray 1986 in Froese and Pauly 2002). According to Wyatt (1976), its depth range rarely exceeds 25 m. But Robins and Ray (1986), in Froese and Pauly (2002) report that it can be found to 100 m depth. Maximum reported size is 25 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 15.7 cm TL; natural mortality rate, 0.77 (Froese and Pauly 2002). In the northeastern Caribbean, individuals in spawning condition have been observed in March (Erdman 1976). This fish is largely nocturnal. It feeds primarily on planktonic organisms (Robins and Ray 1986 in Froese and Pauly 2002), and has a more restricted foraging range than other squirrelfish (Wyatt 1976). *Myripristis* spp. have been observed spawning in open water, a few days after the full moon (Nelson 1994 in Froese and Pauly 2002).

5.2.1.3.17.4 Cardinal soldierfish, *Plectrypops retrospinis*

The Cardinal soldierfish occurs in the Western Atlantic, ranging from Bermuda and southern Florida (USA) to northern South America, and throughout the Caribbean. This species is considered to be of minor importance to commercial fisheries, but also is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

The Cardinal soldierfish occurs to 22 m depth, but is rarely observed, generally remaining in deep recesses of coral reefs during the day. Maximum reported size is 15 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 10 cm TL; natural mortality rate, 1.60 (Froese and Pauly 2002).

5.2.1.3.18 Wrasses and Hogfish, Labridae

The Labridae family contains 500 species in 60 genera, distributed in the Atlantic, Indian, and Pacific Oceans (Nelson 1994 in Froese and Pauly 2002). Six genera are represented in the Caribbean reef fish fishery management unit: *Bodianus*, *Clepticus*, *Halichoeres*, *Hemipteronotus*, *Lachnolaimus*, and *Thalassoma*. Some of these species are utilized primarily in commercial fisheries; others in the aquarium trade.

5.2.1.3.18.1 Spanish hogfish, *Bodianus rufus*

The Spanish hogfish occurs in the Western Atlantic, ranging from Bermuda and southern Florida (USA) to southern Brazil, including the Gulf of Mexico and Caribbean Sea. This species is considered to be of minor importance to commercial fisheries. But it also is utilized in the aquarium trade. It may hybridize with the spotfin hogfish, *Bodianus pulchellus* (Robins and Ray

1986 in Froese and Pauly 2002). Dammann (1969), in Froese and Pauly (2002), report that it can be ciguatoxic.

The Spanish hogfish is found to 70 m depth over rocky or coral reefs. 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). In the northeastern Caribbean, individuals in spawning condition have been observed in February (Erdman 1976). 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).

5.2.1.3.18.2 Creole wrasse, *Clepticus parrae*

The creole wrasse occurs in the Western Atlantic, ranging from Bermuda and southern Florida (USA) to northern South America, including the Caribbean Sea. This species is believed to be of minor importance to commercial fisheries, but also is utilized in the aquarium trade (Cervigón 1993 in Froese and Pauly 2002).

The creole wrasse generally inhabits seaward reef slopes to depths of 40 m but, on occasion, it can be encountered on shallow patch reefs. Maximum reported size is 30 cm TL (male); maximum weight, 320 g (Cervigón 1993 in Froese and Pauly 2002). Size at maturity is estimated as 18.5 cm TL; natural mortality rate, 0.98 (Froese and Pauly 2002). This fish has been observed to spawn year-round in aggregations of hundreds of individuals off the southwest coast of Puerto Rico in depths of 10-30 m (Rielinger 1999). Also, it forms large midwater aggregations to feed on plankton, small jellyfishes, pteropods, pelagic tunicates, and various invertebrate larvae (Cervigón 1993 in Froese and Pauly 2002).

5.2.1.3.18.3 Yellowcheek wrasse, *Halichoeres cyanocephalus*

The yellowcheek wrasse occurs in the Western Atlantic, from Florida (USA) to Brazil, including the Caribbean Sea. Its small average size generally makes it of no interest to fisheries. But it is occasionally taken by recreational fishermen and also is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

The yellowcheek wrasse is generally found over hard substrates, from 27-91 m depth. Maximum reported size is 30 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 18.5 cm TL; natural mortality rate, 0.98 (Froese and Pauly 2002). Juveniles up to 8 cm tend defined cleaning stations sought by several species of reef fishes including damselfishes, goatfishes, and surgeonfishes (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.18.4 Yellowhead wrasse, *Halichoeres garnoti*

The yellowhead wrasse occurs in the Western Atlantic, from Bermuda and southern Florida (USA) to southeastern Brazil (Robins and Ray 1986 in Froese and Pauly 2002), including the Caribbean Sea. This species is generally of no interest to fisheries because of its small average size. But it is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

The yellowhead wrasse is commonly found from depths of 2-80 m, on shallow and deep reefs and exposed rocky ledges. Maximum reported size is 19.3 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 12.5 cm TL; natural mortality rate, 1.34 (Froese and Pauly 2002). This fish feeds on a variety of invertebrates. It is constantly on the move, but easily attracted by divers (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.18.5 Clown wrasse, *Halichoeres maculipinna*

The clown wrasse occurs in the Western Atlantic, from North Carolina (USA) and Bermuda to Brazil (Robins and Ray 1986 in Froese and Pauly 2002), including the Caribbean Sea. This species generally is of no interest to commercial fisheries because of its small average size. But it is utilized in the aquarium trade. The tri-colored pattern of the initial phase is similar to that of the juveniles of the yellowmouth grouper, *Mycteroperca interstitialis*, an aggressive mimic (Robins and Ray 1986 in Froese and Pauly 2002).

The clown wrasse is usually found in shallow rock areas and on reef tops, to depths of at least 25 m. It can also be found in seagrass (*Sargassum*) beds. But its solitary and cautious behavior can make it difficult to approach. Maximum reported size is 18 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 11.8 cm TL; natural mortality rate, 1.41 (Froese and Pauly 2002).

5.2.1.3.18.6 Puddingwife, *Halichoeres radiatus*

The puddingwife occurs in both the Western and Eastern Central Atlantic. In the Western Atlantic, it ranges 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. This species is believed to be of minor importance to commercial fisheries, but also is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002). Olsen *et al.* (1984), in Froese and Pauly (2002), report that it can be ciguatoxic.

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. 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). In the northeastern Caribbean, individuals in spawning condition have been observed in March, April, and December (Erdman

1976). Prey items include mollusks, sea urchins, crustaceans, and brittle stars (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.18.7 Pearly razorfish, *Hemipteronotus novacula*

The pearly razorfish occurs in both the Western and Eastern Atlantic Oceans. In the Western Atlantic, it ranges from North Carolina (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. This species is considered to be of minor importance to commercial fisheries. But it is also taken in recreational fisheries and is utilized in the aquarium trade (Gomon and Forsyth 1990 in Froese and Pauly 2002).

The pearly razorfish is a demersal species. It can be found to depths of 90 m, but most commonly inhabits clear shallow areas with sandy bottoms, usually in the vicinity of seagrass beds and corals. It builds nests with coral debris, and dives head first into the sand when frightened. Maximum reported size is 38 cm TL (male) (Gomon and Forsyth 1990 in Froese and Pauly 2002). Size at maturity is estimated as 22.8 cm TL; natural mortality rate, 0.63 (Froese and Pauly 2002). This fish is a protogynous hermaphrodite. Its diet is composed primarily of mollusks, but also of crabs and shrimps (Gomon and Forsyth 1990 in Froese and Pauly 2002).

5.2.1.3.18.8 Green razorfish, *Hemipteronotus splendens*

The green razorfish occurs in the Western Atlantic, from Bermuda and southern Florida (USA), to Brazil, and throughout the Caribbean Sea . This species generally is of no interest to commercial fisheries because of its small average size. But it is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

A demersal species, the green razorfish is most commonly encountered in shallow, sandy areas in and around seagrass beds, from 3-15 m depth. It prefers clear waters. Maximum reported size is 17.5 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 11.5 cm TL; natural mortality rate, 0.99 (Froese and Pauly 2002).

5.2.1.3.18.9 Hogfish, *Lachnolaimus maximus*

The hogfish occurs 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). This species is taken in both commercial and recreational fisheries, is utilized in the aquarium trade, and has been reared in captivity. It can be ciguatoxic (Robins and Ray 1986 in Froese and Pauly 2002).

The hogfish is found from 3-30 m depth, over open bottoms or coral reef habitats. It is often encountered where gorgonians are abundant. 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). 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. 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).

5.2.1.3.18.10 Bluehead wrasse, *Thalassoma bifasciatum*

The bluehead wrasse occurs in the Western Atlantic, from Bermuda and Florida (USA) to northern South America, including the Gulf of Mexico and the Caribbean Sea. The small average size of this fish generally makes it of no interest to commercial fisheries. But it is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

This species inhabits reef areas, inshore bays, and seagrass beds, to depths of 40 m. Maximum reported size is 25 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 15.7 cm TL (Froese and Pauly 2002). Maximum age is 3 years (Robins and Ray 1986 in Froese and Pauly 2002). Estimated natural mortality rate is 1.09 (Froese and Pauly 2002). This fish is reportedly hermaphroditic, and spawns at midday throughout the year. It feeds mainly on zooplankton and small benthic animals, but may also feed on ectoparasites of other fishes (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.19 Snappers, Lutjanidae

The Lutjanidae family contains 103 species in 17 genera, distributed in the tropical and subtropical Atlantic, Indian, and Pacific Oceans (Nelson 1984 in Froese and Pauly 2002). These fishes are generally slow-growing and moderately long-lived. Sexes are separate (Thompson and Munro 1974a). Some species are sequential hermaphrodites, but no indications of hermaphroditism have been observed for Caribbean Council-managed species. Genera represented in the Caribbean reef fish fishery management unit include *Apsilus*, *Etelis*, *Lutjanus*, *Ocyurus*, *Pristipomoides,* and *Rhomboplites*.

Most species are believed to exhibit sexually dimorphic growth rates and sizes at maturity (Thompson and Munro 1974a). These fishes are generally serial spawners, releasing several batches of eggs over a spawning season that sometimes extends year round (SAFMC 1999). Spawning activity generally peaks in the spring and summer months in the northeastern Caribbean (Erdman 1976). Annual fecundity reportedly ranges from one hundred thousand eggs released by young snappers and smaller species, to millions of eggs released by older snappers and larger species (SAFMC 1999; Thompson and Munro 1974a).

All species have complex life histories, with most dependent on different habitats during the egg, larval, juvenile, and adult phases of their life cycle. Eggs and early larvae are typically pelagic (AFS 2001). No long-lived oceanic larval or post-larval phases have been reported for snappers, as have been reported for many other reef fish families. Thus, they probably have a relatively short planktonic larval or post-larval life (Thompson and Munro 1974a). Larvae settle into various nearshore nursery habitats such as seagrass beds, mangroves, oyster reefs, and marshes (AFS 2001). Very early juvenile stages of snappers are not often seen but do not appear to be as secretive as hinds and groupers (Thompson and Munro 1974a).

Adults are generally sedentary and residential. Movement is generally localized and exhibits an offshore-inshore pattern, usually associated with spawning events. Many species have been reported to form mass spawning aggregations, where hundreds or even thousands of fish convene to reproduce (Rielinger 1999). Other species also aggregate to swim (Froese and Pauly 2001; SAFMC 1999). Generally, larger snapper inhabit deeper areas than smaller snapper, although there are many exceptions.

Juveniles occupying inshore areas generally feed on shrimp, crab, worms and small fish. Fish becomes a more important component of their diet as they grow and move offshore (SAFMC 1999). On reefs, snappers must certainly compete among themselves for food and space. A 1967 study reported that snappers in the Virgin Islands feed primarily on crabs and fishes, with shrimps, lobsters, gastropods, stomatopods and octopus completing the diet (Thompson and Munro 1974a). Competition with groupers (Serranidae), jacks (Carangidae), moray eels (Muraenidae) and grunts (Pomadasyidae) probably also occurs, although the extent of competition is not known. Predators of juvenile snappers include large carnivorous fishes, such as jacks, groupers, sharks, barracudas, and morays, as well as large sea mammals and turtles (SAFMC 1999). Major reef predators such as sharks, groupers and barracuda are probably the most important predators of adult snappers (Thompson and Munro 1974a).

5.2.1.3.19.1 Black snapper, *Apsilus dentatus*

The black snapper occurs in the Western Central Atlantic, off the Florida Keys (USA), and in the western Gulf of Mexico and Caribbean Sea. This species is considered to be a good food fish (Allen 1985 in Froese and Pauly 2002). But Halstead (1970), in Froese and Pauly (2002), report that it can be ciguatoxic.

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).

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). 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 January-April and September-November (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). Prey includes fishes and benthic organisms, including cephalopods, tunicates (Allen 1985 in Froese and Pauly 2002), and crustaceans (Thompson and Munro 1974a).

5.2.1.3.19.2 Queen snapper, *Etelis oculatus*

The queen snapper occurs in the Western Atlantic, ranging 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. This species is considered to be a good food fish (Allen 1985 in Froese and Pauly 2002)

The queen snapper is a bathydemersal species (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) indicate it is primarily found over rocky bottom habitat, in depths of 100-450 m. Thompson and Munro (1974a) report it was caught on mud slopes of the south Jamaica shelf at a depth of 460 m (Thompson and Munro 1974a). 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. Spawning is reported to occur during April and May off St. Lucia (Murray *et al.* 1992). Approximate life span is 4.7 years; natural mortality rate, 0.76 (Froese and Pauly 2002). Primary prey items include small fishes and squids (Allen 1985 in Froese and Pauly 2002).

5.2.1.3.19.3 Mutton snapper, *Lutjanus analis*

The mutton snapper occurs in the Western Atlantic, ranging 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). This fish is considered to be of high importance to commercial fisheries, and also is taken by recreational anglers (Allen 1985 in Froese and Pauly 2002). According to Olsen *et al.* (1984), in Froese and Pauly (2002), it can be ciguatoxic.

According to Allen (1985), in Froese and Pauly (2002), the 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).

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).

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).

This fish wanders a bit more than other snapper species (SAFMC 1999). But the extent of its movement is unknown. It forms small aggregations which disband during the night (Allen 1985 in Froese and Pauly 2002). It feeds both day and night on fishes, shrimps, crabs, cephalopods, and gastropods (Allen 1985 in Froese and Pauly 2002).

5.2.1.3.19.4 Schoolmaster snapper, *Lutjanus apodus*

The schoolmaster snapper occurs in both the Western and Eastern Atlantic Oceans. In the Western Atlantic, its range extends as far north as Massachusetts (USA), southward to Trinidad and northern Brazil, including the Gulf of Mexico and Caribbean Sea. This species is considered to be a good food fish (Allen 1985 in Froese and Pauly 2002). But Dammann (1969), in Froese and Pauly (2002), report that it can be ciguatoxic.

The schoolmaster snapper is 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).

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). 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).

This schoolmaster snapper sometimes forms resting aggregations during the day (Allen 1985 in Froese and Pauly 2002). Schools of this species observed over reefs off Florida dispersed at dusk in search of food (Thompson and Munro 1974a). Prey items include fishes, shrimps, crabs, worms, gastropods and cephalopods (Allen 1985 in Froese and Pauly 2002).

5.2.1.3.19.5 Blackfin snapper, *Lutjanus buccanella*

The 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. It is considered to be a good food fish, but can be ciguatoxic (Allen 1985 in Froese and Pauly 2002).

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).

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).

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). 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).

5.2.1.3.19.6 Gray snapper, *Lutjanus griseus*

The gray snapper occurs in the Western Atlantic, ranging from Massachusetts (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. A good food fish, this species is taken in both commercial and recreational fisheries. It also is utilized in the aquarium trade and has been reared in captivity (Allen 1985 in Froese and Pauly 2002). Halstead (1970), in Froese and Pauly (2002), report that it can be ciguatoxic.

The gray snapper occurs from 5-180 m depth, in coral reef habitat, rocky areas, estuaries, mangrove areas, and sometimes in the lower reaches of rivers (especially the young). This fish is easily approached. It often forms large aggregations (Allen 1985 in Froese and Pauly 2002). This fish is moderately resilient, with a minimum population doubling time of 1.4-4.4 years (K = 0.10; tm = 2-3; tmax = 21). Maximum reported size is 89 cm TL (male); maximum weight, 20 kg (Allen 1985 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated as 47 cm TL and 6.2 years (Froese and Pauly 2002). Maximum age is 21 years (Allen 1985 in Froese and Pauly 2002). Estimated natural mortality rate is 0.30 (Ault *et al.* 1998). Thompson and Munro (1974a) report that this species spawned at the Florida Cays in July and August. In the northeastern Caribbean, individuals in spawning condition have been observed in May, August, and September (Erdman 1976). Off Cuba, Garcia-Cagide *et al.*(1994) reported that gray snapper spawn during June through October with a peak in July. In Key West, FL, the spawning season for female gray snapper ranges from June to September with a peak in July (Domeier *et al.* 1993).

The gray snapper feeds mainly at night on small fishes, shrimps, crabs, gastropods, cephalopods, and some planktonic items (Allen 1985 in Froese and Pauly 2002). The stomachs of 18 juveniles collected off the south coast of Jamaica contained 60% by volume of larval fish and 40% crabs and shrimp (Thompson and Munro 1974a).

5.2.1.3.19.7 Dog snapper, *Lutjanus jocu*

The dog snapper occurs in both the Western and Eastern Atlantic. In the Western Atlantic, it ranges from Massachusetts (USA), southward to northern Brazil, including the Gulf of Mexico and Caribbean Sea. This species is taken in commercial fisheries and also is utilized in the aquarium trade. It can be ciguatoxic (Allen 1985 in Froese and Pauly 2002).

The dog snapper is 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). 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). 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). The dog snapper feeds mainly on fishes and benthic invertebrates, including shrimps, crabs, gastropods and cephalopods (Allen 1985 in Froese and Pauly 2002).

5.2.1.3.19.8 Mahogany snapper, *Lutjanus mahogoni*

The mahogany snapper occurs in the Western Atlantic, ranging from North Carolina (USA) to Venezuela, including the Gulf of Mexico and Caribbean Sea. This species is common in the Caribbean. It is taken in both commercial and recreational fisheries (Allen 1985 in Froese and Pauly 2002). According to Olsen *et al.* (1984), in Froese and Pauly (2002), it has been known to cause ciguatera poisoning.

The mahogany snapper is found to 100 m depth. It usually occurs in clear shallow waters over rocky bottoms in the vicinity of coral reefs, and is less frequently found in sandy or seagrass areas. It often forms large aggregations during the day (Allen 1985 in Froese and Pauly 2002) and has been observed to school in association with the white grunt, *Haemulon plumieri*, at Grand Cayman (Thompson and Munro 1974a). Maximum reported size is 48 cm TL (male); maximum weight, 1,300 g (Allen 1985 in Froese and Pauly 2002). Size at maturity is estimated as 28 cm TL; natural mortality rate, 0.30 (Ault *et al.* 1998). Erdman (1976) reports the occurrence of ripe females in August in the northeastern Caribbean. This fish feeds at night mainly on small fish, shrimps, crabs and cephalopods (Allen 1985 in Froese and Pauly 2002).

5.2.1.3.19.9 Lane snapper, *Lutjanus synagris*

The lane snapper occurs in the Western Atlantic, ranging 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. This species is taken in commercial and recreational fisheries, and also is utilized in the aquarium trade. It is considered to be a good food fish (Allen 1985 in Froese and Pauly 2002). According to Olsen *et al.* (1984), in Froese and Pauly (2002), it can be ciguatoxic.

The lane snapper can be found over all types of bottom, but is 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). 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).

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). But 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). This species feeds at night on small fishes, bottom-living crabs, shrimps, worms, gastropods and cephalopods (Allen 1985 in Froese and Pauly 2002).

5.2.1.3.19.10 Silk snapper, *Lutjanus vivanus*

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. A good food fish, this species is taken in both commercial and recreational fisheries. It can be ciguatoxic (Allen 1985 in Froese and Pauly 2002).

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.

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 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).

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).

5.2.1.3.19.11 Yellowtail snapper, *Ocyurus chrysurus*

The yellowtail snapper occurs in the Western Atlantic, ranging 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. It is taken in both the commercial and recreational fisheries, is cultured commercially, and is utilized in the aquarium trade (Allen 1985 in Froese and Pauly 2002). Dammann (1969), in Froese and Pauly (2002), reports that it can be ciguatoxic.

The yellowtail snapper inhabits waters to 180 m depth, and usually occurs 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).

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).

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).

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).

5.2.1.3.19.12 Wenchman, *Pristipomoides aquilonaris*

The wenchman occurs in the Western Atlantic, ranging from North Carolina (USA) to Guiana, including the Caribbean Sea. Although considered to be a good food fish, this species is believed to be of minor importance to commercial fisheries (Allen 1985 in Froese and Pauly 2002). Olsen *et al.* (1984), in Froese and Pauly (2002), report that it can be ciguatoxic.

The wenchman is a demersal species, found from 24-370 m depth. 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). Its diet is composed primarily of small fishes (Allen 1985 in Froese and Pauly 2002).

5.2.1.3.19.13 Vermilion snapper, *Rhomboplites aurorubens*

The vermilion snapper occurs in the Western Atlantic, ranging from Bermuda and North Carolina (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea (Allen 1985 in Froese and Pauly 2002).

The vermilion snapper is a demersal species, 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).

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).

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). Prey items include fishes, shrimps, crabs, polychaetes, other benthic invertebrates, cephalopods, and planktonic organisms (Allen 1985 in Froese and Pauly 2002).

5.2.1.3.20 Tilefishes, Malacanthidae

The Malacanthidae family contains 40 species in 5 genera, distributed in the Atlantic, Indian, and Pacific Oceans (Nelson 1984 in Froese and Pauly 2002). Only two genera are represented in the Caribbean reef fish fishery management unit: *Caulolatilus* and *Malacanthus*. All tilefish live in a burrow, some in a large rubble mound of their own construction, in pairs or colonies (Nelson 1984 in Froese and Pauly 2002).

5.2.1.3.20.1 Blackline tilefish, *Caulolatilus cyanops*

The blackline tilefish occurs in the Western Atlantic, from North Carolina (USA) and Bermuda to northern South America, and throughout the Caribbean. Highly appreciated as a food fish, this species is taken in both commercial and recreational fisheries (Dooley 1978 in Froese and Pauly 2002).

A demersal species, the blackline tilefish inhabits sandy and muddy bottom habitats from depths of 45-495 m. Maximum reported size is 60 cm TL (male); maximum weight, 11 kg (Dooley 1978 in Froese and Pauly 2002). Size at maturity is estimated as 34.1 cm TL; natural mortality rate, 0.42 (Froese and Pauly 2002). Prey items include invertebrates and small fishes (Dooley 1978 in Froese and Pauly 2002).

5.2.1.3.20.2 Sand tilefish, *Malacanthus plumieri*

The sand tilefish occurs in the Western and Southeast Atlantic. In the Western Atlantic, it ranges from North Carolina (USA) and Bermuda to Venezuela, Brazil, and to Rio de la Plata in Uruguay, including the Gulf of Mexico and Carribean Sea. This species is generally believed to be of minor importance to commercial fisheries. It tends to bite when handled (Dooley 1978 in Froese and Pauly 2002).

The sand tilefish can be found from 10-153 m depth, but is described as primarily a shallow-water benthic species. It generally occurs on sand and rubble bottoms, and is known to build mounds of rubble and shell fragments near reefs and grass beds, in which it hides its head when frightened. Maximum reported size is 70.0 cm SL (male); maximum weight, 1,020 g (Dooley 1978 in Froese and Pauly 2002). Size at maturity is estimated as 39.1 cm TL (Froese and Pauly 2002). No estimate of natural mortality rate is available for this species. Prey items include stomatopods, fishes, polychaete worms, chitons, sea urchins, sea stars, amphipods, and shrimps (Dooley 1978 in Froese and Pauly 2002).

5.2.1.3.21 Goatfishes, Mullidae

The Mullidae family contains 55 species in 6 genera, distributed in the Atlantic, Indian, and Pacific Oceans (Nelson 1994 in Froese and Pauly 2002). Only two genera are represented in the Caribbean reef fish fishery management unit: *Mulloidichthys* and *Pseudupeneus*. A Jamaican study reports that juveniles of these species are commonly observed in association with schools of juvenile grunts and that they might be, to some extent, competitive for the same foods. Other obvious competitors include wrasses, and small jacks, particularly the bar jack, C*aranx ruber*. Goatfishes probably fall prey to most of the larger reef predators including sharks, groupers, snappers, and jacks. Studies of age and growth and population structures indicate that these species do not likely survive more than 5 years (Munro 1974b).

5.2.1.3.21.1 Yellow goatfish, *Mulloidichthys martinicus*

The yellow goatfish occurs in both the Western and Eastern Atlantic. In the Western Atlantic, it ranges from Bermuda to Brazil, including the Gulf of Mexico and Caribbean Sea. This species is believed to be of minor commercial importance (Robins and Ray 1986 in Froese and Pauly 2002). Olsen *et al.* (1984), in Froese and Pauly (2002), report that it can be ciguatoxic.

The yellow goatfish is found over sandy areas of lagoon and seaward reefs to depths of 49 m. Juveniles are common in seagrass beds (Robins and Ray 1986 in Froese and Pauly 2002), and have been observed to form large schools (Munro 1974b). Maximum reported size is 39.4 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated in Froese and Pauly (2002) as 23.5 cm TL; natural mortality rate, 0.89. Age at first maturation, as reported by a Jamaican study, is about 18.5 cm FL (118 g) and at or before 17.5 cm FL (90 g) for males and females, respectively; full maturity, within one cm of those lengths. Spawning in that area occurs mostly in March-April and September-October (Munro 1974b). In the northeastern Caribbean, individuals in spawning condition have been observed from February through May (Erdman 1976). The yellow goatfish feeds on benthic invertebrates (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.21.2 Spotted goatfish, *Pseudupeneus maculatus*

The spotted goatfish occurs in the Western Atlantic, ranging from New Jersey (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. The flesh of this species is highly esteemed (Cervigón 1993). According to Olsen *et al.* (1984), in Froese and Pauly (2002), it can be ciguatoxic.

The spotted goatfish inhabits shallow waters to depths of 90 m, and is usually found over sand and rock bottoms in reef areas. Young juveniles are often found on seagrass (e.g., *Thalassia*) beds. Maximum reported size is 30 cm TL (male) (Cervigón 1993). Size at maturity and age at first maturity are estimated in Froese and Pauly (2002) as 17.3 cm TL and 1.1 years, respectively. The smallest ripe male collected in a Jamaican study measured about 17.5 cm FL. Size at full maturity was estimated as 18.5-19.5 cm FL (116-137 g) for males, and probably less than 16 cm FL (80 g) for females (Munro 1974b). Approximate life span is 4.1 years; natural mortality rate, 1.33 (Froese and Pauly 2002). This fish spawns in large aggregations (Erdman 1976). One spawning aggregation site has been documented in the USVI National Marine Park off St. John, USVI. About 300-400 individuals have been observed to spawn at that site during the month of March at about 21 m depth (Rielinger 1999). Spotted goatfish in the northeastern Caribbean also have been observed in spawning condition in January, February, and October (Erdman 1976). Peak spawning season in Jamaican waters is January to April, with a subsidiary peak in October. Larvae and post-larvae are pelagic, and metamorphose and transfer to demersal habitat at sizes of around 4-8 cm (Munro 1974b). Its diet consists of small invertebrates (Cervigón 1993).

5.2.1.3.22 Morays, Muraenidae

The Muraenidae family contains 200 species in 15 genera, distributed in tropical and temperate seas worldwide (Nelson 1994 in Froese and Pauly 2002). Only two genera are represented in the Caribbean reef fish fishery management unit: *Echidna* and *Gymnothorax*. These fishes are solitary, benthic species (Robins and Ray 1986 in Froese and Pauly 2002), and are utilized primarily in the aquarium trade.

5.2.1.3.22.1 Chain moray, *Echidna catenata*

The chain moray occurs in the Western Atlantic, the Eastern Atlantic , and around the southern Atlantic islands. In the Western Atlantic, it ranges from Bermuda to Brazil, including the Caribbean Sea. This species is believed to be of minor importance to commercial fisheries, but also is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

The chain moray is commonly found on reefs and rocky shore areas to depths of 12 m. Maximum reported size is 165 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 83.4 cm TL; natural mortality rate, 0.29 (Froese and Pauly 2002). This fish feeds on small fishes and crustaceans (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.22.2 Green moray, *Gymnothorax funebris*

The green moray occurs in the Western and Eastern Atlantic, and in the Eastern Pacific Oceans. In the Western Atlantic, it ranges from New Jersey (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. It was once reported in Nova Scotia, Canada. This species is marketed both fresh and salted, but is generally believed to be of minor importance to commercial fisheries. It also is utilized in the aquarium trade. Large individuals are reportedly ciguatoxic (Robins and Ray 1986 in Froese and Pauly 2002).

The green moray occurs along rocky shorelines, reefs, and mangroves, usually at less than 30 m depth. It is aggressive. Capable of reaching 2.5 m (male) in length, and up to 29 kg weight, its bites are particularly dangerous (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 12 m TL; natural mortality rate, 0.22 (Froese and Pauly 2002).

5.2.1.3.22.3 Goldentail moray, *Gymnothorax miliaris*

The goldentail moray occurs in the Western and Eastern Atlantic Oceans, and also around the mid-Atlantic islands. In the Western Atlantic, it ranges from Bermuda to northern South America, including the Caribbean Sea. This species is believed to be of minor importance to commercial fisheries, but also is utilized in the aquarium trade (Robins *et al.* 1991 in Froese and Pauly 2002).

The goldentail moray inhabits coral reefs and rocky shorelines, to depths of 60 m. Maximum reported size is 70 cm TL (male) (Robins *et al.* 1991 in Froese and Pauly 2002). Size at maturity is estimated as 39.1 cm TL; natural mortality rate 0.37 (Froese and Pauly 2002).

5.2.1.3.23 Batfishes, Ogcocephalidae

The Ogcocephalidae family contains 62 species in 9 genera, distributed in all tropical and many subtropical seas. These demersal fishes are capable of walking on the bottom using their large armlike pectorals and smaller pelvic fins. Some achieve up to 40 cm in length. But most do not grow longer than 20 cm. They feed on small invertebrates and fishes (Nelson 1994 in Froese and Pauly 2002).

Only *Ogcocephalus* species are included in the Caribbean reef fish fishery management unit. Little is known about batfish biology. Known depth ranges of *Ogcocephalus* species known to occur in Caribbean waters are 29-126 m (*O. parvus*), 28-228 m (*O. rostellum*), and 35-348 m (*O. pumilus*). Maximum reported size ranges from 6.1 cm SL (*O. pumilus*; male) (Bradbury 1980 in Froese and Pauly 2002) to 30.5 cm TL (*O. vespertilio*; male) (Claro 1994 in Froese and Pauly 2002). Erdman (1976) reports that *O. parvus* and *O. vespertilio* spawn in the northeastern Caribbean from January to April.

The status of batfish has not been assessed relative to the pre-SFA definitions of overfished and overfishing. Under these definitions, the stock would be overfished when the transitional SPR is less than 20% SPR. Overfishing is defined as a fishing mortality rate in excess of that corresponding to a 20% SPR level (NMFS 2002). These fishes are aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown." The methodology used to make this determination is described in Section 4.2.2.

5.2.1.3.24 Snake eels, Ophichthidae

The Ophichthidae family contains 250 species in 52 genera (Nelson 1994 in Froese and Pauly 2002). Only one species, the goldspotted eel (*Myrichthys ocellatus*) is included in the Caribbean reef fish fishery management unit. It is utilized in the aquarium trade.

5.2.1.3.24.1 Goldspotted eel, *Myrichthys ocellatus*

The goldspotted eel has been reported in both the Western and Eastern Atlantic. In the Western Atlantic, its range extends from Bermuda to northern South America, including the Caribbean Sea (Robins *et al.* 1991 in Froese and Pauly 2002).

The goldspotted eel is common near islands and in rocky or coral areas. It is also found in seagrass beds, and areas with sand and coral rubble. It may move beneath the sand. Maximum reported size is 11 m TL (male) (Robins *et al.* 1991 in Froese and Pauly 2002). Size at maturity is estimated as 5.8 m TL; natural mortality rate, 0.39 (Froese and Pauly 2002). This species forages at night, feeding primarily on crabs (Robins *et al.* 1991 in Froese and Pauly 2002).

5.2.1.3.25 Jawfishes, Opistognathidae

The Opistognathidae family contains 60 species in 3 genera, distributed in the Western and Central Atlantic, Indian, and Pacific Oceans (Nelson 1994 in Froese and Pauly 2002). Both species included in the Caribbean reef fish fishery management unit belong to the genus *Opistognathus*.

5.2.1.3.25.1 Yellowhead jawfish, *Opistognathus aurifrons*

The yellowhead jawfish occurs in the Western Central Atlantic, from southern Florida (USA) to northern South America, including the Caribbean Sea. This species is utilized in the aquarium trade and has been reared in captivity (Robins and Ray 1986 in Froese and Pauly 2002).

A demersal species, occurring from depths of 3-40 m, the yellowhead jawfish inhabits burrows made of crushed coral or sand, where it hovers vertically, above or near its hole. Maximum reported size is 10 cm TL (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 7 cm TL; natural mortality rate, 2.12 (Froese and Pauly 2002). The males brood eggs orally (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.25.2 Dusky jawfish, *Opistognathus whitehursti*

The dusky jawfish occurs in the Western Atlantic, from southern Florida (USA) to northern South America, including the Caribbean Sea. This species is utilized in the aquarium trade (Böhlke and Chaplin 1993).

A demersal species, the dusky jawfish occurs to 12 m, inhabiting rock and sand bottoms or the eroding edges of weed beds. Maximum reported size is 14 cm TL (male) (Böhlke and Chaplin 1993). Size at maturity is estimated as 9.4 cm TL; natural mortality rate, 1.67 (Froese and Pauly 2002). Egg masses are incubated in the mouths of males (Böhlke and Chaplin 1993).

5.2.1.3.26 Boxfishes, Ostraciidae

The Ostraciidae family contains 33 species in 14 genera, distributed in the Atlantic, Indian and Pacific Oceans. These fishes are territorial and haremic, spawning pelagic eggs at dusk (Nelson 1994 in Froese and Pauly 2002). All five species in the Caribbean reef fish fishery management unit belong to the genus *Lactophrys*.

5.2.1.3.26.1 Spotted trunkfish, *Lactophrys bicaudalis*

The spotted trunkfish 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. This species is utilized in the aquarium trade and is probably marketed fresh locally (Robins and Ray 1986 in Froese and Pauly 2002). According to Dammann (1969), in Froese and Pauly (2002), it can be ciguatoxic.

The spotted trunkfish is found to depths of 50 m, in clear water around coral reefs and, sometimes, under ledges and near small holes. Maximum reported size is 48 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 28 cm TL; natural mortality rate, 0.49 (Froese and Pauly 2002). This fish feeds on a variety of small bottom invertebrates such as mollusks, crustaceans, starfishes, sea urchins, sea cucumbers, sessile tunicates, seagrasses, algae, crabs and brittle stars. It releases toxins when excited, which are capable of killing other fishes (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.26.2 Honeycomb cowfish, *Lactophrys polygonia*

The honeycomb cowfish occurs in the Western Atlantic, ranging from New Jersey (USA) to Brazil (Cervigón *et al.* 1992 in Froese and Pauly 2002), including the Caribbean Sea. It is reportedly absent in the Gulf of Mexico. This species is taken in commercial fisheries and also is utilized in the aquarium trade (Cervigón *et al.* 1992 in Froese and Pauly 2002). Olsen *et al.* (1984), in Froese and Pauly (2002), report that it can be ciguatoxic.

The honeycomb cowfish occurs in clear water around coral reefs, from 3-80 m depth. Maximum reported size is 50 cm NG (male) (Cervigón *et al.* 1992 in Froese and Pauly 2002). Size at maturity is estimated as 29 cm NG (Froese and Pauly 2002). No estimate of natural mortality is available for this species. Prey items include sponges, alcyonarians, tunicates, and shrimp (Cervigón *et al.* 1992 in Froese and Pauly 2002).

5.2.1.3.26.3 Scrawled cowfish, *Lactophrys quadricornis*

The scrawled cowfish occurs in tropical and temperate waters of the Atlantic. In the Western Atlantic, it ranges from Massachusetts (USA) to southeastern Brazil, including the Gulf of Mexico (Smith 1986 in Froese and Pauly 2002) and Caribbean Sea. It has also been reported off the tip of South Africa. Considered an excellent food fish, it is marketed fresh. It also is utilized in the aquarium trade (Smith 1986 in Froese and Pauly 2002). According to Olsen *et al.* (1984), in Froese and Pauly (2002), it can be ciguatoxic.

The scrawled cowfish is found in shallow water down to about 80 m. Seagrass beds are reportedly its preferred habitat. Maximum reported size is 55 cm TL (male) (Smith 1986 in Froese and Pauly 2002). Size at maturity is estimated as 31.6 cm TL; natural mortality rate, 0.44 (Froese and Pauly 2002). Ruiz *et al.* (1999) reported that January and February as well as June through September were the times of peak spawning of scrawled cowfish off Venezuela. This fish feeds on sessile invertebrates such as tunicates, gorgonians, and anemones, as well as on slow-moving crustaceans, sponges, hermit crabs and marine plants (Smith 1986 in Froese and Pauly 2002).

5.2.1.3.26.4 Trunkfish, *Lactophrys trigonus*

Also known as the "buffalo trunkfish," the trunkfish occurs in the Western Atlantic, from Massachusetts (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. This species is a highly esteemed food fish in the Caribbean, and also is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002). Halstead *et al.* (1990), in Froese and Pauly (2002), report that it can be ciguatoxic.

The trunkfish inhabits seagrass beds, coral rubble areas, and offshore reefs down to about 50 m depth. Maximum reported size is 55 cm TL (male); maximum weight, 3,310 g (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 31.6 cm TL; natural mortality rate, 0.44 (Froese and Pauly 2002). This fish feeds on a wide variety of small benthic invertebrates such as mollusks, crustaceans, worms and sessile tunicates, as well as some seagrasses (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.26.5 Smooth trunkfish, *Lactophrys triqueter*

The smooth trunkfish occurs in the Western Atlantic, ranging from Canada to Brazil, including the Gulf of Mexico and Caribbean Sea. This species is marketed fresh locally, but is generally believed to be of minor importance to commercial fisheries. It also is utilized in the aquarium trade (Coad 1995 in Froese and Pauly 2002). According to Dammann (1969), in Froese and Pauly (2002), it can be ciguatoxic.

The smooth trunkfish is found on coral reefs to depths of 50 m. It is easily approached, and is solitary or occurs in small groups. Maximum reported size is 47 cm TL (male) (Coad 1995 in Froese and Pauly 2002). Size at maturity is estimated as 27.5 cm TL; natural mortality rate, 0.49 (Froese and Pauly 2002). This fish preys on a wide variety of small bottom invertebrates such as mollusks, crustaceans, worms, sessile tunicates and sponges exposed by a jet of water ejected through the mouth. It releases toxins when excited, which are capable of killing other fishes (Coad 1995 in Froese and Pauly 2002).

5.2.1.3.27 Angelfishes, Pomacanthidae

The Pomacanthidae family contains 74 species in 9 genera, distributed in the tropical Atlantic, Indian, and (mainly western) Pacific Oceans. All species studied to date are protogynous hermaphrodites with a haremic social system (Nelson 1994 in Froese and Pauly 2002). Genera represented in the Caribbean reef fish fishery management unit include *Centropyge*, *Holacanthus*, and *Pomacanthus*.

5.2.1.3.27.1 Cherubfish, *Centropyge argi*

The cherubfish occurs in the Western Atlantic, ranging from Bermuda to French Guiana, including the Gulf of Mexico and Caribbean Sea . This species is utilized in the aquarium trade and has been reared in captivity (Allen 1985 in Froese and Pauly 2002).

The cherubfish occurs from 5-80 m depth, and is normally encountered in rubble areas, where it feeds on various types of algae. It has been observed to retreat into holes when frightened. Maximum reported size is 8 cm TL (male) (Allen 1985 in Froese and Pauly 2002). Size at maturity is estimated as 5.8 cm TL; natural mortality rate, 1.72 (Froese and Pauly 2002).

5.2.1.3.27.2 Queen angelfish, *Holacanthus ciliaris*

The queen angelfish occurs in both the Western and Eastern Central Atlantic Oceans. In the Western Atlantic, its range extends from Florida (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. This species is believed to be of minor importance to commercial fisheries, but also is utilized in the aquarium trade (Allen 1985 in Froese and Pauly 2002). It can be ciguatoxic (Olsen *et al.* 1984 in Froese and Pauly 2002).

This sedentary species generally occurs solitarily or in pairs on coral reefs to depths of 70 m. Maximum reported size is 45 cm TL (male); maximum weight, 1,600 g (Allen 1985 in Froese and Pauly 2002). Estimated size at maturity is 26.5 cm TL; natural mortality rate, 0.51 (Froese and Pauly 2002). In the northeastern Caribbean, individuals in spawning condition have been observed in January, March, April, and August (Erdman 1976). The queen angelfish has been reported to prey almost exclusively on sponges, supplemented by small amounts of algae, tunicates, hydroids and bryozoans. Juveniles have been observed to pick ectoparasites from other fishes (Allen 1985 in Froese and Pauly 2002).

5.2.1.3.27.3 Rock beauty, *Holacanthus tricolor*

The rock beauty occurs in the Western Atlantic, ranging from Georgia (USA) and Bermuda to Brazil, including the Gulf of Mexico (Allen 1985 in Froese and Pauly 2002) and Caribbean Sea. This species is considered to be of minor importance to commercial fisheries. It also is utilized in the aquarium trade (Allen 1985 in Froese and Pauly 2002). It can be ciguatoxic (Olsen *et al.* 1984 in Froese and Pauly 2002).

This sedentary species inhabits rock jetties, rocky reefs, and rich coral areas, from 3-92 m depth. Juveniles are often associated with fire corals. Maximum reported size is 35 cm TL (male) (Allen 1985 in Froese and Pauly 2002). Estimated size at maturity is 21.2 cm TL; natural mortality rate, 0.88 (Froese and Pauly 2002). In the northeastern Caribbean, individuals in spawning condition have been observed in February, March, and May (Erdman 1976). Dietary items include tunicates, sponges, zoantharians, and algae (Allen 1985 in Froese and Pauly 2002).

5.2.1.3.27.4 Gray angelfish, *Pomacanthus arcuatus*

The gray angelfish occurs in the Western Atlantic, ranging from New England (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. Although its flesh is reported to be of excellent quality, this species is considered to be of minor importance to commercial fisheries. It has been reared in captivity, and is utilized in the aquarium trade (Allen 1985 in Froese and Pauly 2002). It can be ciguatoxic (Olsen *et al.* 1984 in Froese and Pauly 2002).

The gray angelfish is common in coral reefs, from depths of 2-30 m. It is usually solitary, but occasionally occurs in pairs, and is known to approach divers. Maximum reported size is 60 cm TL (male); maximum weight, 1,830 g (Allen 1985 in Froese and Pauly 2002). Estimated size at maturity is 34.1 cm TL; natural mortality rate, 0.42 (Froese and Pauly 2002). In the northeastern Caribbean, individuals in spawning condition have been observed in February, March, May, and June (Erdman 1976). Juveniles are part-time cleaners. The gray angelfish feeds mainly on sponges, but also takes tunicates, algae, zoantharians, gorgonians, hydroids, byrozoans, and seagrasses (Allen 1985 in Froese and Pauly 2002).

5.2.1.3.27.5 French angelfish, *Pomacanthus paru*

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. Although its flesh is considered to be of good quality, this species is believed to be of minor importance to commercial fisheries. It is also utilized in the aquarium trade and has been reared in captivity (Allen 1985 in Froese and Pauly 2002). It can be ciguatoxic (Olsen *et al.* 1984 in Froese and Pauly 2002).

The French angelfish occurs from 3-100 m depth, but is common in shallow reefs. It usually occurs in pairs, often near sea fans. It is generally sedentary. 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 (male) (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). In the northeastern Caribbean, individuals in spawning condition have been observed in March and May (Erdman 1976). 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).

5.2.1.3.28 Damselfishes, Pomacentridae

The Pomacentridae family contains 321 species in 28 genera, distributed in all tropical seas across the globe, but primarily in the Indo-Pacific (Allen 1991 in Froese and Pauly 2002). Nest-guarding behavior is characteristic of all males (Allen 1991 in Froese and Pauly 2002). Four genera are represented in the Caribbean reef fish fishery management unit: *Abudefduf*, *Chromis*, *Microspathodon*, and *Pomacentrus*.

5.2.1.3.28.1 Sergeant major, *Abudefduf saxatilis*

The sergeant major occurs in the Atlantic and Western Pacific Oceans. In the Western Atlantic, it ranges from Rhode Island (USA) to Uruguay, including the Carribean Sea. This species is believed to be of minor importance to commercial fisheries, but also is utilized in the aquarium trade, and has been reared in captivity (Allen 1991 in Froese and Pauly 2002).

A sedentary species, the sergeant major is found to depths of 15 m. Juveniles are common in tide pools; adults are found over shallow reef tops. Maximum reported size is 22.9 cm TL (male); maximum weight, 200 g (Allen 1991 in Froese and Pauly 2002). Estimated size at maturity is 14.6 cm TL; natural mortality rate, 0.82 (Froese and Pauly 2002). Males are known to brood eggs. These fishes feed on algae, small crustaceans, and fish, and various invertebrate larvae. Adults frequently form large feeding aggregations of up to several hundred individuals (Allen 1991 in Froese and Pauly 2002).

5.2.1.3.28.2 Blue chromis, *Chromis cyanea*

The blue chromis occurs in the Atlantic Ocean, off Bermuda, southern Florida (USA), in the Gulf of Mexico, and throughout the Carribean Sea, including the Bahamas, and Antilles. This species is utilized primarily in the aquarium trade (Allen 1991 in Froese and Pauly 2002).

The blue chromis is encountered in 3-60 m depth, but commonly occurs above deep outer reefs. It is sedentary, and retreats into coral crevices when frightened. Maximum reported size is 15 cm TL (male) (Allen 1991 in Froese and Pauly 2002). Estimated size at maturity is 10 cm TL; natural mortality rate, 1.60 (Froese and Pauly 2002). In the northeastern Caribbean, individuals in spawning condition have been observed in April (Erdman 1976). This fish feeds on zooplankton, primarily copepods. It often associates with the creole wrasse (Allen 1991 in Froese and Pauly 2002).

5.2.1.3.28.3 Sunshinefish, *Chromis insolata*

The sunshinefish occurs in the Atlantic Ocean, off Bermuda, Florida (USA), and the Bahamas, and throughout the Caribbean Sea. This species is utilized primarily in the aquarium trade, but also may be taken incidentally in traps and small-meshed beach nets (Allen 1991 in Froese and Pauly 2002).

A sedentary species, the sunshinefish inhabits outer and seaward reefs, from 20-100 m depth. Maximum reported size is 16 cm TL (male) (Allen 1991 in Froese and Pauly 2002). Estimated size at maturity is 10.6 cm TL; natural mortality rate, 1.53 (Froese and Pauly 2002). This fish feeds on plankton (Allen 1991 in Froese and Pauly 2002).

5.2.1.3.28.4 Yellowtail damselfish, *Microspathodon chrysurus*

The yellowtail damselfish occurs in the Atlantic Ocean, ranging from Bermuda to Venezuela and Brazil, and throughout the Caribbean Sea, including the Antilles. This species is taken by subsistence fishermen and is utilized in the aquarium trade. It is occasionally marketed fresh, and has been reared in captivity (Allen 1991 in Froese and Pauly 2002).

The yellowtail damselfish can be encountered to 120 m depth, but is generally found in very shallow waters of coral reefs, usually near top of outer edge where there are caves, holes, and abundant fire coral. Maximum reported size is 21 cm TL (male) (Allen 1991 in Froese and Pauly 2002). Estimated size at maturity is 13.5 cm TL; natural mortality rate, 0.87 (Froese and Pauly 2002). In the northeastern Caribbean, individuals in spawning condition have been observed in March (Erdman 1976). Fire coral polyps, and other invertebrate animal materials, constitute a portion of its diet. But this territorial and sedentary species feeds primarily on algae. Juveniles, in particular, associate with fire coral, and occasionally pick parasites from other species of fish (Allen 1991 in Froese and Pauly 2002).

5.2.1.3.28.5 Dusky damselfish, *Pomacentrus fuscus*

Some authors describe the dusky damselfish as belonging to the genus *Stegastes* (e.g., *S. fuscus*). It also is described as the species, *dorsopunicans* (e.g., *P. dorsopunicans*; *S. dorsopunicans*). This fish occurs in the Western Atlantic, off southern Florida (USA), the Bahamas, and in the Caribbean Sea. It is utilized primarily in the aquarium trade, but also may be taken incidentally in traps and small-meshed beach nets (Allen 1991 in Froese and Pauly 2002).

This sedentary and territorial species inhabits rocky shores that are exposed to wave action. It occurs to depths of 3 m, and is often encountered in tide pools. Maximum reported size is 15 cm TL (male) (Allen 1991 in Froese and Pauly 2002). Estimated size at maturity is 8.6 cm TL; natural mortality rate, 1.81 (Froese and Pauly 2002). In the northeastern Caribbean, individuals in spawning condition have been observed in January, June, and September (Erdman 1976). Algae and detritus are the main components of its diet (Allen 1991 in Froese and Pauly 2002).

5.2.1.3.28.6 Beaugregory, *Pomacentrus leucostictus*

Some authors describe this species as belonging to the genera *Stegastes*. It occurs in the Western Atlantic, ranging from Bermuda to Brazil, including the northern Gulf of Mexico (Allen 1991 in Froese and Pauly 2002) and Caribbean Sea. The beaugregory is utilized primarily in the aquarium trade, but also may be taken incidentally in traps and small-meshed beach nets.

The beaugregory occurs in seagrass beds, coral or rocky reefs, and sandy areas, to depths of 10 m. It also can be encountered around mangrove shores and sponge beds. It is less common on flourishing coral reefs. A sedentary species, it usually remains within about 50 cm from the substrate. Maximum reported size is 10 cm TL (male) (Allen 1991 in Froese and Pauly 2002). Estimated size at maturity is 7 cm TL; natural mortality rate, 2.12 (Froese and Pauly 2002). In the northeastern Caribbean, individuals in spawning condition have been observed in September (Erdman 1976). Juveniles feed on copepods, nemerteans and polychaetes; adults, on algae, polychaetes, amphipods, foraminiferans, and gastropods (Allen 1991 in Froese and Pauly 2002).

5.2.1.3.28.7 Bicolor damselfish, *Pomacentrus partitus*

Some authors describe this species as belonging to the genera *Stegastes*. It occurs in the Western Atlantic, ranging from southern Florida (USA) southward to (possibly) Brazil, including the Bahamas and the Caribbean Sea. The bicolor damselfish is primarily an aquarium trade species. But it also may be taken incidentally in traps and small-meshed beach nets (Allen 1991 in Froese and Pauly 2002).

This species inhabits shallow coral reefs and isolated patch reefs in waters as deep as 100 m. A sedentary and territorial fish, it feeds primarily on algae, but also on polychaetes, hydroids, copepods, and ascidians. Maximum reported size is 10 cm TL (male) (Allen 1991 in Froese and Pauly 2002). Estimated size at maturity is 7 cm TL; natural mortality rate, 2.12 (Froese and Pauly 2002).

5.2.1.3.28.8 Threespot damselfish, *Pomacentrus planifrons*

Some authors describe this species as belonging to the genera *Stegastes*. It occurs in the Western Atlantic, off southern Florida (USA), and throughout the Caribbean Sea. The threespot damselfish is utilized primarily in the aquarium trade, but also may be taken incidentally in traps and small-meshed beach nets (Allen 1991 in Froese and Pauly 2002).

Also a sedentary and territorial species, the threespot damselfish inhabits inshore and offshore coral reefs. It can be found to 30 m depth, often in tangles of staghorn coral. It tends to seek the shelter of caves at night. This fish is highly resilient, with a minimum population doubling time of less than 15 months (K=0.33-0.58). Maximum reported size is 13 cm TL (male) (Allen 1991 in Froese and Pauly 2002). Estimated size at maturity and age at first maturity are 9.3 cm TL and 1.4 years, respectively. Approximate life span is 4.8 years; natural mortality rate, 1.38 (Froese and Pauly 2002). Juveniles feed on the external parasites of fishes. Adults feed mainly on algae, but also consume copepods, small gastropods, mollusk eggs, sponges, polychaetes, and hydroids (Allen 1991 in Froese and Pauly 2002).

5.2.1.3.29 Bigeyes, Priacanthidae

The Priacanthidae family contains 18 species in 4 genera, distributed in the tropical and subtropical Atlantic, Indian, and Pacific Oceans (Starnes 1988 in Froese and Pauly 2002). The two species included in the Caribbean reef fish fishery management unit belong to the genus *Priacanthus*.

5.2.1.3.29.1 Bigeye, *Priacanthus arenatus*

Also known as the "Atlantic bigeye," this species occurs in tropically influenced areas of the Atlantic Ocean. In the Western Atlantic, it ranges from Bermuda and North Carolina (USA), southward to northern Argentina (Starnes 1988 in Froese and Pauly 2002), including the Caribbean Sea. Its flesh, considered to be of excellent quality, is marketed fresh. This species also is taken in recreational fisheries and is utilized in the aquarium trade (Starnes 1988 in Froese and Pauly 2002). It can be ciguatoxic (Halstead 1970).

The bigeye is an epibenthic species, inhabiting coral reefs and rocky bottoms from 10-200 m depth. It has been observed to form small aggregations near the sea bottom. Maximum reported size is 50 cm TL (male); maximum weight, 2,850 g (Starnes 1988 in Froese and Pauly 2002). Estimated size at maturity and age at first maturity are 26.8 cm TL and 1 year, respectively. Approximate life span is 4.2 years; natural mortality rate, 1.17 (Froese and Pauly 2002). Eggs, larvae and early juvenile stages are pelagic. It feeds at night, primarily on larvae, small fishes, crustaceans, and polychaetes (Starnes 1988 in Froese and Pauly 2002).

5.2.1.3.29.2 Glasseye snapper, *Priacanthus cruentatus*

Also known simply as the "glasseye," this species is widely distributed in tropical and tropically influenced areas around the globe. In the Western Atlantic, it ranges from Florida (USA) to Argentina, including the Gulf of Mexico and Caribbean Sea. This species is marketed fresh, but is believed to be of minor importance to commercial fisheries. It also is utilized in the aquarium trade (Starnes 1988 in Froese and Pauly 2002). According to Dammann (1969), in Froese and Pauly (2002), it can be ciguatoxic.

The glasseye snapper is found from 5-300 m depth. It most commonly occurs in lagoon and seaward reefs, primarily around islands, and can be found under or near ledges by day. Juveniles are pelagic; adults demersal. Maximum reported size is 50.7 cm TL (male); maximum weight, 2,725 g (Starnes 1988 in Froese and Pauly 2002). Estimated size at maturity is 29.4 cm TL; natural mortality rate, 0.47 (Froese and Pauly 2002). This fish is usually solitary or occurs in small groups during the day. But at dusk it may gather in large numbers (Starnes 1988 in Froese and Pauly 2002). Spawning aggregations composed of about 200 individuals have been observed to occur at 21 m depth in the USVI National Park, off St. John, USVI (Rielinger 1999). A nocturnal species, the glasseye snapper feeds primarily on octopi, pelagic shrimp, stomatopods, crabs, small fish, and polychaetes (Starnes 1988 in Froese and Pauly 2002).

5.2.1.3.30 Parrotfishes, Scaridae

The Scaridae family contains 83 species in 9 genera, distributed in the Atlantic, Indian, and Pacific Oceans (Nelson 1994 in Froese and Pauly 2002). The 10 species in the Caribbean reef fish fishery management unit belong to one of two genera: *Scarus* or *Sparisoma*. All these species are marketed for food, but are considered to be of minor importance to commercial fisheries. With the exception of the midnight parrotfish, *Scarus coelestinus*, all are utilized in the aquarium trade.

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. They have a tendency to exhibit residential behavior for variable periods of time, but may move over distances of up to several hundred meters during feeding (Reeson 1975b). These fishes are herbivores. 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).

Parrotfishes are diurnally active, feeding during the day and resting at night. They tend to aggregate in shallow waters near dusk, then move to deeper areas before nightfall. Mixed-species aggregations may occur, or the schools may also contain representatives of other families. For example, it is common around Jamaica to find members of the Surgeonfish (Acanthuridae), Goatfish (Mullidae), Grunt (Pomadasyidae) and Wrasse (Labridae) families in association with the usually numerically dominant striped parrotfish (*Scarus croicensis*) (Reeson 1975b).

Many species undergo sex reversal, with an initial phase of both males and females, and the latter changing into a brilliantly colored male terminal phase. Terminal males dominate several females. These fishes are pelagic spawners (Nelson 1994 in Froese and Pauly 2002); some spawn in pairs; others in small groups or aggregations (Reeson 1975b). Juveniles are present in the northeastern Caribbean year-round (Erdman 1976). Moray eels are believed to be important predators. Other predators include groupers, jacks, and snappers (Reeson 1975b). With the exception of the midnight parrotfish, all species in the Caribbean fishery management unit have been known to cause ciguatera poisoning.

5.2.1.3.30.1 Midnight parrotfish, *Scarus coelestinus*

The midnight parrotfish occurs in the Western Atlantic, ranging from Bermuda to Brazil, including the Caribbean Sea (Robins and Ray 1986 in Froese and Pauly 2002).

The midnight parrotfish occurs from rocky coastal reefs to seaward reefs, in depths of 5-75 m. It is often encountered in schools, feeding on algae along with surgeonfishes. Maximum reported size is 77 cm TL (male); maximum weight, 7,000 g (Robins and Ray 1986 in Froese and Pauly 2002). 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).

5.2.1.3.30.2 Blue parrotfish, *Scarus coeruleus*

The blue parrotfish occurs 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).

The blue parrotfish inhabits coral reef habitat, occurring from 3-25 m depth. Juveniles are found on seagrass (*Thalassia*) beds. 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). 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). Dietary items include benthic plants and small organisms in the sand (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.30.3 Striped parrotfish, *Scarus croicensis*

The 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).

The 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. 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). 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). It feeds on plants (Böhlke and Chaplin 1993).

5.2.1.3.30.4 Rainbow parrotfish, *Scarus guacamaia*

The 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).

The rainbow parrotfish species is found from 3-25 m depth. Juveniles are commonly encountered in mangrove areas. It inhabits a home cave at night and when threatened.

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). 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). This fish feeds primarily on benthic algae (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.30.5 Princess parrotfish, *Scarus taeniopterus*

The princess parrotfish occurs in the Western Atlantic, ranging from Bermuda to Brazil, and throughout the Caribbean Sea (Robins and Ray 1986 in Froese and Pauly 2002).

The princess parrotfish is found on coral or rock bottoms, from 2-25 m depth. Juveniles often occur in association with seagrass (*Thalassia*). 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). 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). It feeds on plants in large aggregations, and sleeps in a mucus cocoon (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.30.6 Queen parrotfish, *Scarus vetula*

The queen parrotfish occurs 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).

The queen parrotfish inhabits coral reefs and adjacent habitats, from 3-25 m depth. It is often observed in groups of one supermale with several young adults, most of which are believed to be females. 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). 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). The queen parrotfish feeds on algae and sleeps in a mucus cocoon (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.30.7 Redband parrotfish, *Sparisoma aurofrenatum*

The redband parrotfish occurs in the Western Atlantic, ranging from Bermuda to Brazil, and throughout the Caribbean Sea (Robins and Ray 1986 in Froese and Pauly 2002).

The redband parrotfish inhabits 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. 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). 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. And pair spawning has been observed (Reeson 1975b). It feeds on plants (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.30.8 Redtail parrotfish, *Sparisoma chrysopterum*

The redtail parrotfish occurs 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).

The redtail parrotfish occurs in coral reefs and adjacent habitats to depths of 15 m. Juveniles most commonly inhabit seagrass beds. 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). No estimate of natural mortality rate is available for this species. 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). The redtail parrotfish feeds on benthic algae and seagrasses (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.30.9 Redfin parrotfish, *Sparisoma rubripinne*

The redfin parrotfish occurs in both the Eastern and Western Atlantic. In the Western Atlantic, this species ranges from Massachusetts (USA) to Brazil, and throughout the Caribbean Sea. It is apparently absent in the Gulf of Mexico (Randall 1990 in Froese and Pauly 2002).

The redfin parrotfish inhabits coral reefs and seagrass beds to depths of 15 m. Maximum reported size is 47.8 cm TL (male) (Randall 1990 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated as 28.3 cm TL and 1.2 years, respectively. Approximate life span is 4.9 years; natural mortality rate, 1.05 (Froese and Pauly 2002). Spawning usually occurs in small groups (Randall 1990 in Froese and Pauly 2002), but also in pairs. Deeper reef fronts (15-20 m) appear to be the focal points for spawning groups. Data collected in a Jamaican study indicate that the highest proportion of active and ripe fishes occurs between January and

May. Ripe males and females have been collected in all months of the year off the Virgin Islands (Reeson 1975b). The redfin parrotfish feeds on benthic algae and seagrasses (Randall 1990 in Froese and Pauly 2002).

5.2.1.3.30.10 Stoplight parrotfish, *Sparisoma viride*

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).

The stoplight parrotfish inhabits 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. Maximum reported size is 64 cm TL (male); maximum weight, 1,600 g. 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). 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).

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). Pair spawning has been observed in May off the Virgin Islands (Reeson 1975b). 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).

5.2.1.3.31 Drums, Sciaenidae

The Sciaenidae family contains 270 species in 70 genera, distributed in the Atlantic, Indian and Pacific Oceans (Nelson 1994 in Froese and Pauly 2002). Only the genus *Equetus* is represented in the Caribbean reef fish fishery management unit.

5.2.1.3.31.1 High-hat, *Equetus acuminatus*

The high-hat occurs in the Western Atlantic, ranging from North Carolina (USA) and Bermuda, southward to Brazil. This species is believed to be of minor importance to commercial fisheries, but also is utilized in the aquarium trade. It has been reared in captivity (Robins and Ray 1986 in Froese and Pauly 2002).

The high-hat occurs in clear waters of tropical islands, usually near coral reefs, but also in adjacent bays over rough bottom. It also is often found under the eroded edges of seagrass beds.

Maximum reported size is 23 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Estimated size at maturity is 14.6 cm TL; natural mortality rate, 1.18 (Froese and Pauly 2002).

5.2.1.3.31.2 Jackknife-fish, *Equetus lanceolatus*

The jacknife-fish occurs in the Western Atlantic, ranging from Bermuda and North Carolina (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. This species is believed to be of minor importance to commercial fisheries, but also is utilized in the aquarium trade. It has been reared in captivity (Robins and Ray 1986 in Froese and Pauly 2002). Olsen *et al.* (1984), in Froese and Pauly (2002), report that it can be ciguatoxic.

A demersal species, the jacknife-fish inhabits bays, sounds, and coral reefs, occurring from 10-60 m depth. This fish is easily approached. Maximum reported size is 25 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Estimated size at maturity is 15.7 cm TL; natural mortality rate, 1.11 (Froese and Pauly 2002). It feeds primarily on small shrimps and crabs, but also consumes polychaete worms and gastropod mollusks (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.31.3 Spotted drum, *Equetus punctatus*

The spotted drum occurs in the Western Atlantic, ranging from Bermuda to Brazil, including the Caribbean Sea. This species is believed to be of minor importance to commercial fisheries, but also is utilized in the aquarium trade. It has been reared in captivity (Robins and Ray 1986 in Froese and Pauly 2002). Olsen *et al.* (1984), in Froese and Pauly (2002), reports that it can be ciguatoxic.

The spotted drum occurs from 3-30 m depth; primarily on coral reefs. It is secretive and, usually, solitary, found under ledges or near small caves. It is often observed during the day around the bases of corals, and is easily approached. Maximum reported size is 27 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Estimated size at maturity is 16.9 cm TL; natural mortality rate, 1.05 (Froese and Pauly 2002). This fish feeds at night on crabs, shrimps, and polychaetes (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.32 Scorpionfishes, Scorpaenidae

The Scorpaenidae family contains 172 species in 23 genera, distributed in all tropical and temperate seas (Nelson 1994 in Froese and Pauly 2002). All species are utilized in the aquarium trade.

Scorpionfishes are benthopelagic fishes. Most species live in the shallow water of the continental shelves, although a few species occur on the continental slope (MBARI 2003). Fertilization is internal for most species. Some lay eggs in a gelatinous balloon. Larvae are planktonic (Nelson 1994 in Froese and Pauly 2002). The majority of scorpaenids are sit and wait predators that either lie on the bottom or hover above a reef or rock outcrop waiting for prey such as fish, crustacean, or cephalopods to swim by (MBARI 2003).

5.2.1.3.33 Groupers, hinds, and sea basses, Serranidae

The Serranidae family contains 449 species in 62 genera, distributed in tropical and temperate oceans across the globe. These species are monoecious, with some functional hermaphrodites (Nelson 1994 in Froese and Pauly 2002). Protogynous hermaphroditism is known to occur in several species of groupers, although in related serranids synchronous hermaphroditism is also encountered. A broad overlap of the length distributions of the sexes is encountered in most species and suggests that there is no close correlation of age or size with sexual transition (Thompson and Munro 1974b). Seven genera are represented in the Caribbean reef fish fishery management unit: *Epinephelus*, *Mycteroperca*, *Hypoplectrus*, *Liopropoma*, *Paranthias*, *Rypticus*, and *Serranus*. Many groupers, but especially the largest Epinephelus species, appear to be the resident apex predators of the reef systems that they inhabit (Huntsman *et al.* 1999).

5.2.1.3.33.1 Rock hind, *Epinephelus adscensionis*

The rock hind occurs in both the Western and Eastern Atlantic. In the Western Atlantic, it ranges from Massachusetts (USA) to southern Brazil, including the Gulf of Mexico and Caribbean Sea. This species is taken in both commercial and recreational fisheries. Its flesh is considered to be of good quality (Heemstra and Randall 1993 in Froese and Pauly 2002). But Halstead (1970), in Froese and Pauly (2002), reports that it can be ciguatoxic.

The rock hind is a demersal species, inhabiting rocky reef habitat to depths of 120 m. It is usually solitary and is difficult to approach. 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). 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). 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).

5.2.1.3.33.2 Graysby, *Epinephelus cruentatus*

The graysby occurs 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). Olsen *et al.* (1984), in Froese and Pauly (2002), reports that it can be ciguatoxic.

The graysby inhabits seagrass (*Thalassia*) beds and coral reefs, and can be found to 170 m depth. It is sedentary, solitary, and secretive, usually hiding during the day, and feeding at night. But it is easily approached and fed by divers. 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). 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. Approximate life span is 8.1 years; natural mortality rate, 0.20 (Ault *et al.* 1998). Juveniles feed on shrimp; adults, primarily on fishes. The brown chromis, *chromis multilineata*, has been identified as a preferred food item (Heemstra and Randall 1993 in Froese and Pauly 2002).

5.2.1.3.33.3 Yellowedge grouper, *Epinephelus flavolimbatus*

The yellowedge grouper occurs in the Western Atlantic, ranging from North Carolina (USA) to southern Brazil, including the Gulf of Mexico and the Caribbean Sea. Its flesh is considered to be of good quality, and is marketed fresh. It is taken in both commercial and recreational fisheries (Heemstra and Randall 1993 in Froese and Pauly 2002).

A solitary and demersal species, the yellowedge grouper occurs in rocky areas and on sand mud bottom, ranging from 64-275 m depth. On soft bottoms, it is often seen in or near trenches or burrow-like excavations. This fish is of low resilience, with a minimum population doubling time of 4.5 - 14 years (K=0.10; tmax=35). Maximum reported size is 115 cm TL (male); maximum weight, 18.6 kg (Heemstra and Randall 1993 in Froese and Pauly 2002). Estimated size at maturity and age at first maturity are 50.5 cm TL and 6.2 years, respectively (Froese and Pauly 2002). 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). Maximum reported age is 32 years (Heemstra and Randall 1993 in Froese and Pauly 2002). Natural mortality rate is estimated as 0.20 (Ault *et al.* 2002). It feeds on a wide variety of invertebrates (mainly brachyuran crabs) and fishes (Heemstra and Randall 1993 in Froese and Pauly 2002).

5.2.1.3.33.4 Coney, *Epinephelus fulvus*

The coney occurs 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). Olsen *et al.* (1984), in Froese and Pauly (2002), report that it can be ciguatoxic.

The coney is a sedentary species. It prefers coral reefs and clear water, and can be found to depths of 150 m. 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).

Several studies have indicated that the coney does 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). 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).

5.2.1.3.33.5 Red hind, *Epinephelus guttatus*

The red hind occurs in the Western Atlantic, ranging from North Carolina (USA) to Venezuela, including the Caribbean Sea. An excellent food fish, this species is readily caught on hook and line, and is easily speared by divers. It is taken in both commercial and recreational fisheries, and is utilized in the aquarium trade (Heemstra and Randall 1993 in Froese and Pauly 2002). Halstead (1970), in Froese and Pauly (2002), reports that it can be ciguatoxic.

The red hind is found in shallow reefs and rocky bottoms, from 2-100 m depth. It is usually solitary and territorial. 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). One study showed 233,273 eggs for a specimen of 35.8 cm SL (Thompson and Munro 1974b).

The red hind is a protogynous hermaphrodite (Thompson and Munro 1974b). Thompson and Munro (1974b) report that mean size at sex reversal appears to be in the region of 38 cm TL. 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).

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). The red hind feeds mainly on crabs and other crustaceans, fishes, such as labrids and haemulids, and octopus (Heemstra and Randall 1993 in Froese and Pauly 2002).

5.2.1.3.33.6 Goliath grouper, *Epinephelus itajara*

The Goliath grouper, formerly known as the "jewfish," occurs 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. Considered to be of excellent quality, its flesh is marketed both fresh and salted. It is targeted in both commercial and recreational fisheries (Heemstra and Randall 1993 in Froese and Pauly 2002). But the take and possession of the Goliath grouper has been prohibited in both federal and state waters of the USVI. Puerto Rico implemented new regulations on March 12, 2004, to prohibit the possession or sale of Goliath grouper.

A solitary species, the Goliath grouper inhabits 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).

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).

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.

This fish feeds primarily on crustaceans, particularly spiny lobsters, as well as turtles and fishes, including stingrays.

5.2.1.3.33.7 Red grouper, *Epinephelus morio*

The red grouper occurs in the Western Atlantic, ranging as far north as Massachusetts (USA) to southern Brazil, including the Gulf of Mexico and Caribbean Sea. This species is taken in both commercial and recreational fisheries, and is utilized in the aquarium trade. It is marketed both fresh and frozen (Heemstra and Randall 1993 in Froese and Pauly 2002).

A sedentary species, the red grouper is 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. 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). It is a protogynous hermaphrodite. 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). Most females transform to males between ages 7 to 14. 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). In the northeastern Caribbean, individuals in spawning condition have been observed from February through May (Erdman 1976). It feeds on a wide variety of fishes and invertebrates (Heemstra and Randall 1993 in Froese and Pauly 2002).

5.2.1.3.33.8 Misty grouper, *Epinephelus mystacinus*

The misty grouper occurs in both the Western and Eastern Atlantic Ocean. In the Western Atlantic, it ranges from Bermuda and North Carolina (USA) to Mexico, including the Gulf of Mexico and Caribbean Sea. This species is taken in both commercial and recreational fisheries, and is marketed fresh (Heemstra and Randall 1993 in Froese and Pauly 2002).

The misty grouper is a solitary, bathydemersal, deep-water species, ranging from 30-400 m depth. Juveniles occur in shallower waters. 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). In the northeastern Caribbean, individuals in spawning condition have been observed in January, April, August, and November (Erdman 1976). Prey items include fishes, crustaceans, and squids (Heemstra and Randall 1993 in Froese and Pauly 2002).

5.2.1.3.33.9 Nassau grouper, *Epinephelus striatus*

The Nassau grouper occurs in the tropical Western Atlantic, ranging from Bermuda, the Bahamas, and Florida (USA) to southern Brazil. It is not known from the Gulf of Mexico, except at the Campeche Bank off the coast of Yucatan, at Tortugas, and off Key West. This species is a popular food fish and also is utilized in the aquarium trade (Heemstra and Randall 1993 in Froese and Pauly 2002). However, the take and possession of Nassau grouper is prohibited in federal waters. Furthermore, Puerto Rico implemented new regulations on March 12, 2004, to prohibit the possession or sale of Nassau grouper. Its flesh is marketed fresh (Heemstra and Randall 1993 in Froese and Pauly 2002). Olsen *et al.* (1984), in Froese and Pauly (2002), report that it can be ciguatoxic.

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). Adults lead solitary lives outside of spawning aggregations (NMFS 2001b).

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.

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).

The Nassau grouper aggregates 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).

It is a top-level predator. 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).

5.2.1.3.33.10 Butter hamlet, *Hypoplectrus unicolor*

The butter hamlet occurs in the Western Central Atlantic, off Florida (USA), the Bahamas, and throughout the Caribbean. It is apparently absent from the Gulf of Mexico. This species is utilized in the aquarium trade, and has been reared in captivity (Domeier 1994 in Froese and Pauly 2002).

The butter hamlet reaches 12.7 cm TL (male) (Domeier 1994 in Froese and Pauly 2002). Estimated size at maturity is 8.6 cm TL; natural mortality rate, 1.80 (Froese and Pauly 2002). This fish is mainly carnivorous (Domeier 1994 in Froese and Pauly 2002).

5.2.1.3.33.11 Swissguard basslet, *Liopropoma rubre*

Also known as the "peppermint bass," this species occurs in the Western Atlantic, ranging from southern Florida (USA) to northern South America, including the Caribbean Sea. It is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

Little is known about the biology of this solitary species, which inhabits coral reefs, from 3-45 m depth. Although fairly common, it is secretive and rarely seen. Maximum reported size is 100 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Estimated size at maturity is 53.5 cm TL; natural mortality rate, 0.42 (Froese and Pauly 2002).

5.2.1.3.33.12 Yellowfin grouper, *Mycteroperca venenosa*

The yellowfin grouper occurs in the Western Atlantic, ranging from Bermuda to Brazil and Guianas, including the Gulf of Mexico and Caribbean Sea. This species is taken in both commercial and recreational fisheries, and also is utilized in the aquarium trade. Although often implicated in ciguatera poisonings, it is a desirable food fish. Even large (5-10 kg) fish taken from areas that are considered to be safe are sold in markets (Heemstra and Randall 1993 in Froese and Pauly 2002).

The yellowfin grouper occurs from 2-137 m depth. Juveniles are commonly found in shallow turtle grass beds; adults, on rocky and coral reefs. 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). This fish is believed to be a protogynous hermaphrodite. One studied specimen contained a total of 1,425,443 eggs (Thompson and Munro 1974b). The yellowfin grouper reportedly aggregates 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). It feeds mainly on fishes (mostly on coral reef species) and squids (Heemstra and Randall 1993 in Froese and Pauly 2002).

5.2.1.3.33.13 Tiger grouper, *Mycteroperca tigris*

The tiger grouper occurs in the Western Atlantic, ranging from Bermuda and south Florida (USA) to Venezuela and, possibly, Brazil, including the Gulf of Mexico and Caribbean Sea. Easily approached, this species is taken in commercial fisheries and also is utilized in the aquarium trade (Heemstra and Randall 1993 in Froese and Pauly 2002). Dammann (1969), in Froese and Pauly (2002), reports that it can be ciguatoxic.

A solitary species, the tiger grouper inhabits coral reefs and rocky areas, from 10-40 m depth. 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). 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.

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).

5.2.1.3.33.14 Creole-fish, *Paranthias furcifer*

The creole-fish occurs in both the Western and Eastern Atlantic. In the Western Atlantic, it ranges from Bermuda to Brazil, including the Gulf of Mexico and Caribbean Sea. It is reportedly absent in the northern Bahamas. This fish is used for food, but more often for bait, and also for the aquarium trade (Heemstra and Randall 1993 in Froese and Pauly 2002).

A benthopelagic species, the creole-fish inhabits coral reefs and hard bottom areas, from 8-100 m depth. This fish is moderately resilient, with a minimum population doubling time of 1.4 - 4.4 years (K=0.22-0.28). Maximum reported size is 30 cm SL (male) (Heemstra and Randall 1993 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated as 24.9 cm TL and 3.1 years, respectively. Approximate life span is 12.9 years; natural mortality rate, 0.49

(Froese and Pauly 2002). This fish feeds on zooplankton, including copepods, pelagic tunicates, shrimps, and shrimp larvae (Heemstra and Randall 1993 in Froese and Pauly 2002).

5.2.1.3.33.15 Greater soapfish, *Rypticus saponaceus*

The greater soapfish occurs in the Western and Eastern Atlantic. In the Western Atlantic, it ranges from Bermuda to Brazil (Robins and Ray 1986 in Froese and Pauly 2002), including the Caribbean Sea. This species is fished for subsistence, and also is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

A solitary species, the greater soapfish generally occurs in shallow water, on bottoms with eroded limestone or mixed sand and rocks, as well as around reefs. It can be found to depths of 60 m. This fish is nocturnal, and is often encountered lying motionless against rocks, or around the bases of coral colonies and near the mouths of caves. When disturbed, it secretes a mucus that contains a toxic protein. Maximum reported size is 35 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Estimated size at maturity is 21.2 cm TL; natural mortality rate, 0.88 (Froese and Pauly 2002).

5.2.1.3.33.16 Orangeback bass, *Serranus annularis*

The orangeback bass occurs in the Western Atlantic, ranging from Bermuda to northern South America (Robins and Ray 1986 in Froese and Pauly 2002), including the Caribbean Sea. This species is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

The orangeback bass inhabits rocky and reef habitats, from 10-70 m depth. Maximum reported size is 9 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Estimated size at maturity is 6.4 cm TL; natural mortality rate, 2.29 (Froese and Pauly 2002). This fish occurs in pairs, and is reportedly synchronously hermaphroditic, having both sexes in the same individual at the same time (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.33.17 Lantern bass, *Serranus baldwini*

The lantern bass occurs in the Western Atlantic, from southern Florida (USA) to northern South America, including the Caribbean Sea. It is utilized in the aquarium trade (Böhlke and Chaplin 1993 in Froese and Pauly 2002).

This reef-associated species inhabits rocky and weedy areas, to depths of 80 m. Maximum reported size is 12 cm TL (male) (Böhlke and Chaplin 1993 in Froese and Pauly 2002). Estimated size at maturity is 8.2 cm TL; natural mortality rate, 1.87 (Froese and Pauly 2002). The lantern bass is reportedly synchronously hermaphroditic, having both sexes in the same individual at the same time. Its diet is composed of shrimp and small fishes (Böhlke and Chaplin 1993 in Froese and Pauly 2002).

5.2.1.3.33.18 Tobaccofish, *Serranus tabacarius*

The tobaccofish occurs in the Western Atlantic, ranging from Bermuda to northern Brazil, including the Caribbean Sea. This species is believed to be of negligible value to commercial fisheries because of its small size. But it is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

The tobaccofish inhabits shallow rocky or coral bottoms, from 4-70 m depth. It prefers clear water, and usually occurs in groups on deeper reefs. Maximum reported size is 22 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Estimated size at maturity is 14.1 cm TL; natural mortality rate, 0.84 (Froese and Pauly 2002). This fish is a synchronous hermaphrodite, having both sexes in the same individual at the same time. It reportedly sometimes follows goatfishes (family Mullidae) as they probe the sand for invertebrates (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.33.19 Harlequin bass, *Serranus tigrinus*

The harlequin bass occurs in the Western Atlantic, ranging from Bermuda to northern South America, and throughout the Caribbean. This species is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

The harlequin bass is most common in areas with rock or scattered coral. It occurs singly, or in pairs, to 40 m depth. Maximum reported size is 29 cm FL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Estimated size at maturity is 17.9 cm FL (Froese and Pauly 2002). No estimate of natural mortality rate is available for this species. This fish is a synchronous hermaphrodite. It feeds primarily on crustaceans (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.33.20 Chalk bass, *Serranus tortugarum*

The chalk bass occurs in the Western Atlantic, off southern Florida (USA), the Bahamas, Honduras, and probably throughout Caribbean reef areas. It is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

This demersal species is often found in small groups, over rubble, silty, or sandy bottoms, from 12-396 m depth. It is difficult to approach. Maximum reported size is 8 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Estimated size at maturity is 5.8 cm TL; natural mortality rate, 2.48 (Froese and Pauly 2002). The chalk bass is a synchronous hermaphrodite. It and feeds on plankton (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.34 Soles, Soleidae

The Soleidae family contains 89 species in 22 genera (Nelson 1994 in Froese and Pauly 2002). Only one species, the Caribbean tonguefish (*Symphurus arawak*), is included in the Caribbean reef fish fishery management unit.

5.2.1.3.34.1 Caribbean tonguefish, *Symphurus arawak*

The Caribbean tonguefish occurs in the Western Atlantic, ranging from Florida (USA) and the Bahamas to Curaçao and Colombia. It is utilized primarily in the aquarium trade (Munroe 1998 in Froese and Pauly 2002).

This demersal species inhabits bays and coastal waters, from 3-30 m depth. Maximum reported size is 5.1 cm TL (male) (Munroe 1998 in Froese and Pauly 2002). Estimated size at maturity is 3.9 cm TL; natural mortality rate, 3.42 (Froese and Pauly 2002). This fish is a pelagic spawner, and feeds on benthic invertebrates and fishes (Nelson 1994 in Froese and Pauly 2002).

5.2.1.3.35 Porgies, Sparidae

The Sparidae family contains 112 species in 35 genera, distributed in tropical and temperate waters of the Atlantic, Indian, and Pacific Oceans. These fish are premier food and game fishes. Many species have been found to be hermaphroditic; some have male and female gonads simultaneously; others change sex as they get larger (Nelson 1994 in Froese and Pauly 2002). The spawning season of these fishes is limited (Erdman 1976). Only two genera are represented in the Caribbean reef fish fishery management unit: *Archosargus* and *Calamus*.

5.2.1.3.35.1 Sea bream, *Archosargus rhomboidalis*

Also known as the "Western Atlantic sea bream," this species occurs in the Western Atlantic, ranging from New Jersey (USA) to the northern coast of South America, including the Gulf of Mexico (Robins and Ray 1986 in Froese and Pauly 2002) and Caribbean Sea. This species is reportedly absent in the Bahamas. This species is fished commercially (Robins and Ray 1986 in Froese and Pauly 2002).

The sea bream is commonly found over mud bottoms in mangrove sloughs and on vegetated sand bottoms, sometimes in brackish water and, occasionally, in coral reef areas near mangroves. This fish is highly resilient, with a minimum population doubling time of less than 15 months (K=1.27; tm=0.4; tmax=2). Maximum reported size is 33 cm TL (male); maximum weight, 550 g (Robins and Ray 1986 in Froese and Pauly 2002). Estimated size at maturity and age at first maturity are 16.6 cm TL and 0.6 years, respectively (Froese and Pauly 2002). Maximum reported age is 2 years (Robins and Ray 1986 in Froese and Pauly 2002). Natural mortality rate is estimated as 2.10 (Froese and Pauly 2002).

Erdman (1976) reports that over 100 sea breams crowded into one fish pot set in less than 3.7 m of water at La Parguera in February 1954, the majority of which were ripe females measuring 20-22 cm SL. He notes that February continued to be the peak spawning month of this species in continuing years, although spawning extended from November to March. In the southern Gulf of Mexico, Chavance *et al.* (1986) reported that sea bream were in spawning condition from October to July with greater spawning activity occurring during February through May. The sea bream feeds on benthic invertebrates, such as small bivalves and crustaceans, and of plant material (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.35.2 Jolthead porgy, *Calamus bajonado*

The jolthead porgy occurs in the Western Atlantic, ranging from Rhode Island (USA), southward to Brazil, including parts of the Gulf of Mexico and Caribbean Sea. An excellent food fish, this species is taken in both commercial and recreational fisheries (Robins and Ray 1986 in Froese and Pauly 2002). According to Lieske and Myers (1994), in Froese and Pauly (2002), it can be ciguatoxic.

The jolthead porgy inhabits coastal waters, from 3-200+ m depth. It can be found on vegetated sand bottoms, but occurs more frequently on coral bottoms. Large adults are usually solitary. This fish is moderately resilient, with a minimum population doubling time of 1.4 - 4.4 years (tm=3). Maximum reported size is 76 cm FL (male); maximum weight, 10.6 kg (Robins and Ray 1986 in Froese and Pauly 2002). Estimated size at maturity is 42 cm FL (Froese and Pauly 2002). Jolthead porgy have been reported to spawn during October through June off Cuba with a peak during March and April (Garcia-Cagide *et al.* 1994). No estimate of natural mortality rate is available for this species. Sea urchins, crabs, and mollusks are primary prey items (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.35.3 Sheepshead porgy, *Calamus penna*

The sheepshead porgy occurs in the Western Atlantic, ranging from Florida (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea (Robins and Ray 1986 in Froese and Pauly 2002). This species is fished commercially, and is marketed both fresh and frozen (Robins and Ray 1986 in Froese and Pauly 2002). Olsen *et al.* (1984), in Froese and Pauly (2002), report that it can be ciguatoxic.

This species occurs from 3-87 m depth, in clear reef areas over soft or semi-hard bottoms. Juveniles are encountered in seagrass (*Thalassia*) beds. Maximum reported size is 46 cm TL (male); maximum weight, 1,000 g (Robins and Ray 1986 in Froese and Pauly 2002). Estimated size at maturity is 27 cm TL; natural mortality rate, 0.72 (Froese and Pauly 2002). In the northeastern Caribbean, individuals have been observed in spawning condition in February and March (Erdman 1976).

5.2.1.3.35.4 Pluma, *Calamus pennatula*

The pluma occurs in the Western Atlantic, from the Bahamas to Brazil, including the southern part of the Gulf of Mexico and throughout the Caribbean Sea. This species is an important food fish (Cervigón 1993 in Froese and Pauly 2002). Olsen *et al.* (1984), in Froese and Pauly (2002), report that it can be ciguatoxic.

Adult pluma porgies are often observed over rocky areas or reefs, but also on flat bottoms to about 85 m depth. Juveniles inhabit shallower waters. Maximum reported size is 37 cm TL (male) (Cervigón 1993 in Froese and Pauly 2002). Estimated size at maturity is 22.3 cm TL; natural mortality rate, 0.84 (Froese and Pauly 2002). In the northeastern Caribbean, individuals have been observed in spawning condition in February and March (Erdman 1976). Prey items include crabs, mollusks, worms, and brittle stars (Cervigón 1993 in Froese and Pauly 2002).

5.2.1.3.36 Seahorses and pipefishes, Syngnathidae

The Syngnathidae family contains 215 species in 52 genera, distributed in mostly warm temperate to tropical waters of the Atlantic, Indian, and Pacific Oceans (Nelson 1994 in Froese and Pauly 2002). Only *Hippocampus* (seahorses) and *Syngnathus* (pipefishes) species are represented in the Caribbean reef fish fishery management unit. These species are utilized primarily in the aquarium trade.

Little is known about the biology of the Syngnathids. These species are usually limited to shallow water and do not grow more than 60 cm in length. They feed on minute invertebrates sucked into a tubular snout. Males have a brood pouch in which the eggs are laid and where they are fertilized and incubated (Nelson 1994 in Froese and Pauly 2002).

5.2.1.3.37 Lizardfishes, Synodontidae

The Synodontidae family contains 55 species in 5 genera, distributed in the Atlantic, Indian, and Pacific Oceans (Nelson 1994 in Froese and Pauly 2002). Only one species, the sand diver (*Synodus intermedius*), is included in the Caribbean reef fish fishery management unit

5.2.1.3.37.1 Sand diver, *Synodus intermedius*

The sand diver occurs in the Western Atlantic, ranging from Bermuda and North Carolina (USA) to Guianas, including the Gulf of Mexico and Caribbean Sea. This species is believed to be of minor importance to commercial fisheries, but also is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

The sand diver is found on the sandy bottom around boulders, or in sandy corridors in patch reefs, from 3-320 m depth. It is uncommon near the shore. Maximum reported size is 46 cm TL (male); maximum weight, 1,000 g (Robins and Ray 1986 in Froese and Pauly 2002). Estimated size at maturity is 27 cm TL; natural mortality rate, 0.50 (Froese and Pauly 2002). This fish is a voracious predator of small fishes (Nelson 1994 in Froese and Pauly 2002).

5.2.1.3.38 Puffers, Tetraodontidae

The Tetraodontidae family contains 121 species in 19 genera, distributed in tropical and subtropical areas of the Atlantic, Indian, and Pacific Oceans (Nelson 1994 in Froese and Pauly 2002). Only two genera, *Canthigaster* and *Diodon*, are represented in the Caribbean reef fish fishery management unit.

5.2.1.3.38.1 Sharpnose puffer, *Canthigaster rostrata*

The sharpnose puffer occurs in both the Western and Eastern Atlantic. In the Western Atlantic, it ranges from Bermuda to northern South America, including the Gulf of Mexico (Robins and Ray 1986 in Froese and Pauly 2002) and Caribbean Sea. This species is utilized in the aquarium trade (Robins and Ray 1986 in Froese and Pauly 2002).

The sharpnose puffer occurs to 30 m depth. It is found in clear waters of coral reefs and reef flats; also in tide pools and seagrass beds. Maximum reported size is 12 cm TL (male) (Nelson 1994 in Froese and Pauly 2002). Estimated size at maturity is 8.2 cm TL; natural mortality rate, 1.87 (Froese and Pauly 2002). This fish is believed to be a "nest-guarding" species (Nelson 1994 in Froese and Pauly 2002). Its diet consists mainly of seagrass. But it also has been reported to consume invertebrates, sponges, crabs and other crustaceans, mollusks, polychaete worms, sea urchins, starfishes, hydroids, and algae (Robins and Ray 1986 in Froese and Pauly 2002).

5.2.1.3.38.2 Porcupinefish, *Diodon hystrix*

Also known as the "spot-fin porcupinefish," this species is widely distributed in tropical oceans around the globe. It has been reported in the Eastern Pacific, and in the Western and Eastern Atlantic. In the Western Atlantic, it ranges from Massachusetts (USA) to Brazil, including the Gulf of Mexico (Randall *et al.* 1990 in Froese and Pauly 2002) and Caribbean Sea. It is poisonous (Halstead *et al.* 1990 in Froese and Pauly 2002) and, thus, not normally eaten. But it is utilized in the aquarium trade (Randall *et al.* 1990 in Froese and Pauly 2002).

This species occurs in lagoon and seaward reefs, to at least 50 m. It is commonly observed in caves and holes in shallow reefs. Maximum reported size is 91 cm TL (male); maximum weight, 2,800 g. It is pelagic until it reaches about 20 cm in length, after which time it is benthic (Randall *et al.* 1990 in Froese and Pauly 2002). Estimated size at maturity is 49.3 cm TL; natural mortality rate, 0.31 (Froese and Pauly 2002). In the northeastern Caribbean, individuals in spawning condition have been observed in February and March (Erdman 1976). This fish is solitary and nocturnal, and feeds on hard shelled invertebrates, such as sea urchins, gastropods, and hermit crabs (Randall *et al.* 1990 in Froese and Pauly 2002). It also is presumed to exhibit nest-guarding behavior (Nelson 1994 in Froese and Pauly 2002).

5.2.1.4 Caribbean coral reef resource

The Caribbean coral reef resource comprises more than 160 species of invertebrates and plants. This diverse group of organisms includes sponges, a variety of reef-building (hermatypic) and non-reef building (ahermatypic) corals, anemones, annelid worms, mollusks, arthropods, bryozoans, echinoderms, tunicates, algae, and seagrasses. Over 67 species are utilized in the aquarium trade. These include the sponges, anemones, colonial anemones, false corals, annelid worms, mollusks (with the exception of the gastropods described in Section 5.2.1.2.2), crustaceans, echinoderms, tunicates, and algae. The remaining species have been classified as prohibited species, the take or possession of which is prohibited under the Caribbean Council's Coral FMP. Prohibited species, include over 94 species of hydroids, soft corals, gorgonians, hard corals, black corals, bryozoans, and seagrasses.

This section provides a summary description of each category of organisms that comprises the coral reef resource, along with information on their classification and status. In-depth summaries on the biology of these Caribbean reef invertebrates and plants can be found in Colin (1978) and in Sefton and Webster (1986). The section concludes with a broader description of the distribution of these organisms throughout the coral reef environment.

5.2.1.4.1 Sponges, Phylum Porifera

Sponges are classified into four classes, though only the class Demospongiae is represented in the Caribbean coral reef fishery management unit. This is the largest class of sponges, both in number of species and range of distribution (Colin 1978). Species included in the Caribbean coral reef fishery management unit are *Aphimedon compressa* (erect rope sponge; also known as *Haliclona rubens*), *Chondrilla nucula* (chicken liver sponge), *Cynachirella alloclada*, *Geodia neptuni* (potato sponge), *Haliclona* spp. (finger sponges), *Myriastra* spp., *Niphates digitalis* (pink vase sponge), *N. erecta* (lavender rope sponge), *Spinosella policifera*, *S. vaginalis*, and *Tethya crypta*.

Sponges are the least complex of all multi-cellular animals (Sefton and Webster 1986), typically attached to hard substrates and possessing various specialized cells but lacking organization of such cells into organs and tissues (Colin 1978). They are all sessile and exhibit little detectable movement (CFMC 1994).

Demosponges range from intertidal to abyssal depths in the ocean. *C. nucula* is found in shallow waters of reef areas, where it sometimes overgrows large areas of corals. *Haliclona rubens* occurs from 1-20 m depth (Colin 1978) on shallow to deep reefs, where it may intertwine with other species of finger sponge (Sefton and Webster 1986). *H. hogarthi* occurs from mangrove areas to reefs, at depths to 30 m (Colin 1978). But this species is most commonly found on reefs at moderate depths (Sefton and Webster 1986). *T. crypta*, a black, inconspicuous sponge, occurs in back reef areas or on limestone shelves in sheltered areas, from 1-8 m depth (Colin 1978).

The sponges display great variability in size and shape, with growth rates and body form highly dependent on space availability, the inclination of the substrate, and current velocity (CFMC 1994). Although their basic body plan is simple, some species attain surprising size (hundreds of pounds in weight out of water). The demosponges are encrusting to massive, ranging from nearly microscopic to over 2 m in diameter (Colin 1978).

Fingers of *H. hogarthi* may reach 1 m or more in length. And thickets formed by this species sometimes measure 2 m across. It usually reaches its greatest size on fore reef slopes and on buttresses below the level where strong wave action is likely to occur (Sefton and Webster 1986). The branches of *H. rubens* may reach 40 cm in length and 1-4 cm in diameter (Colin 1978).

Sponges reproduce sexually as well as asexually, by fragmentation or budding. Sperm are released to the sea, sometimes in numbers so great that the sponges seem to be "smoking," and many sponges of the same species may release sperm simultaneously. Fertilization is internal. Larvae are planktonic for some period of time before settling and growing in some unoccupied patch of reef habitat. As newly settled individuals, *T. crypta* is open to predation by sea urchins, but once beyond a critical size, this species may live to an age of at least 20 years or more (Colin 1978).

While the sponges are ancient in origin (abundant in reef habitats for at least 200 million years), their biological importance should not be underestimated. In some areas of the reef, the biomass of sponges present can exceed that of any other group, including reef-building corals (Colin 1978). They are important colonizers of bare reef rock, shipwrecks, and other newly available space. In turn, they house an amazing array of commensal "guests" such as worms, shrimps, brittle stars, fishes, and algae. At night, and in dimly lit water, brittle stars may be seen on the surface of *H. rubens* (Sefton and Webster 1986).

Some species bore into the limestone reef framework, weakening its structure and making it more susceptible to storm damage. Others produce extensive, nearly stony skeletal structures which cement and stabilize reef rubble and add to the structure of the reef. All combine in their nearly constant filtering activity to remove bacteria, small planktonic organisms, and larger organic particles from the water and are, thus, partially responsible fo the clarity of the water above the reef (Sefton and Webster 1986).

5.2.1.4.2 Coelenterates or Cnidaria, Phylum Coelenterata

The Coelenterates are among the most widely represented of all the invertebrate phyla on the coral reef. The phylum is divided into three classes: Hydrozoa (hydroids, fire corals, siphonophores); Anthozoa (corals, anemones, black corals, gorgonians); and Scyphozoa (true jellyfishes), of which only Hydrozoa and Anthozoa are represented in the Caribbean coral reef fishery management unit (Sefton and Webster 1986).

Basic coelenterate structure is fairly straightforward. The polyp (such as an anemone or solitary coral) is a bag with a hole (mouth-anus) at the top surrounded by a ring of tentacles. Polyps are usually attached to the bottom or some other hard substrate, such as a colonial skeletal framework. Most polyps divide asexually to produce colonies (colonial corals, zoanthids, gorgonians, hydroids, etc.) consisting of hundreds to thousands of individuals (Sefton and Webster 1986). Most reef-dwelling Hydrozoa are colonial, although solitary species do exist. More than one type of polyp may exist in a colony, with specializations for feeding, reproduction, or defense (Colin 1978).

All reef-building corals contain symbiotic algae, called zooxanthaellae, in their tissues, as do most of the sea fans and other gorgonians. These microscopic dinoflagellates help to nourish the coelenterate host and, in the case of corals, aid in the process of calcium carbonate secretion to form the coral exoskeleton (Sefton and Webster 1986).

5.2.1.4.2.1 Hydrocorals, Class Hydrozoa

The Class Hydrozoa is divided into five orders, of which only three are of any significance on Atlantic reefs: Athecatae (hydroids), Milleporina (fire corals), and Stylasterina.

The Athecatae, which include most species of the Hydrozoa, are solitary or colonial with the polypoid generation much more extensively developed than the medusoid generation. The solitary hydroids are not important on Caribbean reefs, but the colonial species can be conspicuous members of the reef community (Colin 1978).

Milleporina species represented in the Coral FMP are the fire corals (*Millepora* spp.), which belong to the family Milleporidae. Their name derives from the powerful stinging cells they possess, which enable them to paralyze and capture prey. These colonial corals are found from deep fore reef areas to back reefs (Colin 1978), and are considered to play a significant role in coral reef construction, particularly in shallow windward substrates, where they have a buffering effect (Goenaga and Boulon 1992).

Three described species of western Atlantic *Millepora* exist: *M. alcicornis*, *M. complanata*, and *M. squarrosa*. They differ only in the morphology of the skeleton and are often considered ecological variants of a single species. The branched form, *M. alcicornis*, occurs somewhat deeper than the others, while *M. squarrosa* is found in heavy surf or in areas exposed to air in the troughs of waves. Under extreme wave conditions or when covering the remains of another organisms, *Millepora* can be encrusting. Colonies sometimes cover entire sea fans and may also grow on the outer portion of the stalks of dead gorgonians. Barnacles and serpulid worm tubes may occur on the sides of the blade-like forms of *Millepora* (Colin 1978).

Stylasterina species represented in the Coral FMP belong to the family Stylasteridae. These corals are also colonial but do not contain zooxanthallae. They have been used frequently as ornamental pieces (Goenaga and Boulon 1992). Only one species, the rose lace coral (*Stylaster* *roseus*) is represented in the Caribbean coral reef fishery management unit. *S. roseus* occur at depths of 6 m to at least 30 m. These small, fragile, fan-like colonies reach 10 cm in height. They commonly occur in caves or crevices, often growing on inverted surfaces and occasionally (as at Mona Island) on open vertical rock faces (Colin 1978).

5.2.1.4.2.2 Anthozoans, Class Anthozoa

The second class of Coelenterata in the management unit, anthozoans include black corals (Order Antipatharia), gorgonians, sea fans (Sub-class Octocoralia), sea anemones and other similar organisms (Orders Actinaria, Zoanthidea and Corallimorpha), as well as the true reef-building corals (Order Scleractinia) (CFMC 1994). Anthozoans has its life cycle restricted to the polyp phase exclusively, with no medusa stage occurring. They typically attach to a substrate and have the oral end expanded into a flattened oral disk. A calcareous skeleton may be constructed. Further, a planula larvae may be produced, which is capable of being transported some distance by ocean currents.

5.2.1.4.2.2.1 Octocorals, Orders Alcyonacea and Gorgonacea

Due to the large numbers of species in these two orders, please refer to Table 4 for a list of all managed species. The following discussion on octocoral biology is offered to represent the order.

These two orders consist of sea fans, sea whips and other gorgonian species. Alcyonacea, also known as soft corals, includes species with skeletons consisting of spicules but no axial skeleton (Goenaga and Boulon 1992). Gorgonacea is the more dominant group of Octocorallia, occurring in abundance on Caribbean reefs (Colin 1978). All gorgonian colonies possess an axial skeletal structure of either a horny or calcareous central cylinder or a zone of tightly bound spicules. Most species have an erect skeletal structure attached to a solid substrate by a holdfast, by a smaller number of species may occur as an encrusting mat (Colin 1978). Gorgonians may live for more than 20 years with annual growth rates ranging from 0.8 - 4.5 cm/yr for 13 species studied in southeastern Puerto Rico over a five-year period (CFMC 1994). At study sites on southeastern Puerto Rico, mortality was found to be higher in small colonies, as compared to larger specimens, the major causes of death being damage to the colony base or detachment (CFMC 1994). Two species of sea whips, *Ellisella barbadensis* and *E. elongata*, reach sizes of nearly 2 m and can occur in dense stands on rocky, often vertical substrates at about 20 to at least 250 m. Three other smaller species may also occur within diving depths on deep reefs. Most species have wide geographic ranges, generally from southern Florida to the Caribbean.

The common sea fan, *Gorgonia ventalina*, has the widest distribution, both on the reef and geographically, of any gorgonian species. It can be found on nearly ever reef and is a characteristic part of reef environments in the Atlantic. It can occur near shore in areas of extreme wave action and on deeper outer reefs at 15 m or more in depth. It can reach a height of nearly 2 m and shows a somewhat "clumped" (non-random) distribution of individuals on a reef

(Colin 1978). This species is known from Bermuda to Curacao, including the Florida Keys and western Caribbean.

The Venus sea fan, *G. flabellum*, is often restricted to shallow water with very strong wave action. It occurs in areas generally somewhat shallower and rougher than *G. ventalina* where the two occur in the same geographic area. It is seldom found below 10 m depth and can reach sizes near those of *G. ventalina*. Its known geographic distribution is somewhat odd. It is abundant and easily distinguished from *G. ventalina* in the Bahamas, but becomes scarce and less distinctive in Florida and the Lesser Antilles. It is common on the windward reef flats and back reef zones where fire corals are abundant. This species is known to fall prey to the flamingo tongue snail (Sefton and Webster 1986).

G. mariae, the wide-mesh sea fan, is the smallest of the sea fans, the fan-like form reaching only about 30 cm in height. There are two other growth forms of this species. One has short free branchlets form one or both faces, while the plumose form, which may reach 40 cm in height, has the inner and lower branches anastomosed, but the terminal branches free. This is generally a deeper water species than the *G. ventalina* and *G. flabellum* and has been encountered as deep as 47 m and as shallow as 5 m. Known from Cuba, Jamaica, Puerto Rico, the Virgin Islands, and the northern Lesser Antilles (Colin 1978).

There are several species of *Pseudopterogorgia* (sea plumes) on Caribbean reefs. Most are tall, plume-like colonies. On the leeward side of some islands in the Caribbean, a zone of dense growth of these species can occur at 7-10 m, with colonies reaching heights over 1.5 m. They are pinnately branched, with no interconnections between branches, and some are slimy to the touch with abundant mucus. *Pseudopterogorgia spp.* may be so common as to be the dominant feature of some reefs. Flamingo tongue snails are also common predators of sea plumes (Sefton and Webster 1986). The bipinnate plume produces planulae in Jamaica in late January an dearly February. Unlike stony coral planulae, those of the bipinnate plume do not contain zooxanthellae. In the laboratory, they settle 11 days after release and must acquire their initial zooxanthellae from the environment, as these plant cells are abundant in the adult colonies (Colin 1978).
The genus *Eunicea* (sea rods) is an important group of reef-dwelling alcyonarians. Most occur from a few meters depth to a maximum of about 30 m (Colin 1978). *Eunicea spp.* occur at shallow and moderate depths. These gorgonians have single-celled algae (zooxanthellae) in the tissues of the polyps, as do most other gorgonians, corals, and anemones of the reef community. These symbiotic algae aid in the nutrition of the host colony (Sefton and Webster 1986).

Muricea spp. are common at moderate depths, particularly in spur and groove systems of the reef. They may also be attached to coral rubble in sandy areas (Sefton and Webster 1986). Sea rods, *Plexaura spp.*, occur to depths of 50 m. *P. homomalla* has recently been the subject of much study since it was discovered to contain high amounts of a type of chemical (prostaglandins) valuable in the pharmaceutical industry. Advances in chemical synthesis of prostaglandins have not made such considerations less important. This species is tan in color and can reach nearly 12 m in height. Trumpet fishes sometimes hide by aligning themselves with the branches of *Plexaurella* colonies (Sefton and Webster 1986). Most *Plexaurella spp.* in the Caribbean commonly occur from about 10 to 50 m depth.

Gorgonian life history is noted by low and variable recruitment of small specimens. Given this uncertain recruitment, the predictable survival of adults is critical to the persistence of gorgonian populations (CFMC 1994). Further, gorgonian species can play an important role as habitat for other managed species. Fire coral, *Millepora spp*., may encrust entire colonies, particularly the sea fans of the genus *Gorgonia*. Bivalve mollusks, sponges, and algae may grow upon dead sections of gorgonian skeletons; whether these organisms simply take advantage of already dead substrate or themselves kill a portion of the gorgonian is not known. The gastropod mollusk, *Cyphoma gibbosum*, feeds on gorgonian polyps by crawling slowly over the skeleton, grazing at will. Other organisms, such as basket starfishes and brittlestars, climb tall gorgonians to reach a position more advantageous for filter-feeding in reef areas (Colin 1978). These factors warrant the prohibition on their harvest.

5.2.1.4.2.2.2 Anemones, Orders Actiniaria and Zoanthidea

The Orders Actinaria and Zoanthidea represent what are commonly known as anemones, which may be either solitary or colonial. The polyps vary greatly in morphology and colonial structure. Actinarians consist of six anemone species: *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). These species are found throughout the Caribbean, and occur on reefs, rocky areas, and lagoonal areas from 1 - 43 m in depth. *Condylactis gigantea* is known to provide shelter for a variety of juvenile and adult fishes and crustaceans. This particular species spawns in late spring in Florida, and may become reproductively active as small as 4.5 g (CFMC 1994). There is no available information on age and growth.

Zoanthus spp. (Sea mat) comprise the only species (e.g., *Zoanthus pulchellus*, *Z. sociatus*) of Zoanthids in the management unit. These colonial organisms form resilient mats which can cover extensive areas in shallow water (i.e., less than 5 m), and are particularly abundant on the back side of shallow reef flats.

5.2.1.4.2.2.3 Hard or stony corals, Order Scleractinia

Almost 50 species belonging to 12 different families are represented in the Caribbean coral reef fishery management unit. Due to the numerous scleractinian species included in the coral reef fishery management unit, and that the ecological importance of corals is widely accepted and understood by the public, the following is only a survey of the major species and species groups.

Scleractinians are the principal reef builders. They are calcium secreting, anemone-like animals that can form colonies comprised of many physically and physiologically linked polyps or else can be solitary or consisting of one polyp. Tentacles occur in multiples of six and the digestive cavities are divided by partitions (sclerosepta and sarcosepta) that radiate from the center of the polyp. The polyps of stony corals are somewhat similar to those of sea anemones but produce a calcium carbonate cup (the corallite) and are usually colonial, producing a massive calcareous skeleton (the corallum) from the many corallites. In contrast to anemones they produce calcium carbonate, aragonitic skeletons that can reach considerable sizes (e.g., over 5 m in diameter and height in individuals of *Montastrea annularis*). The skeleton is internal, in contrast to other skeleton forming cnidarians (Goenaga and Boulon 1992). Often scleractinians are considered in two informal groups, the hermatypic or reef-building corals (those making a significant contribution to reef structure) and ahermatypic or non-reef building corals (often small, solitary species without large skeletons) (Colin 1978).

Many stony corals, particularly those that are hermatypic, contain small unicellular plants called zooxanthellae (dinoflagellata) in their gastrodermis. These zooxanthellae are pigmented, giving corals most of their color, and play a role in the production of calcium carbonate by the coral polyp. The exact nature of their contribution is not known and seems to vary within species of corals. Generally, however, ahermatypic corals lack zooxanthellae while hermatypic species possess large numbers. The zooxanthellae can be expelled by a coral (usually termed bleaching) when under stress (Colin 1978).

It is believed that the requirement of light for the zooxanthellae is the reason why coral reefs are limited to fairly shallow waters. With increasing depth below about 30 m corals are generally less heavily calcified than in shallower water and the ability to form reef structures is much less than in shallow water. Reef corals may occur to depths approaching 90-100 m in extremely clear water, but below 45-50 m in their constructional abilities are severely limited and may be surpassed by those of other groups of organisms such as the sclerosponges (Colin 1978).

Within a colony, all reproduction is asexual. New polyps are budded from other polyps as the colony increases in diameter or length. The rate of growth is variable between species, with branched species generally growing faster than massive species, and is strongly influenced within each species by environmental conditions. Sexually produced larvae, termed planulae, result in the establishment of new colonies. Larvae may either swim (entering the plankton and covering large distances) or crawl (staying close to the parent) until they attach to the bottom to initiate a new colony (Colin 1978).

A number of organisms prey directly on corals. Certain fishes pick polyps from the surface of the colony (butterflyfishes) while others ingest or scrape portions of skeleton with their attached polyps (puffers, parrotfishes). Some gastropod mollusks feed on coral polyps by inserting their proboscis into the polyp, and a few polychaete worms feed on branched corals by engulfing the tip of a branch in their mouth (Colin 1978). Boring sponges and clams occur in the skeleton and weaken it by their mechanisms of removing calcareous material (Colin 1978).

Acropora cervicornis (staghorn coral), found throughout the Caribbean, is characteristic of seaward facing reefs, but generally occurs on reefs below 6 to 9 m depth. It occurs from low water to 50 m but is most common at 12 to 22 m. This is one of the most rapidly growing corals. Length increases of nearly 30 cm per year have been recorded for single branches under optimal conditions. This species can also occur in shallow, quiet back reef areas where the water is fairly clear. Damselfishes frequently stake out their territories in staghorn, as well as elkhorn coral (Sefton and Webster 1986).

A. palmata (elkhorn coral) is also characteristic of seaward facing reefs. It is the most abundant stony coral in shallow water areas, often growing up to low water levels. The "*A. palmata* zone" is a characteristic component of most West Indian reefs, and it thrives where wave conditions are rough. Severe storms such as hurricanes can have disastrous effects on reefs comprised of this species. Entire reefs may be reduced to rubble, much of this transported over the reef crest or piled above low water levels. Large colonies may be overturned and often renew their growth in the inverted position. *A. palmata* is strictly a shallow-water coral. Seldom are colonies found below 15 m, and its greatest abundance is in the top 6 m of the water. It can occur in surprisingly turbid water, but may be limited in some areas by low winter temperatures. The fast-growing branching colonies of *A. palmata* are sometimes 4 m or more across. One of the dominant corals in the Caribbean, elkhorn coral competes by growing rapidly and by shading or over-topping its neighbors. Entire barrier reefs, with no adjacent reef flat, may be built of this coral. The famous barrier reef at Buck Island, St. Croix, is an excellent example of such a situation, but similar reefs are found in many areas of the Caribbean. Occasionally, the branches of *A. palmata* will have lumpy growths of polyps, termed "neoplasms," on the normally flattened branches. If any portion of the coral surface dies this provides a site of attachment for a wide variety of organisms, and branches of *A. palmata* with algae, hydroids, and actinians in sections have been observed. Certain crabs, such as *Domecia acanthophora*, form cavities in the junctions of branches by preventing the coral from growing in these areas (Colin 1978).

Corals of the genus *Agaricia* and *Leptoseris*, commonly known as the "lettuce corals," are among the most fragile corals occurring on reefs. However, they play an important role in reef construction, particularly in the deeper sections. Various species are also important elements of the shallow reef environment (Colin 1978). While *Agaricia tenuifolia* is generally restricted to depths shallower than 18 m, other species are found on reefs down to 80 m in depth.

Two species of Caryophyllidae are in the coral reef fishery management unit, *Eusmilia fastigiata* (flower coral) and *Tubastrea aurea* (cup coral). *E. fastigiata* colonies, found widely in the Caribbean, grow up to 50 cm in diameter. This species has a wide depth range from 1-65 m, but is most common at 3-30 m depth. It can occur in a variety of habitats from back reefs to fore reefs, and under overhanging sides of larger corals. Encrusting sponges, algae, and tubeworms often grow on the dead branches from which the polyps grow (Sefton and Webster 1986). *T. aurea* is non-reef building (ahermatypic) but is, on occasion, abundant on reefs in the proper habitat. It is not solitary, with clumps containing a few to hundreds of polyps occurring on undercut wave-swept rocks, on overhanging faces in deeper water and in fairly dimly lit caves.

One pier off western Puerto Rico has all the area available on the inside of the pilings, beneath a platform providing shade, completely covered by this coral to a depth of 1.5 m. This species lacks zooxanthellae.

Diploria spp. include *D. clivosa* (knobby brain coral), *D. labyrinthiformis* (grooved brain coral), and *D. strigosa* (symmetrical brain coral). In Bonaire, *D. clivosa* is one of the dominant corals on the leeward side of a fringing reef of *Acropora palmata*, but is not as significant a constructor on reefs as are the other two species of *Diploria*. It does not occur as deep as *D. strigosa*, with its maximum depth begin about 15 m and its distribution centered around 1 to 3 m. This species grows in shallow to moderately deep areas, often in quiet back reef and lagoon habitats. Where wave action is stronger, it exhibits a more plate-like growth and becomes an important structural element of the reef community in some locations (Sefton and Webster 1986). *D. labyrinthiformis* forms sizeable heads over 1 m in diameter. This species is a minor reef constructor on the seaward slope of reefs and is the most restricted species of *Diploria* in its distribution on reefs. It occurs as deep as 43 m, but is most common at 2-15 m depth. This common coral is found from shallow to deep locations, but is most abundant at moderate depths on windward reef terraces (Sefton and Webster 1986). *D. strigosa* can form immense heads well over 2 m across and is capable of making a significant contribution to reef structure. This species, like most brain corals, is slow growing, with an annual increase of size of a head estimated at up to 1 cm per year. This means specimen of 2 m in diameter would be at least 100 years old and probably several hundred with all factors considered. This species occurs from low water to at least 40 m but is most abundant above 10 m. It is perhaps the most widely distributed species of *Diploria* on the reef and has even been reported from muddy bays where few other corals grow. This species occurs at all scuba depths from shallow nearshore reefs to moderately deep fore reef slopes (Sefton and Webster 1986).

Montrastrea annularis (boulder star coral) and *M. cavernosa* (great star coral) are generally the most common species of coral on Atlantic reefs at moderate depths (Colin 1978). *M. annularis* forms massive boulders or heads reaching several meters across in shallow water (1-20 m) and flattened heads or plate-like colonies in deeper water (below 20 m). It reaches depths of at least 60 m (Colin 1978). There is great variation in this species, and much of it seems related to depth. This species is slow growing compared to branching corals such as *A. cervicornis*, but rates of 1.0-2.5 cm per year increase in height have been recorded. *M. annularis* is attached by a wide variety of organisms other than corals. Boring sponges are quite abundant in this species, gastropod mollusks of the genus *Coralliophila* feed either on the polyps or on plankton ingested by the polyps, and filamentous algae occur on areas where coral tissue was removed by mechanical action. This star coral often forms massive mounds that are important structural elements of buttresses and other fore reef elements at moderate depth. Colonies become more plate-like as depth increases. This is frequently the dominant reef-builder in buttresses and fore reef slopes (Sefton and Webster 1986).

In many localities at moderate depths, *M. cavernosa* is the predominant species of coral present. Either this species or *M. annularis* is generally the most common coral between 10-30 m in buttressed or sloping areas of Atlantic reefs lacking sizable thickets of *A. cervicornis*. Below 30 m, *M. cavernosa* clearly predominates over *M. annularis*, but increasing importance of agariciid corals and sclerosponges in reef construction somewhat diminishes its contribution. *M. cavernosa* is one of the most effective zooplankton feeders among stony corals. It is one of the deepest occurring hermatypic corals, found at depths from only a few meters to at least 90 m (Colin 1978). *M. cavernosa* is somewhat less common than *M. annualris* but, nevertheless, is an important reef-builder in many areas (Sefton and Webster 1986).

Dendrogyra cylindricus (pillar coral) is one of the most spectacular stony corals found on West Indian reefs. Colonies may contain dozens of upright cylindrical branches and reach a total height of nearly 3 m. If a single one of the "pillars" is broken off and comes to rest in a position where it continues to live, the branch will give rise to several new pillars which again grow vertically. This species is unusual in that the polyps with their tentacles are expanded in the daytime unlike most other stony corals. Pillar coral varies considerably in abundance throughout its range and is a very minor constructor of reefs. It is found on flat or gently sloping reef bottoms between 1 and 20 m. Colonies form spires 3 m or more tall. Distribution is spotty throughout the Caribbean (Sefton and Webster 1986).

Four Poritidae species are represented in the management unit: *Porites astreoides (*Mustard hill coral); *Porites branneri* (Blue crust coral); *Porites divaricata* (Small finger coral); and *Porites porites* (Finger coral). *P. asteroides* can occur in a variety of growth forms. In shallow water it can be encrusting, while at deeper depths the colonies are either rounded or flattened with the surface facing towards the light. Fam worms often occur with *P asteroides* and the sponge *Mycale laevis*, which grows on the undersurfaces of certain corals, can also be associated with it. Asexual reproduction is accomplished either through extratentacular budding or intratentacular budding. *P. asteroides* occurs abundantly in nearly all reef zones to depths of over 50 m. *P. branneri* colonies are encrusting and found from 0.1-12 m of depth, generally associated with bank reef types. *P. divaricata* is a delicate species of *Porites*. The branches are about 6 mm in diameter and form, at most, a small clump with widely spaced branches. *P. divaricata* are typical of back reef areas in shallow water, but occur rarely as deep as 15 m (Colin 1978). *P. porites* have thick branches, often 25 mm in diameter, that resemble stubby fingers, hence the name. *P. porites* can occur in many reef situations including back and clear water fore reef areas, It common throughout the Caribbean, but is rare below 20 m (Colin 1978).

5.2.1.4.2.2.4 Black corals, Order Antipatharia

Entire colonies are harvested for artisanal purposes in some regions of the Caribbean. In 1970, the local precious coral jewelry industry (black and pink coral) was estimated to have a retail value of more than 4 million dollars. Their axial skeleton is polished and attains considerable thickness in some species, rendering them commercially valuable in the jewelry trade to humans. Species that do not branch are bent for making necklaces. In Puerto Rico and the Virgin Islands, commercial harvesting is apparently uncommon but is known to occur (Goenaga and Boulon 1992).

The ecology and life history of these organisms is, for the most part, unknown. Taxonomy, to a large extent, is also unknown. Two genera are represented in the Caribbean coral reef fishery management unit: *Antipathes spp.* (bush black corals) and *Stichopathes spp.* (wire corals) (Goenaga and Boulon 1992). Black corals are typically deep sea, slow growing colonial anthozoans usually occurring under ledges, possibly because their larvae is negatively phototactic. The axial skeleton is black, spiny and scleroproteinaceous, and is secreted in concentric layers around a hollow core. The polyps overlay the horny skeleton, are interconnected and possess six non-retractile, unbranched tentacles. They usually contain a diverse array of internal and external unstudied commensal organisms that include palaemonid crustaceans, lichomolgid copepods, and pilargiid polychaetes. Available evidence suggests that recruitment is infrequent.

Thick stemmed, branched, and large (i.e., potentially important economically) bush black corals occur in water depths below 50 m in La Parguera, Puerto Rico. Unbranched, thin stemmed wire corals are present at depths of 20 m. Both genera can also occur sparsely in very shallow, turbid waters off Mayaguez, western Puerto Rico and in La Parguera, southwestern Puerto Rico. Individual *Antipathes spp.* have been observed above depths of 8 m south of Arrecife La Gata, La Parguera, indicating that adult colonies of these species do not require deep waters. In the Virgin Islands, these species are most common at depths exceeding 30 m but can be found on the north shore of St. Croix and north of St. John (e.g., Haulover Bay) at depths of less than 20 m. Some of these colonies have been observed to have been harvested over a several year period which would indicate either cautious harvesting (some of these areas being within the VI National Park) or personal collecting for low level jewelry production (Goenaga and Boulon 1992).

5.2.1.4.2.2.5 False corals, Order Corallimorpharia

The corallimorpharians are a small order of Hexacorallia. They lack a skeleton but they form sheet-like colonies or can occur singularly. While they occur on Carribean reefs, they are of minor importance (Colin 1978).

Discosoma spp. are often found in groups on rocky substrates, and they may reach 10 cm in diameter. Generally occurring in shallow waters 2 to 30 m in depth, it can be found growing on vertical shaded areas, on dead branches of coral, and symbiotically growing on sponges (Colin 1978). The Florida false coral, *Ricordia florida*, covers large areas of rocky substrates on the back and fore reef from 0 to 20 m of water, and can consist of hundreds of polyps. Individual specimens of *R. florida* are no large than 5 cm in diameter, and has short, rounded tentacles.

5.2.1.4.3 Bryozoans

The bryozoans are colonial, largely marine animals numbering around 1,000 species which occur attached to a substrate (Colin 1978). The individual animal in a bryozoan colony is called a zooid. Zooids have polyp-like tentacles encircling the mouth, but they have developed a complete digestive system, including an anus that lies outside the ring of tentacles. Bryozoan colonies of different species vary greatly in appearance. Some look like a clump of seaweed or moss, while others grow as lacy fans (e.g., *Reteporellina evalinae*). Still other species simply form a low-lying encrustation (e.g., *Trematooecia aviculifera*). Colonies can be either rigid or flexible. Rigid colonies, while calcareous, are often extremely fragile. Because of the many variable, members of the phylum are not easily recognized as a group; many species can only be differentiated by the shape of the individual zooid, which often requires microscopic examination.

5.2.1.4.4 Aquarium trade species

The aquarium trade, occurring primarily in state waters where shallow water depth facilitates specimen collection by divers, includes species of sponges, anemones, false corals, annelid worms, mollusks, crustaceans, echinoderms, and algae. A description of sponge, anemone, and false coral biology and status was included in Sections 4.2.2.1.4.1 and 4.2.2.1.4.2.2. The status of the annelid worms, mollusks, crustaceans, echinoderms, has not been assessed relative to the pre-SFA definition of overfishing. Under that definition, these stocks are experiencing overfishing when annual catch exceeds OY. No definition of overfished has been developed for these stocks (NMFS 2002). The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown." The methodology used to make this determination is described in Section 4.2.2. The following offers biological information on these remaining groups.

5.2.1.4.4.1 Annelid worms, Phylum Annelida.

Polychaetes are a large class of segmented marine worms numbering over 10,000 species. They are easily divided into the sedentary tube dwellers (Subclass Sedentaria) and the free-moving species (Subclass Errantia) (Colin 1978). Both families represented in the Caribbean coral reef fishery management unit belong to the Subclass Sedentaria. These include the Sabellidae (feather duster worms) and Serpulidae.

Species in the Coral FMP that belong to the Sabellidae family include *Sabellastarte* spp. (tube worms) and *S. magnifica* (magnificent duster). *S. magnifica*, the largest of the Caribbean feather dusters, is found in the Caribbean at depths of 1 to at least 20 m, and may be abundant on pilings and on reefs among corals where there is a fair amount of suspended material in the water. Other Sabellidae on reefs may occur in groups of dozens of individuals (Colin 1978).

Only one species in the Coral FMP, *Spirobranchus giganteus* (Christmas tree worm), belongs to the Serpulidae family. Abundant on all areas of the reef, *S. giganteus* can be found from 1 to 25 m of depth.

5.2.1.4.4.2 Mollusks (with the exception of the Caribbean Conch Resources)

Mollusk species that are included in the management plan include gastropod and bivalve representatives, as well as octopi. The lettuce sea slug (*Tridachia crispata*) is common species found on reefs and other areas, and are generally found in shallow water, with a maximum depth of 15 m. The netted olive (*Oliva reticularis*) is a colorful gastropod whose shell is common in curio shops and collected along the beach. It is also found in shallow water, with a maximum depth of 10 m. It inhabits sandy areas near shallow patch and back reefs. Several species of Strombidae are also included in the Coral FMP, but a discussion on their biology and status can be found in Section 3.2.1.2.2. The flamingo tongue (*Cyphoma gibbosum*) is a colorful gastropod and is commonly associated with gorgonian species, which it feeds on. As with the other mollusk species, it is found in shallow water, with a maximum depth of approximately 15 m. The Atlantic triton trumpet (*Charonia tritonis*; *Charonia variegata*) is a large gastropod that is most likely prized more for its shell by specimen collectors, than by aquarists. It is found occasionally throughout the Caribbean, but has become rare in other regions due to over-collecting. It inhabits sandy bottoms and reefs, usually hiding in reef recesses during the day but actively feeding on sea cucumbers in the open at night. It typically is found in 6 to 20 m of water.

Three species of fileclams can be found in the Caribbean region. The rough fileclam (*Lima scabra*) is common throughout the Caribbean, and inhabits cracks, crevices, and recesses in 1 to 40 m of water. While it can attach itself to substrate with byssal threads typical of mussels, it can also swim with jerky motions by repeatedly snapping its valves open and shut. In contrast to the fileclam, the spiny fileclam (*Lima lima*) and the Antillean fileclam (*Lima pellucida*) are typically found in shallow waters from 1 - 9 m. The spiny fileclam is common throughout the region, while the Antillean fileclam is only occasionally encountered. Both generally hide under rocks and reef debris, but can swim like the spiny fileclam by opening and closing its valves.

Included in the management unit are several species of octopi. Five managed species are known to exist in the Caribbean, though only one is common. The Caribbean reef octopus (*Octopus briareus*) can reach a size of 30 to 60 cm, weight of 1 kg, and lives in 5 to 25 m of water. *O. briareus* spawns only once; the male dies after mating and the female after the eggs have hatched. Its eggs are large, up to 1.59 cm long, and in clusters usually numbering less than 1,000. The eggs hatch in about to months and the young quickly take up a bottom-dwelling habit. The lifespan of *O. briareus* is typically around one year. Other managed species that are uncommon to rare in the Caribbean are the white spotted octopus (*O. macropus*), the Caribbean two-spot octopus (*O. filosusi*), the Atlantic pygmy octopus (*O. joubini*), and the brownstripe octopus (*O. burryi*).

5.2.1.4.4.3 Crustaceans

A diverse and numerous group (22 species) of crustaceans, such as hermit crabs and cleaner shrimp, are included in the management unit. Cleaner shrimp such as the scarlet-striped cleaning shrimp (*Lysmata grabhami*) inhabit reefs and the recesses of sponges, and serve an important ecological role by cleaning numerous finfish species of parasites. Most shrimp are associated with reef habitat, and some, such as the squat anemone shrimp (*Thor amboinensis*), the Pederson cleaner shrimp (*Periclimenes pedersoni*), and the spotted cleaner shrimp (*P. yucatanicus*), live in association with anemones. As such, these shrimp species are typically found in depths of 1 to 40 m, with most found in water less than 30 m of depth.

Hermit crabs (e.g., *Paguristes cadenati*, *P. erythrops*) utilize abandoned gastropod shells as mobile shelter. They occupy the shell by wrapping their abdomen around the internal spirals of the shell and extend only their head, antennae, and legs from the opening. The occur in a wide variety of habitats, including reefs, and can be found in depths from 1 to 40 m of water. Similar in body structure to the hermit crabs, in that they posses a long abdomen, are the mantic crabs. The swollen claw mantis (*Gonodactylus oerstedii*) and the dark mantis (*G. curacaoensis*) are found on reefs, under ledges, and other recesses from 1 to 25 m in depth.

Also included are several other species of true crabs, such as the green clinging crab (*Mithrax sculptus*), the banded clinging crab (*M. cinctimanus*), and the nimble spray crab (*Percnon gibbesi*), that are common throughout the Caribbean. Generally found in rocky and coral reef areas, they can be found in 1 to 40 m in depth. The nimble spray crab is commonly associated with sea urchins, and seeks shelter under their long spines.

5.2.1.4.4.4 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 species include crinoids (feather stars), sea stars, brittle stars, sea urchins, and sea cucumbers.

Four species of crinoids, *Davidaster rubiginosa* (golden crinoid), *D. discoidea* (beaded crinoid), *Nemaster grandis* (black and white crinoid), and *Analcidometra armata* (swimming crinoid) are included in the management unit. These are filter feeding organisms and use the fine pinnules on the arms for straining material from the water. *D. rubiginosa* is perhaps the most abundant crinoid species in the Caribbean, and is found on reefs from 10 to 40 m of depth. The other species are all common to occasional throughout the management area, and are also found on reef habitat. *A. armata* has developed the unique ability to coordinate arm movements, which enables it to swim in open water. It is commonly found attached to branches of sea plumes and sea whips.

Sea stars typically are found on sandy of mud bottoms, though *Linckia guildingii*, an occasional Caribbean species, is found on reefs from 7 to 40 m of water. They are not important animals of Caribbean coral reefs (Colin 1978). They are star shaped and the number of arms vary within and between species. The mouth is on the under surface and the anus is generally on the upper surface. The cushion sea star (*Oreaster reticulatus*) is frequently found just offshore in 2 to 11 m of water, amongst sand flats and grass beds. Due to its robust size, it is commonly collected as a curio by tourists. Similar to sea stars, brittle stars have numerous arms radiating from its central body. The arms are also commonly used for locomotion, and in many species are used from filter feeding. When handled, brittle stars tend to break off their arms, hence their common name. The arms will regenerate after a time. Six species are included in the Coral FMP, and all inhabit reefs. The species in the management unit all are found in relatively shallow water, from 2 to 35 m of water.

Urchins, such as the long-spined urchin (*Diadema antillarum*) can play an important role on the reefs as herbivores. They are found in all habitats from 0 to 45 m of water, though they tend to hide in sheltered locations during the day, waiting to feed openly on algae after dark. Densities of *D. antillarum* can be high on reefs, with as many as 13/m^2 having been reported (Colin 1978). Aside from grazing on reef algae, urchins can denude areas of seagrass beds as well. This grazing on the reefs is an important factor in coral reef health and stability. In some instances where *D. antillarum* was not present, algae were literally taking over the reef from the corals. At least 15 species of fishes are known to prey on *D. antillarum*. Some juvenile fishes and shrimp and known to utilize the long spines of this urchin species as shelter. *D. antillarum* are known to aggregate and spawn throughout the year in the Caribbean. The remaining species of urchin, such as *Echinometra lucunter* and *Lytechinus variegatus*, occur in shallower water than *Diadema antillarum*, generally from 0 to 20 m in depth, and do not play as critical a role as the latter species. The West Indian sea egg (*Tripneustes ventricosus*) also inhabits seagrass beds, but its numbers have been greatly reduced in some areas of the Caribbean due to harvest for its roe.

While there are about 25 species of sea cucumbers that occur in shallow Caribbean water, only three species of sea cucumbers are also in the management unit; the donkey dung sea cucumber (*Holothuria mexicans*) is perhaps the most common of the three. It inhabits seagrass beds and sandy areas around reefs from 3 to 20 m of water. Sea cucumbers feed by passing sediment through the gut and digesting any organic material contained in it, or by catching detritus or small planktonic organisms on mucous-covered tentacles centered around the mouth. The body wall of sea cucumbers often contain a toxin, called holothurin, which makes them distasteful to predators. The slender sea cucumber (*H. impatiens*) and the tiger tail cucumber (*H. thomasi*) occur on reefs are rubble areas from 7 to 45 m of water.

5.2.1.4.4.5 Tunicates (Class Ascidiacea)

Ascidians are bottom dwelling organisms on hard substrates generally in shallow water. However, there are several species of pelagic tunicates, such as sea salps, that are free-swimming. They are sac-like or irregular in shape and vary from a few millimeters to several centimeters in length. They may occur singularly or colonially. Most ascidians are hermaphroditic, producing a larvae which resembles vertebrate larvae. It possesses a notochord which is lost after metamorphosis, and the larva eventually attaches to the substrate. It then transforms into the typical sea squirt. Probably close to 100 species of Ascidiacea occur in the

Caribbean, many of which occur on reefs (Colin 1978). Ascidians are found at all depths on the reef ad most species are widespread in their distribution.

5.2.1.4.5 Marine plants

Marine plants encompass a wide spectrum of the plant kingdom. Generally, there are three groups: flowing plants or spermatophytes, algae, and fungi. Spermatophytes, such as seagrass, consist of relatively few species in the Caribbean, but where they occur they are abundant and of great importance in shallow water communities. Algae are much more diverse and divided into green, red, and brown algae, plus other groups such as diatoms and dinoflagellates; only green and red algae are included in the management unit.

Photosynthetic marine plants are limited in depth they can inhabit by available light. In even the clearest tropical waters, macroalgae are essentially absent below approximately 100 m (Colin 1978).

5.2.1.4.5.1 Algae

Algae lack true roots, stems, leaves, and flowers associated with plants. The vegetative portion of the plant is often divisible into root-like rhizoids, a stem-like stipe, and leaf-like blades. *Caulerpa racemosa*, like other species of *Caulerpa*, has erect branches arising from a horizontal stolon attached to the sediment at intervals by descending rhizomes (Colin 1978). *C. racemosa*, the most ubiquitous plant of the genus, have branches rising every few centimeters, reaching as much as 30 cm in height. It occurs from shallow muddy bays to clear water reef environments.

Another important algae is *Halimeda spp.* The highly calcified segments of *Halimeda* can be a very significant contributor of material to the sediments in many areas. *H. opuntia*, the most predominant species of the genus to depths of 20 m, is found in all tropical oceans. In deeper depths, *H. copiosa* is the most abundant algae species, growing on steep coral-overgrown slopes. Its contribution to deep reef sediments is extremely high; their production of carbonate material at these depths may well exceed that produced by stony corals (Colin 1978).

Other species are found throughout algal plains and sandy fore reef areas, such as *Udotea spinulosa* and *U. cyathiformis*. Unlike *Halimeda*, the elements making up the skeleton in this genus are relatively small, and are not particularly important in the sediments of sloping fore reef areas. Species in this genus can be found in depths of 10 to 90 m.

Red algae posses chlorophyll like other algae, but they derive their color from phycoerythrin, a red pigment. This algae constitutes a large class with a wide range of diversity. Included are many species capable of producing calcium carbonate reef structures and also tiny filamentous species. Included in this group is coralline algae such as *Lithophyllum congestum*, *Porolithon pachydernum*, and *Neogoniolithon spp.*, which are important algae ridge constructors in St. Croix (Colin 1978).

5.2.1.4.5.2 Seagrasses

The primary production of seagrass beds is extremely important in tropical marine ecosystems. Seagrass beds play a significant role as habitat, nursery, and food source for ecologically and economically important fauna and flora. Direct grazing on seagrasses is limited to a number of species (e.g., sea turtles, parrotfish, surgeonfish, sea urchins, and pinfish). Other grazers (e.g., queen conch) scrape the epiphytic algae on the seagrass leaves.

Turtle grass, *Thalassia testudinum*, is the most ubiquitous plant in shallow water areas of the Caribbean, and forms large meadows. It is often mixed with manatee grass, *Syringodium filiforme*. *Thalassia testudinum* undergoes seasonal fluctuations in productivity; productivity, standing crop, blade length, and density reach a maximum during the warm summer months. Blades of *Thalassia testudinum* can grow rapidly, up to 1 in per week under ideal conditions. Average growth rates for *Thalassia* were also estimated at 2 to 4 mm/leaf/day, with maximum growth at 12.5 mm/leaf/day (Zieman 1975). Turtle grass requires water of high salinity in areas sheltered from extreme wave action.

Shoot longevity and rhizome turnover, rather than capacity to support dense meadows, are key elements in determining either pioneer species (*Halodule wrightii* and *Syringodium filiforme*) versus climax species (*Thalassia testudinum*) of seagrass (Gallegos *et al.* 1994). Because of stored starch in the rhizomes, *Thalassia* can withstand environmental stress for some time (Zieman 1975). However, it was estimated that it takes approximately 2 to 5 years for a *Thalassia testudinum* bed to recover from physical disturbance of the rhizome system, most often caused by motor boat propellers.

Halophila decipiens occurs in Salt River Canyon, St. Croix, USVI. Although the net production of *H. decipiens* is less than other Caribbean seagrasses, in Salt River Canyon, *H. decipiens* represents a major source of primary production. It has been shown that bacteria attached to *H. decipiens* detritus do not efficiently recycle primary production of this seagrass in Salt River Canyon (Kenworthy *et al.* 1989). *H. decipiens* is monoecious, with male and female flowers occurring on the same spathe. Female flowers produce approximately 30 seeds. *Halophila decipiens* is considered a stenohaline species, in that it is intolerant of variation in salinity. When *Halophila johnsonii*, an intertidal to shallow subtidal species, was compared with deeper water populations of *H. decipiens*, *H. johnsonii* showed greater tolerance to higher irradiances, and to variations in temperature and salinity (Dawes *et al.* 1989). *H. baillonis* and *H. engelmanni* both occur in silty, muddy substrates, and reach depths of 9 to 30 m (Colin 1978).

5.2.2 Other affected species

5.2.2.1 Protected species

In addition to Nassau and Goliath grouper described in Sections 5.2.1.3.33.9 and 5.2.1.3.33.6, respectively, other protected species occur in the management area. Protected species under the

ESA, MMPA, and MBTA include various species of cetaceans, sea turtles, and other animals, such as the West Indian manatee and seabirds. This section summarizes the available information on the biology and status of these species and describes the extent of their interaction with commercial and recreational fisheries in the U.S. Caribbean.

5.2.2.1.1 Marine Mammals

At least seventeen species of whales and dolphins have been reported in or near U.S. waters in the northeastern Caribbean (Mignucci-Giannoni 1998). ESA-listed species known to occur in this area include four baleen whales (humpback, fin, and sei), one toothed whale (sperm), and one sirenian (West Indian manatee). The area provides feeding grounds for some of these species, and reproductive grounds for others. Most cetacean species in this area are sighted during the winter and early spring, with the increase in sightings beginning in December, peaking in February, and gradually decreasing in March and April, with few sightings from May through November. Additionally, some species do not migrate, utilizing these waters for feeding and reproduction throughout the year (Mignucci-Giannoni 1998). Except for the humpback whale, which occurs in specific areas during winter to breed and calf, abundances and distributions of most of most marine mammals in the northeastern Caribbean are poorly known (Mignucci-Giannoni 1998).

Mignucci-Giannoni (1989) reviewed cetacean sighting data from published and unpublished records collected in the insular shelf waters of Puerto Rico, the USVI, and the British Virgin Islands (BVI) through 1989. Humpback whales were most commonly sighted, comprising nearly 80% of sightings records (79.22%, 1597 individuals), followed by bottlenose dolphins (7.49%, 151 individuals) shortfin pilot whales (3.42%, 69 individuals) sperm whales (2.13%, 43 individuals), spinner dolphins (2.03%, 41 individuals) and Atlantic spotted dolphins (1.54%, 31 individuals).

Mignucci-Giannoni *et al.* (1999) conducted an assessment of cetacean strandings in waters of Puerto Rico and the U.S. and BVI to identify, document, and analyze factors associated with 129 (159 individuals) reported mortality events through 1995. The bottlenose dolphin was the species most commonly found stranded, followed by Curvier's beaked whales, sperm whale, Atlantic spotted dolphin, and shortfinned pilot whale. Overall, causes of death were not determined in 62.8% of the case. Natural causes contributed 20.9% of the case, while human-related cases totaled 16.3%. The most common natural cause of death category was dependent calf. The most common human related cause categories observed were entanglement and accidental captures.

Under section 118 of the Marine Mammal Protection Act (MMPA), NMFS must publish, at least annually, a List of Fisheries that places all U.S. commercial fisheries into one of three categories based on the level of incidental serious injury and mortality of marine mammals that occurs in each fishery. The final rule for the 2003 List of Fisheries classifies all U.S. Caribbean commercial fisheries under the Caribbean Fishery Management Council's jurisdiction as

Category III fisheries, meaning that the annual mortality and serious injury of a stock resulting from each 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 (68 FR 41725). This classification is primarily due to lack of information, with limited stranding data providing the only information about incidental marine mammal mortality and serious injury in these fisheries. It is often difficult to attribute stranded marine mammals that show clear signs of gear interaction to a specific fishery. Gill nets and buoy lines are known to adversely affect marine mammals in other fishing areas in the U.S. EEZ and therefore, may be occurring in the U.S. Caribbean as well, but are undocumented.

A summary of the biology and status of endangered and threatened marine mammals found in the U.S. Caribbean is included below. Additional information on these species and on the other marine mammals and their occurrence in the U.S. Caribbean may be found in Mignucci-Giannoni (1998). More general information on the biology and status of marine mammals may be found in Perry *et al.* (1999) and on NMFS' website: http://www.nmfs.noaa.gov/prot_res/PR2/Stock_Assessment_Program/individual_sars.html.

5.2.2.1.1.1 Humpback whale, *Megaptera noveangliae*

Humpback whales inhabit all major ocean basins from the equator to subpolar latitudes. They generally follow a predictable migratory pattern in both hemispheres, feeding during the summer in the higher near-polar latitudes and migrating to lower latitudes where calving and breeding takes place in the winter (Perry *et al.* 1999).

5.2.2.1.1.1.1 Biology

In the western Atlantic, humpback whales feed during spring, summer, and fall over a range which encompasses the eastern coast of the United States, including the Gulf of Maine, the Gulf of St. Lawrence, Newfoundland/Labrador and western Greenland (Katona and Beard 1990 in Waring *et al*. 2002). Other North Atlantic feeding grounds are found off Iceland and northern Norway (Christensen *et al*. 1992 and Palsbøll *et al*. 1997 in Waring *et al*. 2002). It is believed that these six regions represent relatively discrete subpopulation which are matrilineally determined (Clapham and Mayo 1987 in Waring *et al*. 2002). Humpback whales are described as opportunistic feeders, foraging on a variety of food items including euphausiids and small schooling fish such as herring, sand lance and mackerel (Paquet *et al*. 1997; Payne *et al*. 1990). In the mid-latitudes during the winter, juvenile humpbacks are also known to eat bay anchovies and menhaden, *Brevoortia tyrannus* (Wiley *et al*. 1995). Feeding on wintering grounds is considered a rare event.

In winter, whales from all six feeding areas mate and calve primarily in the West Indies, where spatial and genetic mixing among subpopulations occurs (Clapham *et al.* 1993; Katona and Beard 1990; Palsbøll *et al.* 1997). In the West Indies, the majority of whales are found in the waters of the Dominican Republic, notably on Silver Bank, on Navidad Bank, and in Samana Bay (Balcomb and Nichols 1982; Mattila *et al.* 1989). Humpback whales are also found at much lower densities throughout the remainder of the Antillean arc, from Puerto Rico to the coast of Venezuela (Price 1985; Mattila and Clapham 1989). Calves are born from December through March and are about 4 m at birth. Sexually mature females give birth approximately every 2 to 3 years. Sexual maturity is reached between 4 and 6 years of age for females and between 7 and 15 years for males. Size at maturity is about 12 m (NMFS 1991).

Mignucci-Giannoni (1998) observed two major areas of humpback whale concentration: one along the northwestern coast of Puerto Rico, and the second widely spread around the northern Virgin Islands. Humpbacks are sporadically seen between St. Thomas and St. Croix, off St. Croix itself, and on the southern coast of Puerto Rico. Humpbacks were also reported near Isla de Mona, Isla Desecheo, and along the north coast of Puerto Rico, at times close to San Juan and Arecibo. Off the northwestern coast of Puerto Rico, humpbacks aggregated more often in two areas: off Punta Higuero in Rincon, and off Punta Agujereada (near Punta Borinquen) in Aguadilla. The only United States-controlled portions of the breeding range are along the northwest coast of Puerto Rico, including Punta Agujereada and nearby Punta Higuero and in the Virgin Islands (NMFS 1991). Females with calves and other whales exhibiting behaviors associated with mating occur along the northwest coast of Puerto Rico. Humpback whales have been sighted off Vieques Island, between Culebra and Vieques (e.g., Erdman *et al.* 1973 in Geo-Marine, Inc. 2001). Stevick *et al.* (1999) reported photographic matches of an individual in Puerto Rico and Dominica, demonstrating an exchange between the eastern Caribbean and more northerly breeding area in the Greater Antilles (Geo-Marine, Inc. 2001).

Humpback whales in the Caribbean are strongly associated with banks and other shallow waters with low sea floor relief (e.g., Mignucci-Giannoni 1998). Roden and Mullin (2000) noted, however, that humpback whales were also sighted in very deep water (water depth of all sightings averaged 2,877 m). There are nine stranding records for this species for Puerto Rico (Mignucci-Giannoni *et al.* 1999). The northwest and west coast of Puerto Rico have most of the strandings (Mignucci-Giannoni 1999).

It is apparent that not all western North Atlantic whales migrate to the West Indies every winter, and that significant numbers of animals are found in mid- and high-latitude regions at this time (Clapham *et al.* 1993; Swingle *et al.* 1993). Humpback whales use the Mid-Atlantic as a migratory pathway to and from the calving/mating grounds, and it may also be an important winter feeding area for juveniles. Since 1989, observations of juvenile humpbacks in the Mid-Atlantic have been increasing during the winter months, peaking January through March (Swingle *et al.* 1993; Wiley *et al.* 1995).

5.2.2.1.1.1.2 Status

Humpback whales are listed as endangered under the ESA of 1973, as amended. They are also protected under the MMPA of 1972. Because of their nature to aggregate near coasts on both summer and winter grounds, humpbacks were relatively easy prey for shore-based whalers. As a result, their populations were severely depleted by the time they achieved protection from commercial hunting in 1966.

Photographic mark-recapture analyses from the Years of the North Atlantic Humpback (YONAH) project conducted in 1992-1993, gave an ocean-basin-wide estimate of 11,570 individuals (CV=0.069), which to date is regarded as the best available estimate for the North Atlantic (Waring *et al*. 2002). However, because the YONAH sampling was not spatially representative in the feeding grounds, this estimate is considered negatively biased. It appears that the humpback whale population is increasing though it is unclear whether this increase is ocean-wide or confined to specific feeding grounds.

Although habitat degradation, such as chemical and noise pollution, may be adversely affecting the recovery of humpbacks, the major threats appear to be vessel collisions and entanglements with fishing gear (see Waring *et al*. 2002 for synopsis of mortality/injury). Wiley *et al*. (1995) examining stranding data obtained principally from the mid-Atlantic, found that in the 20 cases where evidence of human impact was discernable, 30% had major injuries possibly caused by a vessel collision and 25% had injuries consistent with entanglement in fishing gear.

There are insufficient data to reliably establish population trends for humpback whales in the North Atlantic, overall. The total level of human-caused mortality or serious injury for the Gulf of Maine (formerly the western North Atlantic stock) stock is not less than 10% of the calculated Potential Biological Removal level (PBR) of 1.3, and therefore cannot be considered to be insignificant (Waring *et al*. 2002). PBR is a calculation required under the MMPA which estimates the number of animals that can be removed annually from the population or stock, in addition to natural mortality, while allowing that stock to remain at an optimum sustainable population level (OSP). The high mortality of humpbacks off the mid-Atlantic states (52 mortalities recorded between 1990 and 2000) is of concern as some of these animals are known to be from the Gulf of Maine population. A recovery plan was published in 1991 and is in effect (NMFS 1991).

Whaling data indicate that the eastern and southern Caribbean Sea formerly supported a large-scale fishery for humpback whales (Price 1985; Geo-Marine, Inc. 2001). During February-March 2000, acoustic detections of singing humpback whales in the eastern and southern Caribbean Sea formed the basis of a preliminary estimate of the relative abundance of humpback whales in the islands and coastal areas surveyed to be 116 whales in February and 123 in March (Swartz *et al.* 2000). Results of that survey suggest that the abundance of humpbacks in the eastern and southern Caribbean Sea is lower than it was during the 19^{th} century. Observed densities were one or two orders of magnitude lower than those recorded from the primary wintering areas in the eastern Greater Antilles.

5.2.2.1.1.2 Sperm Whale, *Physeter macrocephalus*

Sperm whales are typically found throughout the world's oceans in deep waters between about 60º N and 60º S latitudes (Leatherwood and Reeves 1983). For the purposes of management, the International Whaling Commission (IWC) defines four stocks: the North Pacific, the North Atlantic, the Northern Indian Ocean, and Southern Hemisphere. However, Dufault *et al.* (1999) review of the current knowledge of sperm whales indicates no clear picture of the worldwide stock structure of sperm whales. In general, females and immature sperm whales appear to be restricted in range, whereas males are found over a wider range and appear to make occasional movements across and between ocean basins (Dufault *et al.* 1999).

In the western North Atlantic they range from Greenland to the Gulf of Mexico and the Caribbean. Sperm whales generally occur in waters greater than 180 m in depth. While they may be encountered almost anywhere on the high seas, their distribution shows a preference for continental margins, sea mounts, and areas of upwelling, where food is abundant (Leatherwood and Reeves 1983). Waring *et al.* (1999) suggest sperm whale distribution in the Atlantic is closely correlated with the Gulf Stream edge.

Sperm whales are widely distributed in the Caribbean and are common in the deep water passages between the islands and along continental slopes (Taruski and Winn 1976; Watkins and Moore 1982 in Geo-Marine, Inc. 2001). In the Puerto Rico/Virgin Islands area, sperm whales were observed 64% of the time near the shelf edge, in areas of high bottom relief (Mignucci-Giannoni 1998). Sperm whales have been sighted off Vieques Island (Erdman *et al.* 1973; Mignucci-Giannoni 1998). Despite the fact that recorded sightings and acoustical contacts would indicate that sperm whales appear to be more common during the fall (October-November) and winter/spring (as early as mid-January, but rarely in May) (Erdman *et al.* 1973; Watkins and Moore 1982; Watkins *et al.* 1985), a review of stranding records actually suggests a year-round presence of this species (Mignucci-Giannoni 1998). There are a total of 13 reported strandings of sperm whales for 1867 through 1995 for Puerto Rico and the Virgin Islands (Mignucci-Giannoni *et al.* 1999).

5.2.2.1.1.2.1 Biology

Sperm whales are the largest of the odontocetes (or toothed whales). Males reach a length of 18.3 m, with females reaching lengths of up to 12.2 m (Odell 1992 in Perry *et al.* 1999). Sperm whales have huge, blunt, squarish heads comprising 25-35% of their total body length. Females attain sexual maturity at a mean age of nine years and a length of about 9 m, while males have a prolonged puberty and attain sexual maturity at about age 20 and a body length of 12 m (Waring *et al.* 1999). Male sperm whales may not reach physical maturity until they are 45 years old (Waring *et al.* 1999).

Sperm whales have a distinct social structure. Sperm whale populations are organized into two types of groupings: breeding schools and bachelor schools. Breeding schools consist of females of all ages, calves and juvenile males. Bachelor schools consist of maturing males who leave the breeding school and aggregate in loose groups of about 40 animals. As the males grow older they separate from the bachelor schools and remain solitary most of the year (Best 1979). During the time when females are ovulating (April through August in the Northern Hemisphere) one or more large mature bulls temporarily join each breeding school. A single calf is born after a 15-month gestation. A mature female will produce a calf every 4-6 years (Waring *et al.* 1999).

Sperm whales typically prefer deep-water habitats (>300 m), however, they are periodically found in coastal waters (Scott and Sadove 1997). Their occurrence closer to shore is usually associated with the presence of food. Sperm whales prey primarily on large sized squid but also occasionally take octopus and a variety of fish including shark and skate (Leatherwood and Reeves 1983).

5.2.2.1.1.2.2 Status

The sperm whale was listed as endangered under the ESA in 1973, as amended. They are also protected under the MMPA of 1972. The primary factor for the species' decline, that precipitated ESA listing, was commercial whaling. Sperm whales were hunted in America from the 17th century through the early 1900s, but the exact number of whales harvested in the commercial fishery is not known (Townsend 1935). The IWC estimates that nearly a quarter-million sperm whales were killed worldwide in whaling activities between 1800 and 1900 (IWC 1969). With the advent of modern whaling the larger rorqual whales were targeted. However as their numbers decreased, greater attention was paid to smaller rorquals and sperm whales. From 1910 to 1982 there were nearly 700,000 sperm whales killed worldwide from whaling activities (Committee for Whaling Statistics). The IWC prohibited commercial hunting of sperm whales in 1981, although the Japanese continued to harvest sperm whales in the North Pacific until 1988 (Reeves and Whitehead 1997).

Whitehead (2002) used a population model based on one used by the IWC's Scientific Committee which considers uncertainty in population parameters and catch data and estimates population trajectories. Results suggest that pre-whaling numbers were about 1,100,000 whales (95% CI: 672,000 to 1,512,000) and that in 1999 the global sperm whale population was at about 32% (95% CI: 19% to 62%) of its original population. The best estimate that is currently available for the western North Atlantic sperm population 4,702 (CV=0.36) but is likely to be an underestimate (Waring *et al.* 2002). Currently, the population trend for this species is undeterminable due to insufficient data.

Since the ban of nearly all hunting of sperm whales, there has been little evidence that human-induced mortality or injury is significantly affecting the recovery of sperm whale stocks (Perry *et al.* 1999; Waring *et al.* 1999). Due to their more offshore distribution and benthic feeding habits, sperm whales seem less subject to entanglement in fishing gear than some cetacean species. Documented interactions have primarily involved offshore fisheries such as pelagic drift gill nets and longline fisheries. Overall, the fishery-related mortality or serious injury for the western

North Atlantic stock is considered to be less than 10% of PBR. The estimated PBR for the western North Atlantic sperm whale is 7.0 (Waring *et al.* 2002). Other impacts known to kill or injury sperm whales include ship strikes and ingestion of foreign material (e.g., fishing line, plastics).

5.2.2.1.1.3 Fin whale, *Balaenoptera physalus*

Fin whales have a worldwide distribution and are most commonly sighted where deep water approaches the coast (Jefferson *et al.* 1993). The fin whale makes regular seasonal migrations between temperate waters, where it mates and calves in late fall and winter, and the more polar feeding grounds occupied in the summer months. In the Atlantic, Clark (1995) reported a general southward pattern of fin whale migration in the fall from the Labrador-Newfoundland region, south past Bermuda, and into the West Indies. They are common in the waters of the U.S. Atlantic EEZ primarily from Cape Hatteras northward (Waring *et al.* 2002). Fin whales in Puerto Rico have only been observed north of Isla de Mona and south of Cayo Ratones in Salinas. Most sightings have been from the Virgin Islands, equally distributed in the shelf, near shelf edge and offshore waters, in areas of low sea floor relief. The majority of sightings have been from the winter or early spring and from the Virgin Islands (Geo-Marine, Inc. 2001).

5.2.2.1.1.3.1 Biology

The fin whale is the second largest whale species by length. Mature animals range from 20 to 27 m in length, with mature females being approximately1.47 m longer than mature males (Aguilar and Lockyer 1987). Fin whales achieve sexual maturity at 5-15 years of age (Perry *et al.* 1999), although physical maturity may not be reached until 20-30 years (Aguilar and Lockyer 1987). Conception is believed to occur during the winter with birth of a single calf after a 12-month gestation (Mizroch and York 1984). The calf is weaned 6-11 months after birth (Perry *et al.* 1999). The mean calving interval is 2.7 years (Agler *et al.* 1993).

The predominant prey of fin whales varies greatly in different geographical areas depending on what is locally available (IWC 1992). In the western North Atlantic, fin whales feed on a variety of small schooling fish (e.g., herring, capelin, sand lance) as well as squid and planktonic crustaceans. As with humpback whales, fin whales feed by filtering large volumes of water for their prey through their baleen plates. Foraging areas tend to occur along continental shelves in waters to 200 m (650 ft) deep (Wynne and Schwartz 1999).

5.2.2.1.1.3.2 Status

Fin whales are listed as endangered under the ESA of 1973, as amended. They are also protected under the MMPA of 1972. Modern whaling depleted most stocks of fin whales. Commercial hunting in the North Atlantic ended in 1987 though Greenland still conducts an "aboriginal subsistence" hunt allowed under the IWC.

For management purposes, NMFS recognizes only a single stock of fin whales in the U.S. waters of the western North Atlantic, though genetic data support the idea of several subpopulations (see Bérubé *et al.* 1998). A survey conducted in 1999 from Georges Bank northward to the Gulf of St. Lawrence, led to an estimate of 2,814 (CV=0.21) individuals for the western North Atlantic population. This however, is considered a conservative estimate due to the extensive range of the fin whale throughout the entire North Atlantic and the uncertainties regarding population structure and exchange between surveyed and non-surveyed areas. To date, there is insufficient information in order to determine population trends.

Aside from the threat of illegal whaling or increased legal whaling, potential threats affecting fin whales include collisions with vessels, entanglement in fishing gear and habitat degradation from chemical and noise pollution. Fin whales are known to have been killed or seriously injured by inshore fishing gear (i.e., gill nets and lobster lines) off eastern Canada and the United States (NMFS 1998a). A draft recovery plan for fin whales is available but the plan has not yet been finalized.

5.2.2.1.1.4 Sei whale, *Balaenoptera borealis*

Sei whale are a widespread species in the world's temperate, subpolar, subtropical, and even tropical marine waters. However, they appear to be more restricted to temperate waters than other baleen whales. The Western North Atlantic is comprised of three stocks, including the Nova Scotia, Iceland-Denmark Strait, and Northeast Atlantic (Perry *et al.* 1999).

In the western North Atlantic, it is thought that a large segment of the population is centered in northerly waters, perhaps the Scotian Shelf during the summer feeding season (Mitchell and Chapman 1977 in Waring *et al.* 2002). Their southern range during the spring and summer includes the northern areas of the U.S. Atlantic EEZ (i.e., Gulf of Maine and Georges Bank). Strandings along the northern Gulf of Mexico and in the Greater Antilles, indicate those areas to be the southernmost range for this population (Mead 1977 in Waring *et al.* 1999).

5.2.2.1.1.4.1 Biology

The sei whales is the third largest balean whale, ranging from 12-18 m in length at maturity. They are believed to undertake seasonal north/south movements, with summers spent in higher latitudes feeding and winters in lower latitudes, though the location of winter areas remains largely unknown (Perry *et al.* 1999). Sei whales reach sexual maturity between 5-15 years of age. Similar to the fin whale, conception occurs during a five–month period in the winter of either hemisphere. The calving interval is believed to be 2-3 years (Lockyer and Martin 1983).

The sei whale is generally found in deeper waters though they are known for periodic excursions into more shallow and inshore waters when food is abundant (Payne *et al.* 1990). They consume primarily copepods, but they also feed on euphausiids and small schooling fishes (Mizroch *et al.* 1984 in Perry *et al.* 1999).

5.2.2.1.1.4.2 Status

Sei whales are listed as endangered under the ESA of 1973, as amended. They are also protected under the MMPA of 1972. Sei whales began to be regularly hunted by modern whalers after the populations of larger, more easily taken species (i.e., humpbacks, right whales and gray whales) had declined. Most stocks of sei whales were also reduced, in some cases drastically, by whaling efforts throughout the 1950s into the early 1970s. International protection for the sei whale began in the 1970s, though populations in the North Atlantic continued to be harvested by Iceland until 1986 when the IWC's moratorium on commercial hunting in the Northern Hemisphere came into effect.

Since the cessation of commercial whaling, threats to sei whales in the western North Atlantic appear to be few although do include ship collisions and entanglement in fishing gear. Because of their offshore distribution and overall scarcity in U.S. Atlantic waters, reports of entrapments and entanglements tend to be low. It is unknown whether sei whales are less prone to interact with fishing gear or if they break through or carry the gear away with them causing mortalities that go largely unrecorded. There were no reported fishery-related mortalities or serious injuries observed by NMFS during 1994-1998 (Waring *et al.* 2002). The total level of human- caused impacts on sei whales is unknown but due to the rarity of mortality reports it is thought to be insignificant (Waring *et al.* 2002).

5.2.2.1.1.5 West Indian manatee, *Trichechus manatus*

The West Indian manatee occurs in the Atlantic Ocean (UNEP-WCMC 2003). In the western Atlantic, this species ranges as far north as Georgia (USA), southward to coastal areas of South America, including the Gulf of Mexico and Caribbean Sea. In the U.S. Caribbean, this species is known to occur around the southern and eastern end of Puerto Rico and around nearby Vieques Island. Except for rare sightings, manatees seem to be absent from the Virgin Islands at present, but fossils have been found in middens on St. Croix (USFWS 2003a).

5.2.2.1.1.5.1 Biology

The West Indian manatee inhabits both marine and fresh water environments, generally from 1.5 to less than 6 m depth. It is usually found in canals, rivers, estuarine habitats, and saltwater bays, but has been observed, on occasion, as many as 3.7 mi offshore. Habitat usage appears to be tied to food supply, water depth, and proximity to fresh water. Florida manatees exhibit movement patterns associated with changing weather patterns, migrating south when water temperatures drop below about 21 to 22° C, or forming large aggregations in natural springs and industrial outfalls. Severe cold fronts have been known to kill manatees when the animals did not have access to warm-water refuges. There is no evidence of any periodicity in manatee habitat use in Puerto Rico (USFWS 2003a).

Adults average about 3 m in length and weigh about 1,000 lbs. Observations of mating herds indicate that females mate with a number of males during their 2- to 4-week estrus period. Gestation period is 12-14 months. Births occur year-round, but decrease slightly during winter months. Manatee cows usually bear a single calf, but 1.5% of births are twins. Calves reach sexual maturity at 3 to 6 years of age. Mature females may give birth every 2 to 5 years. Weaning generally occurs between 9 and 24 months of age, although a cow and calf may continue to associate with each other for several more years. There is little information on the life-time reproductive output of females, although they may live over 50 years. Manatees are primarily herbivores, feeding on a wide variety of aquatic vegetation, but also occasionally feed on fish. They may consume 4-9% of their body weight each day (USFWS 2003a).

5.2.2.1.1.5.2 Status

The West Indian manatee was listed under the ESA as endangered throughout its range on March 11, 1967. On January 7, 1975, this species (including all populations) was listed in CITES Appendix I (UNEP-WCMC 2003). Appendix I includes species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances. This species also was classified as vulnerable on the 1996 IUCN Red List of Threatened Species. A vulnerable listing indicates that the manatee faces "a high risk of extinction in the wild in the medium-term future." This determination is based on a reduction of at least 20%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer, based on (and specifying) actual or potential levels of exploitation (IUCN 2003).

Initial population decreases probably resulted from commercial take. Today, hunting is prohibited and is not considered a problem, although there is an occasional incidence of poaching. But heavy mortality does occur from accidental collisions with boats and barges, and from canal lock operations. The combination of high mortality rates and low reproductive rates have led to serious doubts about the species' ability to survive in the United States. Habitat degradation and loss caused by coastal development is also identified as a threat; particularly the destruction of seagrass beds by boating facilities. In Puerto Rico, where the manatee population numbers about 60-100, the primary cause of mortality seems to be entanglement in gill nets (USFWS 2003a). According to 68 FR 1414, the incidental take of at least one manatee in Caribbean gill net fisheries has been documented. The incidental take of this marine mammal by Caribbean haul/beach seines has been documented as well (68 FR 1414). Collisions with boats and illegal killing of manatees for food may also be affecting the Puerto Rican population to some extent, but supporting data are limited (USFWS 2003a).

5.2.2.1.2 Sea Turtles

The U.S. Caribbean provides nesting, foraging, and developmental habitat for three species of marine turtles: the leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), and green (*Chelonia mydas*). Loggerhead sea turtles (*Caretta caretta*) are only occasionally seen, but are transitory (Hillis-Star *et al.* 1998) and rare olive ridleys (*Lepidochelys olivacea*) have been reported in the area only twice (Caldwell and Erdman 1969; Diez pers. comm. in Flemming 2001). The Kemp's ridley has never been reported in the Caribbean region.

Hillis-Starr *et al.* (1998) reports that the greatest threats to sea turtles in Puerto Rico and the USVI are coastal and upland development, introduction of domestic and exotic species, boating, incidental take in fisheries, illegal harvest of adults and eggs, ingestion and entanglement in marine debris, inadequate local protection and enforcement of laws, and insufficient regional cooperation for turtle protection. The BVI, which lie just one km from St. John and St. Thomas, maintain an open season of four months for harvesting green and hawksbill turtles; illegal fishing of turtles, and trade of turtles and turtle products between the USVI and BVI continue to be problematic.

Hillis-Starr *et al.* (1998) states that local fishing practice, such as trap fishing and gillnetting may adversely impact sea turtles in nearshore waters throughout the Virgin Islands. Offshore, longline fishermen targeting 100 fathoms set trap lines, which are 30 to 65 km in length and which hold more than 400 hooks on each line. Longlines are set to catch swordfish and tuna but incidentally catch sea turtles. Abandoned fishing gear entangles and drowns sea turtles, especially young females, which remain near shore between nestings. Young sea turtles also may become entangled in or ingest marine debris. In recent years, the number of sea turtles killed by boat collisions has increased, especially along ferry routes where turtles forage.

USVI records have documented at least 122 turtle strandings from 1982 through 1997, with boat strikes accounting for the greatest number of strandings (34.43%), followed by undetermined causes (29.51%), poaching (13.11%), other (12.3%), and fishing gear entanglement (10.66%) (Boulon 2000). Longlining is reported to be on the increase around St. Croix and several leatherback females have arrived at Sandy Point entangled in or scarred from the gear (Evans pers. comm. 2000)

In general, gill nets and traps and pots are known to adversely affect marine mammals and sea turtles by entangling and/or drowning them. Gill nets of just about any mesh size can catch, and have caught, sea turtles. The risk however, does increase with mesh size. NMFS has many strandings records, and some live incidental captures, of turtles that are entangled in trap and pot buoy lines.

Information on the biology and status of sea turtles that may occur in the U.S. Caribbean are included below. For additional information, see the references within.

5.2.2.1.2.1 Leatherback turtle, *Dermochelys coriacea*

The leatherback turtle occurs in the Atlantic, Indian, and Pacific Oceans, and in the Mediterranean and Black Seas (UNEP-WCMC 2003). Genetic analyses of leatherbacks to date indicate that within the Atlantic basin there are genetically different nesting populations: the St. Croix nesting population (USVI), the mainland nesting Caribbean population (Florida, Costa

Rica, Suriname/French Guiana), and the Trinidad nesting population (Dutton *et al.* 1999a; 1999b). In the western Atlantic, this species ranges from Nova Scotia (Canada) to the U.S. Caribbean, but tends to be found along the eastern seaboard, from the Gulf of Maine to middle Florida, during the summer months. Leatherback sea turtles are found in the Virgin Islands only during their nesting season. Sandy Point National Wildlife Refuge, St. Croix is the principal nesting beach for leatherbacks in the northern Caribbean. The waters adjacent to Sandy Point, St. Croix (up to and including waters from the hundred fathom curve shoreward to the level of mean high tide with boundaries at 17° 42' 12" N and 64° 50' 00" W), have been identified as critical habitat for the leatherback turtle.

5.2.2.1.2.1.1 Biology

The leatherback is the largest living turtle. Adults average 15.5 m curved CL and range in weight from 200-700 kg. Hatchlings average 6.13 cm long and 45.8 g in weight. When the hatchlings leave the nesting beaches, they move offshore but eventually utilize both coastal and pelagic waters. Very little is known about the pelagic habits of the hatchlings and juveniles, and they have not been documented to be associated with the sargassum as are other species. Based on a review of all sightings of leatherback sea turtles of <145 cm curved carapace length (CCL), Erkert (2001) found that leatherback juveniles remain in waters warmer than 26° C until they exceed 100 cm.

Leatherbacks live for over 30 years. They reach sexually maturity somewhat faster than other sea turtles, with an estimated age at sexual maturity of about 13-14 years for females, and an estimated minimum age at sexual maturity of 5-6 years, with 9 years reported as a likely minimum (Zug and Parham 1996) and 19 years as a likely maximum (NMFS SEFSC 2001), with an estimated range from 3-6 years (Rhodin 1985) to 13-14 years (Zug and Parham 1996). In the Caribbean, female leatherbacks nest from March through July. They nest frequently (up to 7 nests) during a nesting season and nest about every 2-3 years. They produce 100 eggs or more in each clutch and, thus, can produce 700 eggs or more per nesting season (Schultz 1975). However, a significant portion (up to approximately 30%) of the eggs can be infertile. Thus, the actual proportion of eggs that can result in hatchlings is less than this seasonal estimate. The eggs will incubate for 55-75 days before hatching.

Leatherbacks are the most pelagic of the turtles, but enter coastal waters on a seasonal basis to feed in areas where jellyfish are concentrated. Leatherback sea turtles feed primarily on cnidarians (e.g., medusae, siphonophores) and tunicates. Leatherbacks are deep divers, with recorded dives to depths in excess of 1,000 m (Eckert *et al.* 1989).

5.2.2.1.2.1.2 Status

The leatherback turtle was listed under the ESA as endangered throughout its range on June 2, 1970. On April 2, 1977, this species was listed in CITES Appendix I (UNEP- WCMC 2003). Appendix I includes species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances. The leatherback also was classified as "critically endangered" on the 2000 IUCN Red List of Threatened Species.

The Pacific population is in a critical state of decline, estimated by Spotila *et al.* (2000) to number less than 3,000 total adults and subadults. The status of the Atlantic population is less clear. In 1996, it was reported to be stable, at best (Spotila *et al.* 1996), with numbers of nesting females in the western Atlantic reported to be on the order of 18,800. According to NMFS (2001j), the nesting aggregation in French Guiana has been declining at about 15% per year since 1987. However from 1979-1986, the number of nests was increasing at about 15% annually. Meaning that this current 15% decline could be part of a nesting cycle which coincides with the erosion cycle of Guyana beaches described by Schultz (1975). The number of nests in Florida and the U.S. Caribbean has been increasing at about 10.3% and 7.5%, respectively, per year since the early 1980s but the magnitude of nesting is much smaller than that along the French Guiana coast (NMFS 2001j). In summary, the conflicting information regarding the status of Atlantic leatherbacks makes it difficult to conclude whether or not the population is currently in decline. Numbers at some nesting sites are up, while at others they are down.

.In the USVI, where one of five leatherback strandings from 1982 to 1997 were due to entanglement (Boulon 2000), leatherbacks have been observed with their flippers wrapped in the line of West Indian fish traps (R. Boulon pers. comm.). Since many entanglements of this typically pelagic species likely go unnoticed, entanglements in fishing gear may be much higher.

5.2.2.1.2.2 Hawksbill turtle, *Eretmochelys imbricata*

The hawksbill turtle occurs in tropical and subtropical seas of the Atlantic, Pacific, and Indian Oceans (UNEP-WCMC 2003). In the western Atlantic, hawksbills range from Florida to Brazil, including the Gulf of Mexico and Caribbean Sea. This species has been recorded along all states bordering the Gulf of Mexico, and as far north as Massachusetts, but sightings north of Florida are rare. Within the United States, this turtle most commonly occurs in the U.S. Caribbean. NMFS has designated critical habitat for the hawksbill sea turtle as the waters extending seaward 3.4548 mi (3 nm or 5.6 km) from the mean high waterline of Culebra Island, Puerto Rico. The area around Culebra (specifically from Cayo Luis Peña to Culebra Island) is an important foraging ground for the hawksbill.

5.2.2.1.2.2.1 Biology

Reproductive females undertake periodic (usually non-annual) migrations to their natal beach to nest. Movements of reproductive males are less well known, but are presumed to involve migrations to the nesting beach or to courtship stations along the migratory corridor (Meylan 1999b). Females nest an average of 3-5 times per season (Meylan and Donnelly 1999). Clutch size is higher on average (up to 250 eggs) than that of other turtles (Hirth 1980). Reproductive females may exhibit a high degree of fidelity to their nest sites.

The life history of hawksbills consists of a pelagic stage that lasts from the time they leave the nesting beach as hatchlings until they are approximately 22-25 cm in straight carapace length (Meylan and Donnelly 1999), followed by residency in developmental habitats (foraging areas where immatures reside and grow) in coastal waters. Adult foraging habitat, which may or may not overlap with developmental habitat, is typically coral reefs, although other hard-bottom communities and occasionally mangrove-fringed bays may be occupied. Hawksbills show fidelity to their foraging areas over periods of time as great as several years (van Dam and Diez 1998).

Their diet is highly specialized and consists primarily of sponges (Meylan 1988) although other food items, including anemone-like corallimorphs and zooanthids, have been documented as important elements of their diet in some areas of the Caribbean (van Dam and Diez 1997; Leon and Diez 2000).

5.2.2.1.2.2.2 Status

The hawksbill turtle was listed under the ESA as endangered in 1970. On April 2, 1977, this species was listed in CITES Appendix I (UNEP-WCMC 2003). Appendix I includes species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances. The hawksbill also was classified as "critically endangered" on the 1996 IUCN Red List of Threatened Species.

There has been a global population decline of over 80% during the last three generations (105 years) (Meylan and Donnelly 1999). In the Western Atlantic, the largest hawksbill nesting population occurs in the Yucatán Península of Mexico, where several thousand nests are recorded annually in the states of Campeche, Yucatán, and Quintana Roo (Garduño-Andrade *et al.* 1999). Important but significantly smaller nesting aggregations are documented elsewhere in the region in Puerto Rico, the USVI, Antigua, Barbados, Costa Rica, Cuba, and Jamaica (Meylan 1999b). Estimates of the annual number of nests for each of these areas are of the order of hundreds to a few thousand. Nesting within the southeastern U.S. and U.S. Caribbean is restricted to Puerto Rico (>650 nests/yr), the USVI (~400 nests/yr), and, rarely, Florida (0-4 nests/yr)(Eckert 1995; Meylan 1999b; Florida Statewide Nesting Beach Survey database 2003). At the two principal nesting beaches in the U.S. Caribbean where long-term monitoring has been carried out, populations appear to be increasing at Mona Island, Puerto Rico, or stable at Buck Island Reef National Monument, St. Croix, USVI (Meylan 1999b).

5.2.2.1.2.3 Green turtle, *Chelonia mydas*

Green turtles are distributed circumglobally. In the western Atlantic they range from Massachusetts to Argentina, including the Gulf of Mexico and Caribbean, but are considered rare north of Cape Hatteras (Wynne and Schwartz 1999). The complete nesting range of the green turtle within the NMFS' Southeast Region includes sandy beaches of mainland shores, barrier islands, coral islands, and volcanic islands between Texas and North Carolina and the USVI and

Puerto Rico (NMFS and USFWS 1991a). Principal United States nesting areas for green turtles are in eastern Florida, predominantly Brevard through Broward counties (Erhart and Witherington 1992). Green turtle nesting also occurs regularly on St. Croix, USVI, and on Vieques, Culebra, Mona, and the main island of Puerto Rico (Mackay and Rebholz 1996). NMFS has designated critical habitat for the green sea turtle as the waters extending seaward 3.4548 mi (3 nm or 5.6 km) from the mean high waterline of Culebra Island, Puerto Rico.

5.2.2.1.2.3.1 Biology

The green sea turtle is the largest hard-shelled sea turtle, with adults commonly reaching 100 cm (39.4 in) in carapace length and 150 kg (330.7 lbs) in weight (Hirth 1997). Hatchlings are about 50 mm in length and weigh about 25 g. Age at sexual maturity is estimated at 20-50 years (NMFS and USFWS 1991a).

Age at sexual maturity is estimated to be between 20-50 years (Balazs 1982; Frazer and Erhart 1985). Green sea turtle mating occurs in the waters off the nesting beaches. Each female deposits 1-7 clutches (usually 2-3) during the breeding season at 12-14 day intervals. Mean clutch size is highly variable among populations, but averages 110-115 eggs/nest. Females usually have 2-4 or more years between breeding seasons, while males may mate every year (Balazs 1983). After hatching, green sea turtles go through a post-hatchling pelagic stage where they are associated with drift lines of algae and other debris.

Green sea turtles are primarily herbivorous, feeding on algae and sea grasses, but also occasionally consume jellyfish and sponges. The post-hatchling, pelagic-stage individuals are assumed to be omnivorous, but little data are available. Green turtle foraging areas in the southeastern United States include any coastal shallow waters having macroalgae or sea grasses near mainland coastlines, islands, reefs, or shelves, and any open-ocean surface waters, especially where advection from wind and currents concentrates pelagic organisms (Hirth 1997; NMFS and USFWS 1991a).

5.2.2.1.2.3.2 Status

The green sea turtle was listed under the ESA on July 28, 1978. The breeding populations off Florida and the Pacific coast of Mexico were listed as endangered. All other populations were listed as threatened. Green turtles were traditionally highly prized for their flesh, fat, and eggs, and shell, and directed fisheries in the United States and throughout the Caribbean are largely to blame for the decline of the species. On June 6, 1981, this species (including all populations) was listed in CITES Appendix I (UNEP-WCMC 2003). Appendix I includes species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances. This species also was classified as "endangered" on the 1996 IUCN Red List of Threatened Species.

Recent population estimates for the western Atlantic are not available. However, the pattern of green turtle nesting shows biennial peaks in abundance, with a generally positive trend during the ten years of regular monitoring since establishment of nesting beach index beaches in 1989, (Meylan *et al.* 1995; Florida Marine Research Institute Statewide Nesting Database 2002). Total nest counts and trends at index beach sites during the past decade suggest that green sea turtles that nest within the southeastern United States are recovering.

Observations of green turtle nesting populations have been collected opportunistically by both leatherback and hawksbill turtle research programs in the USVI and Puerto Rico since the 1980s. The number of green turtle nests remains low, however, there appears to have been a gradual increase in the number of juveniles observed in the foraging grounds since the 1970s (Hillis-Starr *et al.* 1999).

5.2.2.1.3 Seabirds

The northeast Caribbean provides nesting habitat for at least 13 seabird species, including shearwaters (*Puffinus* spp.), gulls (*Larus* spp.), brown pelicans (*Pelecanus occidentalis*), and various tern species (*Sterna* spp.) (Halewyn and Norton 1984). Two species of seabirds are considered endangered: the brown pelican and roseate tern.

While considerable information is available on bird populations and behavior in this area, little information is available on fishery interactions. The primary threat to Caribbean seabirds in the heavily populated Caribbean has been human encroachment. Not only direct human predation, but species associated with human such as rats and feral cats and pigs have proven destructive. A 1984 assessment of fishery interactions in the Caribbean viewed them to be a major threat on Puerto Rico or other Caribbean Islands, except possibly off Venezuela. The nature of Caribbean fisheries have changed substantially since then, however, warranting reassessment in the future. Based on feeding behavior of many tropical species, terns are unlikely to interact with fisheries, however, shearwater and gull interactions are possible.

5.2.2.1.3.1 Brown Pelican, *Pelecanus occidentalis*

Brown pelicans typically inhabit coastal waters and nest on islands. Brown pelicans breed on Pacific coast islands; off of Costa Rica and Panama; in the Galapagos; along the Atlantic, Gulf, and Caribbean coasts; in the northwestern Bahamas, Greater and Lesser Antilles, southern Veracruz, Yucatan Peninsula, and Belize; and along parts of the South American coast. The brown pelican's range includes the Pacific coast of the Americas and parts inland while it occurs casually in the interior of the southwestern U.S. and throughout the Atlantic, Gulf, and Caribbean coastal and insular areas (American Ornithologists' Union 1983).

5.2.2.1.3.1.1 Biology

The brown pelican is usually found in shallow estuarine water and seldom ventures further than 20 mi (32 km) out to sea. This bird uses sand pits and offshore sandbars for daily loafing and nocturnal roost areas. Nesting commonly occurs on small coastal islands that provide protection from predation and that are of sufficient elevation to prevent nests from flooding. Pelicans generally feed on blue fry (*Jenkinsia lamprotaenia*), sharkmouth fry (*Anchoa lyolepis*), sprat (*Harengula* spp.), and whalebone anchovy (*Centengaulis edentulis*). The adult pelican is dark gray-brown in color with white about the head and neck. Immature birds are gray-brown on the upper body and neck and have white underparts. Caribbean pelicans often have dark plumage. The brown pelican reaches a weight of up to 8 lbs (3.6 kg) and has a wingspan of over 2.1 m (Collazo no date; USFWS 1986).

5.2.2.1.3.1.2 Status

The brown pelican was listed as an endangered species in 1970, except the U.S. Atlantic coast, Florida, and Alabama.

5.2.2.1.3.2 Roseate Tern, *Sterna dougallii*

5.2.2.1.3.2.1 Biology

The Virgin Islands and islets off southwestern Puerto Rico support the largest population of roseate terns in the tropical Atlantic (Raffaele *et al.* 1998 in Geo-Marine, Inc. 2001). The roseate tern inhabits coastal waters, bays, and estuaries. It breeds along the Atlantic coast of North America; in the Florida Keys, Bahamas, Cuba, Jamaica, Hispaniola, Puerto Rico, Virgin Islands, Lesser Antilles; and on islands off Venezuela, Belize, and other parts of the Caribbean and the world. The roseate tern winters in the Americas along the eastern Caribbean and also in other parts of the Atlantic coast and the world. It migrates at sea off the Atlantic coast of North America to the Florida area. The roseate tern nests on sandy beaches, open bare ground, and grassy areas and under tumbled boulders primarily on islands. It is mostly pelagic and occurs rarely along seacoasts, bays, and estuaries during the non-breeding season (American Ornithologists' Union 1983 in Geo-Marine, Inc. 2001). Distinguishing characteristics of the roseate tern include its very long, deeply forked tail, pale gray mantle and primaries, tail extending well beyond wing tips when at rest, and the underside primary feather tips with little or no blackish coloration. The breeding adult has a black bill with some red and a black cap; the non-breeding adult has a blackish bill and indistinct dark marking on the shoulder and forehead. The juvenile has a dark forehead and crown, a blackish bill, a mottled back, and a shoulder with indistinct marks (Raffaele *et al.* 1998 in Geo-Marine, Inc. 2001).

5.2.2.1.3.2.2 Status

The roseate tern was listed as an endangered species in 1987 (USFWS 1993).

5.2.2.2 Highly Migratory Species

This section summarizes the available information on the biology, life history, and status of Atlantic HMS, which are managed by NMFS under Secretarial authority. The MSFCMA defines HMS to be tuna species, marlin (*Tetrapturus* spp. and *Makaira* spp.), oceanic sharks, sailfishes (*Istiophorus* spp.), and swordfish (*Xiphias gladius*). Tuna species are further defined as albacore tuna (*Thunnus alalunga*), bigeye tuna (*Thunnus obesus*), bluefin tuna (*Thunnus thynnus*), skipjack tuna (*Katsuwonus pelamis*), and yellowfin tuna (*Thunnus albacares*). Thus, the Secretary currently has the authority to manage directly those species listed above without a Regional Fishery Management Council's FMP.

National Standard 3 of the MSFCMA requires that "to the extent practicable, and individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination." The HMS FMP (NMFS 1999b) developed U.S. policy and management for several interrelated stocks of fish and associated fisheries, throughout their ranges in the Atlantic Ocean and adjacent seas.

Following this guidance and the best available scientific information on the range of the stocks, the HMS management unit consists of the populations of north Atlantic swordfish (north of 5° N); west Atlantic bluefin tuna (west of 45° W above 10° N and at 25° W below the equator, with an eastward shift in the boundary between those parallels); Atlantic yellowfin tuna; Atlantic bigeye tuna; north Atlantic albacore tuna (north of 5° N); west Atlantic skipjack tuna; and the sharks that inhabit the northwest Atlantic Ocean. The management unit and fishing activity for these species, extend across federal, and in some cases, state and international jurisdictional boundaries.

Billfish (marlins, sailfish, and spearfish) are separated from swordfish for purposes of management because of the recreational nature of the billfish fishery. Thus, billfish, other than swordfish, are managed under a separate FMP. More information on the HMS management unit can be found in the HMS FMP (NMFS 1999b) and Amendment 1 to the Atlantic Billfish FMP (NMFS 1999c).

5.2.2.2.1 Biology

For biology and life history of Atlantic HMS, please refer to the HMS FMP (NMFS 1999b), Amendment 1 to the Atlantic Billfish FMP (NMFS 1999c), Amendment 1 to the HMS FMP (NMFS 2003b), and the 2004 Stock Assessment and Evaluation for Atlantic Highly Migratory Species (NMFS 2004).

5.2.2.2.2 Status

The status of stocks managed by the HMS Management Division are identified on a fishery-wide basis rather than a regional basis, such as the Caribbean Sea. With the exception of Atlantic sharks, stock assessments for Atlantic HMS are conducted by the International Commission for the Conservation of Atlantic Tunas (ICCAT) Standing Committee for Research and Statistics (SCRS). In 2003, the SCRS conducted a stock assessment for yellowfin tuna (SCRS 2003). ICCAT conducted a stock assessment on pelagic sharks, particularly blue, porbeagle, and shortfin mako sharks in 2004, but the results are not yet final.

5.3 Social and economic environment

The fisheries in the U.S. Caribbean are multi-species, multi-gear, artisanal in nature, and principally coral reef-based. Division of fishing activity into specific fisheries by species or gear is artificial, but general characterizations are presented in this section. The U.S. Caribbean fisheries cannot be set apart from the fisheries in the wider Caribbean region. The species targeted in the U.S. waters are also available in other countries and regions, and recruitment of these species may derive from areas distant from the area of the fishery.

5.3.1 Commercial fishing activity

5.3.1.1 Fleets

Before 1959, the Puerto Rican fleet was composed mainly of open wooden sailboats (average 27 ft in length) and open wooden rowboats. In 1931, a total of 1,403 active commercial fishermen were reported in Puerto Rico (Matos-Caraballo 1997). In 1959, the Puerto Rico Department of Agriculture, the Economic Development Bank, and the Agricultural Credit Corporation began extending loans to the commercial fishermen to “motorize” the fleet; by 1979, 75% of the commercial fishing fleet had outboard engines. In 1975, there were 865 commercial fishing vessels in Puerto Rico (Suárez-Caabro 1979).

At present, the artisanal commercial fishing fleets of Puerto Rico and the USVI are fairly uniform, in that, the fleets consist of small-sized, open wood or fiberglass fishing boats, which on average are 20 ft in length. There were 4,112 officially registered commercial fishing vessels in Puerto Rico in 1996, but the number of vessels actually fishing commercially in Puerto Rico was probably closer to 1,500, and most of these boats (61%) were between 16-21 ft long (Matos-Caraballo 1997). Only 1% of the fleet was greater than 30 ft long. Average horsepower for Puerto Rican commercial vessels was 43 h.p., and 1,218 motors were reported in 1996 (Matos-Caraballo 1997).

There are 342 registered commercial vessels in the USVI. In St. Thomas, most boats are “small vessels,” 16-19 ft long and of wooden construction, with a much smaller number of “large vessels” (8-9 vessels) greater than 30 ft long. In St. Croix, the larger vessels are used for the trap-based fisheries (as opposed to the gillnet-, vertical gear-, and dive-based fisheries) due to space requirements for traps and machinery (Tobias 2001). Registration fees increase with vessel size for commercial and recreational vessels.

5.3.1.2 Fishermen

Commercial fishermen are required by local laws to have a fishing license in both the USVI and Puerto Rico. In 1975, there were 1,230 commercial fishermen in Puerto Rico, but this had increased to an estimated 1,758 active commercial fishermen in 1996 (1,262 full-time and 496 part-time) with ages ranging from 38-63 and an average age of 46 years old (Matos-Caraballo 1997). In 1996, Matos-Caraballo (1997) concluded that while the number of Puerto Rican commercial fishermen was relatively stable, the amount of fishing effort was increasing. Matos-Caraballo (2002) predicted that the latest information from the pending Puerto Rico Fishery Census would show a loss of approximately 500 fishermen since 1996. However, more recent data showed 1,973 fishermen in 2000 and 2,023 in 2001 (NMFS 2002).

In addition to issues related to overfishing, storms and hurricanes (e.g., Hurricane Georges) have had a negative impact on Puerto Rican fishermen in the recent past (Matos-Caraballo 2001). In 1996, the west coast of Puerto Rico supported the highest number of fishermen (461), with Cabo Rojo having the largest number of fishermen among municipalities (213). In 1996, the percentage of Puerto Rican fishermen belonging to fishing associations had increased to 62%, indicating a greater willingness to unify in order to procure more fishing and social benefits (Matos-Caraballo 1997).

The Matos-Caraballo (1997) census of Puerto Rican fishermen reported 3,613 nets, of which 7% were beach seines, 38% were gill nets, 24% were trammel nets, and 31% were cast nets. In the line category 9,805 units were recorded, of which 9% were longlines, 69% were hand lines, 10% were trolling lines, and 12% were rod and reel. The census recorded 15,481 traps, of which 72% were fish traps and 28% were lobster traps, while 396 winches were used to haul traps. SCUBA divers (n=598) and skin divers (n=281) used 2,170 units of various fishing gear, of which 23% were spears, 61% were gaffs, 11% were snares, and 5% were conch-lifting baskets.

Puerto Rican commercial fishermen typically exploit more than one fishing zone and fishery (Matos-Caraballo 1997), with effort occurring on the shoreline (31%), on the shelf (70%), on the shelf edge (43%), and in oceanic waters beyond the shelf edge (46%). These fishermen pursue multiple species including reef fish, lobster, and conch (74%); pelagic species (68%); deep-water snappers (53%); and baitfish (23%). Fishing trips are generally a half-day long (Matos-Caraballo 2002).

In Puerto Rico, traps are still one of the primary fishing methods, although the most recent data shows traps landings now place second behind line-based fisheries (Matos-Caraballo 2002). Puerto Rico's trap fishermen have recently shown a trap reduction trend, altering the previous historical increase in numbers of traps per fisherman (Scharer *et al.* 2002). Presently, the number of traps/fisher in Puerto Rico ranges from 10 to 300, with an average of 67 traps/fisher. Decreases in trap effort may be due to competition with other gears such as lines, trammel nets, gill nets, and diver-based fishing (Griffith and Valdés-Pizzini 2002). In Puerto Rico, 77% of trap fishermen target both reef fish and spiny lobster, 13% of trap fishermen target only reef fish, and 10% target only lobster (Scharer *et al.* 2002). According to Puerto Rican trap fishermen, habitats targeted for setting traps include areas surrounding coral reefs such as sand, algal plains, seagrasses, and especially low- to medium-relief hard bottom (known as "rastreal" and preferred by 38% of fishermen); but the coral reefs themselves are not targeted (Scharer *et al.* 2002). Most trap hauling is done via winches or other mechanical means (68%), with the remainder being done by hand. Puerto Rican fishermen stated that they pull traps straight up off the bottom to avoid dragging traps on the bottom and losing or damaging them (Scharer *et al.* 2002). Traps are set on the insular shelf in depths ranging from 9-181 m, with a mean depth of 40-62 m, but varying from one region of the island to another. The distribution of traps in a particular area also varies seasonally, based primarily on changing sea conditions and associated safety considerations (Valdés-Pizzini *et al.* 1997). Although trap fishery areas in Puerto Rico have typically been concentrated in the shallow nearshore zone, some fishermen are now exploiting offshore areas because of depleted resources and habitat degradation in the nearshore (Scharer *et al.* 2002). Among trap types, wooden pots (i.e., *cajones*) are used for spiny lobster, while wire-mesh traps (i.e., *nasas*) are used for fish and lobsters (Scharer *et al.* 2002). Only 1 of 47 Puerto Rican trap fishermen interviewed used GPS technology to navigate and locate traps; while local knowledge and landmarks were the principal techniques used by all other fishermen.

Among Puerto Rican trap fishermen, 53% set traps singly and 47% set a series of 2-6 traps connected by a trotline. Among trotline trap fishermen, 68% used buoys to mark the trap string and 32% did not use buoys at all, a technique known as *ahogado* or drowned traps (Scharer *et al.* 2002). The drowned trap technique is used to deter theft, but makes traps harder to recover, especially in areas where human activities have reduced water clarity. Predominant methods of trap recovery include grappling (34%) or diving (32%).

In the USVI, there is presently a moratorium on issuing new commercial fishing licenses. In the USVI during 1998-1999 there were 349 commercial fishermen (Valle-Esquivel and Díaz 2003). St. Thomas has both full- and part-time fishermen who use traps, handlines, and float fishing methods (Downs *et al.* 1997). In St. John, there are very few full-time fishermen (approximately 2-10), with most fishermen being of the part-time variety, who work other jobs and fish to supplement their income (Downs *et al.* 1997). St. John fishermen are concentrated in the Cruz Bay and Coral Bay areas of the island and are primarily West Indian, with some "continentals" from the mainland U.S. participating in the fishery as well (Downs *et al.* 1997). Each of these ethnic groups tends to target different fish species and use different techniques, with West Indians using traps and handlines/floatlines to capture reef species, while "continentals" tend to troll for pelagic species.

Based on St. Croix data (Tobias 2001), both reef fish and lobster fishermen fish approximately five hours per day and market their catch the same day. Fishing with traps, gill nets, diving, and the majority of vertical gear occurred over the insular shelf (< 72 m deep), while additional vertical gear fishing for deepwater snapper occurs seaward of the shelf edge.

Anecdotal information indicates that a segment of the fishery may also include illegal foreign fishermen from Santo Domingo and other countries (*St. Croix Source*, December 5, 2002). The extent of this foreign participation in the U.S. Caribbean is currently unknown.

5.3.1.3 Markets

In Puerto Rico, fishermen may market their catch using two or more strategies including selling their catch to a fish buyer (33%), to an association (40%), to a restaurant (10%), selling it themselves on the street (41%), or selling the catch through their own business (13%), which is usually a fish store or eatery (Matos-Caraballo 1997). As of 1996, Puerto Rican fishermen were still using poor catch management strategies, with 51% gutting their catch at sea but only 1% utilizing ice.

St. Thomas fishermen sell their fish at markets, to restaurants and hotels, and to residential customers. Local demand exceeds local supply, so there is no exporting of fish from St. Thomas. St. John fishermen also sell their fish at informal markets, to restaurants and hotels, and to residential customers (Downs *et al.* 1997). In St. Croix, fishermen sell their catch at landing sites, along roadsides, or to hotels and restaurants (Tobias 2001).

5.3.1.4 Catch data

Commercial landing data used to be reported voluntarily in Puerto Rico, but due to revisions in the Puerto Rican fishing regulations in 2004, reporting is now mandatory. Puerto Rican landings are reported by species or species groups such as red hind, mutton snapper or groupers, snappers, etc. Currently, port samplers collect data from 42 coastal municipalities and 88 identified fishing centers in Puerto Rico (Matos-Caraballo 2002). The composition of the commercial catch (i.e., managed species) for Puerto Rico is documented in Table 5.

According to Matos-Caraballo (2002), the west coast of Puerto Rico produced the greatest catch (with 34% of the total landings) and Cabo Rojo was the most productive municipality (with 18% of the total landings). According to Table 5, the major fish and shellfish species in Puerto Rico as far as percentage of total commercial landings were: spiny lobster (13%), deep-water snappers (e.g., silk snapper, 12%), queen conch (11%), yellowtail snapper (14%), shallow-water snappers (e.g., lane snapper, 16%), grunts (6%), all groupers (7%), and parrotfishes and boxfishes (4%). A trend noticed since the early 1990s has been the retention and marketing of fish and shellfish species that in the past were usually discarded, such as squirrelfishes, surgeonfishes, angelfishes, and crabs (*Carpilius corallinus* and *Mythrax* spp.). These species formerly had little to no market value, but now fetch a reasonable market price (Matos-Caraballo 2002) due to a decline in the availability of formerly preferred species.

Matos-Caraballo (2002) summarizes the available data on total commercial landings in Puerto Rico from 1998-2001. These landings data were adjusted by correction factors, and include landings of species that are not managed by the Caribbean Council, such as tuna, mackerel, and dolphin. 1998 landings were estimated at 4,427,467 lbs and valued at $8,946,870; 1999 landings were estimated at 4,265,435 lbs and valued at $8,795,880; 2000 landings were estimated at 5,756,130 lbs and valued at $11,793,159; and 2001 landings were estimated at 5,233,859 lbs and valued at $10,800,657 (Matos-Caraballo 2002). During 1998-2001, line-based fisheries (handlines, rods and reels, trolled lines, and longlines) accounted for the highest percentage (40%) of the total commercial catch in Puerto Rico, followed by traps (fish and lobster traps) at 21%, nets (trammel nets, beach seines, gill nets, and cast nets) at 20%, and diver-based fisheries (SCUBA and skin-diving) at 19%. Commercial CPUE for Puerto Rico during 1998-2001 (lbs caught per individual fishing trip) ranged from 53-71 lbs per trip. This compares with estimates of 63-80 lbs per trip for 1994-1997, and contrasts with the 123 lbs per trip estimate for 1979-1982 (Collazo and Calderon 1988; Matos-Caraballo 2002). Prices paid per pound for fish and shellfish during 1998-2001 varied among municipalities in Puerto Rico (Matos-Caraballo 2002). Puerto Rico landings for species in the FMUs of the Caribbean FMPs averaged approximately 2.3 million lbs annually from 1997-2001 (Table 5).

Trap-based fisheries in Puerto Rico accounted for 22% of the overall catch in 2001 (Scharer *et al.* 2002). As is the case for U.S. Caribbean fisheries in general, because of lower trap-based catch of preferred species like groupers and snappers (i.e., *primera*), trap fishermen in Puerto Rico (and the USVI as well) are catching and marketing less desirable species (i.e., *segunda*) like parrotfishes, goatfishes, triggerfishes, and grunts (Scharer *et al.* 2002; Garrison *et al.* 1998). Studies in the La Parguera area (southwest Puerto Rico) found that spiny lobster was the most abundant species in the trap catch (Appeldoorn *et al.* 2000). Soak times in Puerto Rico are longer (about 5-7 days) than they were historically (about 1-3 days), most likely due to the effects of overfishing and low catch rates forcing fishermen to extend soak times (Juhl and Suarez-Caabro 1973; Appeldoorn *et al.* 2000; Scharer *et al.* 2002).

In the USVI, reporting is required by law to obtain or renew commercial fishing licenses. During 1998-1999, there were 349 total licensed commercial fishermen in the USVI, down from the reported peak of 846 fishermen in 1976-1977 (USVI DFW). In the USVI, landings are reported by categories – for example pot fish or net fish. With the exception of queen conch and spiny lobster, which are reported separately, it is difficult to describe specific fisheries in the USVI, and to determine how many fishermen are involved. Most commercial fishermen use a multiple number and type of gears – fish traps, hook and line, nets, and SCUBA, among others, which makes them non-specialized harvesters. An exception might be participants in the queen conch fishery. Conch are hand-harvested by a relatively small number of fishermen using SCUBA primarily. Conch fishermen harvest not only conch, but also lobster and fish while diving. Based on 1994-2002 average landings, USVI commercial catch is approximately 677,059 lbs (Table 5).

St. Croix biostatistical data on the commercial reef fish and spiny lobster fisheries collected during 1997-2000 indicated a 10% decrease in average weight of reef fish and a 12% decrease in the average weight of lobster specimens measured during the study period (Tobias 2001). Also, the mean number of fish/trap haul and weight of fish/trap haul decreased (drops of 19% and 13% respectively from 1997-1998 to 1998-1999, and of 40% and 47% respectively from 1998-1999 to 1999-2000). Hurricanes Hugo, Georges and Lenny had a deleterious effect on the St. Croix fisheries, especially trap fisheries, during the study period, because of lost traps and vessel damage. Due to the reduction of trap effort, almost ten times more spiny lobster were landed by divers than by traps from 1997-1999 (Tobias *et al.* 2000). Traps (fish and lobster) are still the most productive gear in St. Croix, with vertical gear taking second place. While traps represented 71% of the landings in 1985, they represented only 41-46% of the landings from 1997 through 1999 (Appeldoorn *et al.* 1992; Tobias *et al.* 2000). Fish traps in St. Croix landed grunts, surgeonfish, and parrotfish most often (Tobias 2001). Mean soak time for traps and pots, in general, was seven days.

The use of gill nets in the USVI has increased over the past 10 years, where they are used in conjunction with SCUBA divers to catch parrotfish (Tobias *et al.* 2000). Divers set nets in sandy offshore areas (between reefs at the shelf edge) where schools of fish congregate just before dark. The highest catches are made during peak spawning times (Tobias 2001). Between 1997-1999, parrotfish represented 74-78% of total net landings in St. Croix (Tobias *et al.* 2000). Gill nets appear to compete with fish traps for similar reef fish resources.

Table 5 reflects the best available data set for USVI managed species. USVI average landings (1994-2002) are based on Valle-Esquivel and Diaz (2003) for all species complexes except for the snapper, grouper, boxfish, and tilefish complexes. USVI landings of snapper and grouper are not identified by species. Therefore, it is not possible to determine precise landings for the various snapper and grouper FMU sub-units in Table 5. Similarly, boxfish and tilefish are not identified at all in USVI landings. USVI snapper and grouper sub-units are extrapolated using the 1994-2002 USVI average for snapper and grouper, and then multiplying that by the same percentage snapper and grouper appear in the sub-units for Puerto Rico landings (e.g., on average, Snapper Unit 1 consists of 26.76% of all Puerto Rican snapper landings). USVI boxfish and tilefish complexes are extrapolated using the same proportion that the species appear in Puerto Rican landings (% of group) out of the total average USVI landings (Valle-Esquivel and Diaz 2003; 673,436 pounds). These extrapolations are necessary due to the fact that those species are either lumped into one category (e.g., snapper, grouper) or not explicitly mentioned in the Valle-Esquivel and Diaz (2003) landings data (e.g., boxfish, tilefish).

5.3.2 Recreational Fishing Activity

5.3.2.1 Boats

All recreational vessels in Puerto Rico must be registered with the DNER. There are a number of charter boats (trolling and bottom fishing), diving boats, shoreline fishermen, and recreational

fishing boats (privately-owned vessels) but information on fishing effort, catch, or other information is largely not known. Most of the information available from the recreational fishing sector deals with tournament data on species such as marlin and dolphin.
The total number of recreational boats registered in Puerto Rico in 1995 (DNER 1995 unpublished data) was reported as 35,931 registered vessels – including personal watercrafts (jet skis). The total number of boats registered in Puerto Rico during 1996 was 44,049, indicating an increase of 8,118 boats in one year.

Eastern Caribbean Center (2002) reported 2,462 registered boat owners in the USVI, with 566 of these from St. Croix and 1,896 from St. Thomas/St. John. However, the number of recreational vessels registered in the USVI in 1997 was estimated to be 5,000 (L. Roberts, USVI/DPNR Division of Environmental Enforcement personal communication). In addition, numerous other recreational vessels are reported in transit through the USVI. Average USVI recreational boat length is 22.8 ft, with most (81.6%) less than 30 ft, while only 5% were 40 ft or greater in length (Eastern Caribbean Center 2002). Downs *et al.* (1997) found eight charter fishing businesses operating in St. Thomas and two in St. John run mostly by “continentals” from the mainland U.S., with vessel sizes ranging from 25-48 ft long. None of these vessels was licensed to carry more than six passengers, and the larger vessels were crewed by a captain and mate. These charter vessels tended to target pelagic fishes and sharks, and the catch not retained by customers was sold to restaurants and hotels.

García-Moliner *et al.* (2002) found that fishing charter activity has increased in the U.S. Caribbean since the survey by Downs *et al.* In 2000, a survey identified 46 year around charter-fishing operations, 27 in the USVI and 19 in Puerto Rico. These operations included 60 vessels. Additional seasonal operations exist during the June-September blue marlin fishery. Most of the charter vessels fish off shore and target pelagic species, but some offer inshore and reef fish trips. The charter industry considered reef fish availability as “fair.” Charter and head boats are not required to maintain records and there is no information available to describe activities of these groups targeted at species under Council authority. Establishment of needed socioeconomic research is necessary to improve data with regard to charter and head boat fisheries.

Of over 100 dive-charter operations in the U.S. Caribbean, 37% of those in Puerto Rico and 21% of those in the USVI allowed fishing (García-Moliner *et al.* 2000). Fishing during dive trips targeted lobsters (hand harvest) and fish (spear fishing).

5.3.2.2 Fishermen

Presently, Puerto Rican recreational fishermen 13 years and older (excluding those fishing off charter or headboats) are required to have a license. Information on the recreational fleet, charter fleet, and fishing enterprises other than the licensed commercial fleet is scant. Queries run on the MRFSS dataset indicate that Puerto Rico had 222,128 recreational fishermen in 2001, and 28,757 of these were from out-of-state. In contrast, Schmied (1989) reported only 81,000 resident marine recreational fishermen (from about 23,000 boats) for Puerto Rico. A creel census of 132 recreational shoreline anglers and 20 boat-based anglers was conducted in the area of Guanica State Forest between October 1997 and September 1998 (Silva *et al.* no date). The age of anglers was not dominated by any one group, but the 41-50 year old group (24.4%) was the most common. Shoreline-based angler effort was highest in August, June, and October; and lowest in January and March. Recreational anglers in Puerto Rico made approximately 1.4 million fishing trips in 2001 (NMFS 2002), of which 0.9 million were from shore, 0.5 million were from private boat, and 11,000 were from charter boat.

A telephone survey of a subset of USVI registered boat owners (n=120) who used their vessels for recreational fishing was conducted in 2000 (Eastern Caribbean Center 2002). Based on that survey the number of boat-based recreational fishermen was estimated at 2,509 for the USVI (712 from St Croix and 1,797 from St. Thomas/St. John). These fishermen were predominantly male (96.7%), with a mean age of 47.5 years old, and were of various ethnic heritages, education levels, and income levels. The number of recreational fishermen in the USVI (boat-based and shore-based fishermen) was estimated to be around 11,000 people in 1999, about 9.2% of the population, which is roughly the same proportion that Jennings (1992) found in 1986 (see Mateo 1999; Eastern Caribbean Center 2002). A survey of 312 boats taken at boat ramps stated that only 41 vessels (13%) reported fishing as one of their activities (Appeldoorn and Valdés-Pizzini 1996). Of these 41 vessels, 80% used hook and line/rod and reel gears.

A total of 814 recreational anglers were counted on St. Croix, of which 404 were interviewed (Eastern Caribbean Center 2002). The highest fishing effort took place in the afternoon hours and during the months of May through July. Most of the fishing areas however are nursery grounds where juveniles of species occur.

Eastern Caribbean Center survey (2002) found that trolling was reported as the most common boat-based fishing method in the USVI (59.7%), followed by bottom fishing (22.7%). However, Jennings (1992) states that bottom fishing (70%) was more common than trolling (20%) in 1986. Eastern Caribbean Center (2002) found that about half (53.3%) the USVI recreational fishermen fished in territorial waters (< 3 mi from shore), while 46.7% fished in federal waters. The most preferred fish group was snappers, followed by dolphin and tuna, and the majority of the catch (72.9%) was used for personal consumption. On average USVI boat-based fishermen make two fishing trips a month and fish about 4 hours per trip (Eastern Caribbean Center 2002). The total USVI boat-based recreational fishing hours in 2000 was estimated to be 320,204 hours.

The average cost of a USVI recreational fishing trip was $125.11, which included gear, bait, ice, refreshments, food, fuel, launching fees, lodging, auto transportation, and charter and guide fees, among other costs (Eastern Caribbean Center 2002). Most gear was purchased in the USVI (77%), but about half of the electronics were bought outside the USVI. Average USVI boat ownership costs were about $2,104.13 annually. Total boat-based recreational fishing expenditures in the USVI in 2000 were approximately $5.9 million, with St. Thomas/St. John contributing about $4.8 million to the total.

5.3.2.3 Catch

MRFSS was expanded to Puerto Rico at the end of 1999. Data from this survey indicate that total recreational landings in Puerto Rico were 2.8 million lbs and 1.7 million lbs in 2000 and 2001, respectively. Recreational fishermen landed, on average, 1.03 million lbs of Council-managed species, annually, in Puerto Rico during that time period (Table 6). The MRFSS does not collect data on USVI fisheries. Table 6 explains how data on the recreational fishery of Puerto Rico were used to help estimate average, annual, recreational landings in USVI fisheries of 85,252 lbs. Total average annual recreational landings for Puerto Rico and the USVI combined are estimated at 1.3 million lbs.

Total recreational finfish catch (i.e., of Council-managed species) for Puerto Rico was 43.77% of commercial finfish landings. For Puerto Rico, the majority of catch occurred in state waters. "Other Fishes" (not identified in the MRFSS data set) and snappers make up the majority of the recreational landings in state waters. Dolphin and tuna dominated the recreational catch in the EEZ. Recreational landings of spiny lobster in Puerto Rico reached 128,560 lbs in 2000 and 142,707 lbs in 2001. Recreational landings of queen conch in Puerto Rico are estimated at 140,157 lbs in 2000 and 124,085 lbs in 2001.

Except for MRFSS data for 2000 and 2001, there is little collection of recreational fishing data for local Puerto Rican waters. A survey of catch from 41 Puerto Rican recreational fishing vessels (Appeldoorn and Valdés-Pizzini 1996) found that, aside from clupeids taken for use as bait, the most caught species were silk snapper, red hind, and lane snapper. Most trips targeted groupers and snappers. This corroborates the available MRFSS data for Puerto Rico, which indicates that silk snapper, lane snapper, queen snapper, black durgon, and red hind were the predominate recreational species. Jacks also were a major recreational target, but were not identified by individual species.

Appeldoorn and Valdés-Pizzini (1996) conducted a three-month survey targeting Puerto Rican recreational boat users who trailered their boats. A total of 312 boats were surveyed; 41 reported fishing and four of these reported fishing for queen conch while snorkeling. They also sampled finfish during the survey and showed that many of the fishes harvested by the recreational sector were juveniles.

Recreational data collection for the USVI has included information from the logbooks voluntarily filled out by offshore recreational fishermen, and a survey of nearshore recreational fishermen. The offshore fishermen target primarily blue marlin, dolphin fish and wahoo. Of 563 recreational nearshore anglers interviewed in the USVI between 1995 and 1998, fishermen most frequently reported catch of french grunts, jacks, and yellowtail snappers (I. Mateo, USVI/DPNR).

The first quantitative report on the shoreline recreational fishery of St. Croix shows that the two (out of a total of 48 species reported) of the most frequently caught fishes (mojarras and anchovies) were primarily used as bait for barracuda and yellowtail snapper (Adams 1997). It also suggests that the shoreline fishery is declining, with CPUE declining since 1995, with increased effort every year. Among the species landed were red hind, yellowtail snapper, and seven other species of snappers, grunts, etc. These were caught using hook and line and nets.

Jennings (1992), from a telephone survey conducted in 1986, estimated fish harvest by recreational fishermen in the USVI at 24,648 kg-fish annually (54,226 lbs./year). The most frequently reported species were yellowtail snapper and red hind, in addition to mackerels and tunas reported specifically from St. Croix. In the mid-1980s, 10% of the residents of the USVI fished recreationally. Jennings (1992) indicates that the proportion of anglers fishing from the shoreline in St. Croix was higher than in St. Thomas/St. John. Bottom fishing and trolling from recreational vessels were the most frequent fishing activities targeting reef fish and were most common in St. Thomas.

5.3.3 The spiny lobster fishery

The spiny lobster fishery in waters around Puerto Rico and the USVI occurs with gill and trammel nets, pots and traps, hand-harvest and beach seines. Available information on the status of that fishery is described in Section 5.2.1.1.2. Due to the predominance of fishable habitat in state waters, it is assumed that most of the commercial harvest occurs in state waters, but fishery statistics do not allow accurate separation of harvest in the EEZ from harvest in state waters. The overall average of 546,640 lbs for the entire U.S. Caribbean (Table 7) is approximately 66% of the MSY estimated in the original FMP, with traps accounting for the majority of those landings.

5.3.3.1 Puerto Rico

Although three species of spiny lobsters occur in the management area, landings of only the Caribbean spiny lobster (*Panulirus argus*) are of significance, and the management system described is restricted to that species. The annual average of commercial lobster landings from 1997-2001 in Puerto Rico is estimated at 290,554 lbs (Table 5). The current landings represent about 90% of the commercial landings reported by Bohnsack *et al.* (1991). There are no annual recreational spiny lobster harvest estimates by MRFSS for Puerto Rico. The SFA Working Group determined based on informed judgement that average recreational landings of spiny lobster were approximately 50% that of commercial landings (135,633 pounds).

The Overview of Puerto Rico`s Small-Scale Fisheries Statistics 1988-1989, published by the Natural Resources Department, reported total lobster landings of 186,423 lbs for 1989, or 23% of total pounds landed in 1979 (CFMC 1990b). Total ex-vessel value was $803,483, a 59% reduction. Bohnsack *et al.* (1991) reported that total annual lobster landings in Puerto Rico averaged 317,451 lbs for 1951, 1964, and 1969-1989, and fluctuated from143,761 to 512,000 lbs. Despite uncertainty about the accuracy of the data, Bohnsack *et al.* (1991) concluded that the data reflected the general landing trends.

Matos-Caraballo (2002) reported average price of commercial lobster landings from Puerto Rico during 1998 to 2001 as follows: 1998 average price was $5.24/pound; 1999 average price was $5.27/pound; 2000 average price was $5.05/pound; and 2001 average price was $5.50/pound. Spiny lobster represented 13% of the total commercial fishery landings (i.e., Council-managed species) in Puerto Rico during 1997-2001 (Table 5). During 1998-1999, the south and west coasts of Puerto Rico reported the highest lobster landings; during 2000-2001, the south and east coasts reported the highest lobster landings, as the west coast experienced a significant decrease in landings (Matos-Caraballo 2002).

According to Matos-Caraballo (2002), SCUBA divers, fish traps, lobster traps, and trammel nets caught the majority of commercial lobster in Puerto Rico from 1998-2001. In 1998, SCUBA divers landed 132,091 lbs, fish traps landed 101,266 lbs, lobster traps landed 40,086 lbs, and trammel nets landed 14,303 lbs. In 1999, fish traps landed 130,003 lbs, SCUBA divers landed 129,490 lbs, lobster traps landed 30,207 lbs, and trammel nets landed 23,253 lbs. In 2000, SCUBA divers landed 134,710 lbs, fish traps landed 93,809 lbs, lobster traps landed 18,908 lbs, and trammel nets landed 7,754 lbs. In 2001, SCUBA divers landed 138,565 lbs, fish traps landed 102, 003 lbs, lobster traps landed 32,198 lbs, and trammel nets landed 5,587 lbs (Matos-Caraballo 2002).

Among Puerto Rican trap fishermen, 77% were found to target both lobster and reef fish, while only 10% target lobster alone (Scharer *et al.* 2002). Wooden traps were used primarily for lobster, but wire mesh traps were used for both lobster and reef fish. Biodegradable panels are required for all traps, including those in state waters, but fishermen have not always followed this regulation.

Spiny lobster have been protected by federal and state management plans for 18 years, but fishing pressure has remained intense. Biostatistical sampling of Puerto Rican lobsters caught during 1998-2001 found that 18% were under the minimum state and federal size limit (89 mm carapace length), which is an improvement over the 36% found undersized during 1994-1997 (Matos-Caraballo 2002).

5.3.3.2 USVI

The annual average of commercial lobster landings from 1994-2002 in the USVI is 80,302 lbs (Table 5). Recreational lobster harvest extrapolated from the MRFSS database for 2000-2001 in Puerto Rico amounted to 40,151 lbs for the USVI (Table 6).

On St. Croix, Mateo and Tobias (2001) reported a steady increase in average commercial landings from 7,800 lbs during the 1980s to 29,600 lbs in the 1990s. However, mean carapace length in St. Croix exhibited a decrease between 1997 and 2000, going from 107.78 mm in 1997-1998 to 102.46 mm in 1999-2000, and in the USVI overall, the mean size of landed lobsters is decreasing, as are landings (Tobias *et al.* 2000; Bolden 2001). However, Tobias (2001) found that a greater number of lobster were being taken per trap haul in St. Croix from 1997 to 2000, but that these lobster were smaller (12% decrease in weight). Tobias (2001) suggests that the spiny lobster resource is overfished based on growth and mortality parameters. Divers accounted for about 85% of total landings from 1990 to 1998. On St. Croix from October 1997 to December 2000, divers landed 74,976 lbs of lobster, while traps caught only 8,300 lbs (Tobias 2001). Total commercial USVI lobster landings averaged 36,534 lbs for St. Thomas/St. John, and 7,284 lbs for St. Croix between 1980 and 1988, and appeared relatively stable (Bohnsack *et al.* 1991).

Among lobster fishermen using traps in the USVI, mean crew size was 2-3 individuals, soak times were about 7 days, and vessels utilized ranged in length from 28-35 ft. In contrast, USVI fishermen harvesting lobster by diving, used vessels ranging from 18-20 ft in length (Tobias 2001).

5.3.3.3 Regulations

Concurrent regulations for spiny lobster apply in the EEZ and in state waters of Puerto Rico and the USVI. The minimum size limit specifies a 3.5-in carapace length. Current regulations prohibit harvest of lobster with spears or other piercing devices. Gaffs are often used to pin the animals down, but regulations prohibit piercing the lobsters. The use of poisons or explosives is also prohibited. Lobsters must be landed whole, and while berried females may be kept in traps, they may not be kept onboard of vessels. It is illegal to pull another fisher's trap without his express permission (except by authorized officers). Traps must be fitted with a biodegradable panel and fasteners. Buoy, boat, and trap identifications and markings must be as displayed according to specifications.

5.3.4 The queen conch fishery

The queen conch fishery in waters around Puerto Rico and the USVI occurs by hand-harvest only. Over-harvest of queen conch in shallow, nearshore waters since the use of SCUBA in the 1970s has led to commercial harvest primarily in waters with depths of 15-30 m (45-95 ft), although harvest can occur in depths in excess of 37 m. Available information on the status of the queen conch fishery is described in Section 5.2.1.2.1.2. Due to the predominance of fishable habitat in state waters, most of the commercial and recreational harvest occurs in state waters, but fishery statistics do not allow accurate separation of harvest in the EEZ from harvest in state waters. Most (92%) conch fishermen fish within 9 nm of the coast and 60% within 3 nm. The average conch fishing trip lasts four hours and 60% of the daily trip catch is in the 100-150 pound range (Rivera 1999).

The Council is promoting the pan-Caribbean management of queen conch, *Strombus gigas*. This is an international effort to evaluate the status of the conch stocks, and develop regional management measures for the sustainable fisheries of the species.

5.3.4.1 Puerto Rico

Rivera (1999) reported that Puerto Rico had 209 commercial conch fishermen, and 16 of them fished federal waters. Half of the Puerto Rico conch fishermen were from the Peñuelas/Cabo Rojo area on the south/southwest coast, another 25% were from the southeast coast (Naguabo, Ceiba, Fajardo, and Vieques Island), with a much smaller number of north coast fishermen (Rivera 1999). A conch biometric survey found that 24% of conch harvested from state waters in Puerto Rico were under the federal size limit (Rivera 1999).

The annual average of commercial queen conch landings from 1997-2001 in Puerto Rico is 248,437 lbs (Table 5). During 1997-2001 queen conch made up 11% of the total commercial landings for Puerto Rico (i.e., Council-managed species; Table 5). Matos-Caraballo (2002) reported commercial queen conch average price from Puerto Rico during 1998 to 2001 as follows: 1998 average price was $2.22/pound; 1999 average price was $2.25/pound; 2000 average price was $2.23/pound; and 2001 average price was $2.44/pound. The west coast of Puerto Rico exhibits the highest landings, followed by the east coast, and then the south coast, with only minimal landings from the Puerto Rican north coast. The southwest corner of Puerto Rico produced the largest catches, and 58% of Puerto Rico's commercial conch landings have come from the municipalities of Lajas, Cabo Rojo, and Mayagüez since 1983-2000 (Valle-Esquivel 2002). Almost all landings are made by SCUBA divers (between 92-99% from 1998-2001), followed by skin divers (between 1-6% from 1998-2001) in Puerto Rico (Matos-Caraballo 2002).

Historically, Puerto Rican commercial queen conch landings increased from 60,000 lbs in the 1970s to a 440,000 pound peak in 1983, than declined thereafter to around 100,000 lbs through the early 1990s (Valle-Esquivel 2002), with an increase since to 248,000 lbs in 2001 (Table 5). Densities of queen conch in Puerto Rico have decreased from 8.11 conch/hectare in 1987 to 5.68 conch/hectare in 1996. Pounds of conch meat landed per trip has also decreased from 160 lbs/trip in the mid 1980s to 72 lbs/trip for 1988-2001 (Valle-Esquivel 2002).

There are no annual recreational conch harvest estimates by MRFSS for Puerto Rico. The SFA Working Group determined based on informed judgement that average recreational landings of queen conch were approximately 50% that of commercial landings (i.e., 132,121 lbs). Statistics on recreational conch catches are not recorded by the Puerto Rican Research Laboratory, however, Appeldoorn and Valdés-Pizzini (1996) interviewed recreational fishermen at boat ramps (71 sites). Only 4 of 41 boats who reported fishing as an activity were recreationally fishing for conch (10 %), and all of these were by free-diving. Most conch were caught for personal consumption. Sixty specimens were examined, 73% were juveniles, and 55% of these had shell lengths less than 19 cm (the approximate minimum size for retention by commercial fishermen).

5.3.4.2 USVI

Rivera (1999) reported no full-time conch fishermen but 23 part-time conch fishermen from St. Thomas and St. John, with none of these fishing in federal waters. St. Croix had 16 full-time and 12 part-time fishermen, with two of these working in federal waters. A conch biometric survey found that 92% of conch harvested from state waters in St. Thomas and St. John were under the federal and state size limit, while in St. Croix 21% were undersized (Rivera 1999).

The annual average of commercial queen conch landings from 1994-2002 in the USVI is 38,927 lbs (Table 5). Queen conch harvest is considerably higher in St. Croix than in Thomas/St. John, and, proportionally, queen conch is more important in St. Croix making up 8% of total commercial landings there, but only 0.2% of commercial landings in St. Thomas/St. John (Valle-Esquivel and Diaz 2003). St. Croix commercial landings peaked in 1979 at 60,000 lbs, but have decreased since then to around 20,000-30,000 lbs per year. There are no annual recreational conch harvest estimates by MRFSS for the USVI. The SFA Working Group determined based on informed judgement that average recreational landings of queen conch were approximately 50% that of commercial landings (i.e., 19,464 lbs).

USVI fishery independent surveys conducted between 1981 and 1996 have found progressive decreases in queen conch densities from 40.87 conch/hectare (in 1981) to 14.71 conch/hectare (in 1996). In St. Croix, the average number of pounds of conch meat caught per commercial trip went from 83 lbs/trip in the 1980s, down to 57 lbs/trip in the 1990s, when effort nearly quadrupled (Valle-Esquivel 2002b). In general, conch fishermen in the U.S. Caribbean believe that search times are longer and that more offshore/deep water fishing has become necessary. In others words, they are spending more time to get less conch (Valle-Esquivel 2002a).

5.3.4.3 Regulations

Federal regulations for queen conch set the minimum size limit at 9 in for shell length or a lip thickness of more than 3/8 of an inch. Conch must be landed whole (in the shell). There is a closed season from July 1 through September 30. Recreational (non-commercial) fishermen may land up to three conch per day with a limit of 12 conch/boat. Commercial fishermen may land up to 150 conch per day. Use of hookahs to harvest conch is prohibited.

Regulations in USVI and Puerto Rican waters are the same as those for federal waters, except that the harvest for recreational fishermen is six conch per day with a limit of 24 conch/boat in the USVI, and Puerto Rican commercial fishermen are not required to land conch in the shell.

5.3.5 The reef fish fishery

Reef fishes targeted by nets and traps, including parrotfish and surgeonfish, were shown to be decreasing in mean size based on 1985-1990 data (Appeldoorn *et al.* 1992), and a new assessment utilizing 1990-2000 data is needed (Tobias 2001). No net restrictions are in place in the U.S. Caribbean federal waters.

It is difficult to describe specific reef fish fisheries in the U.S. Caribbean, and to determine how many fishermen are involved. Most commercial fishermen use multiple number and types of gears – fish traps, hook and line, nets, SCUBA, among others – that make them non-specialized harvesters. Additionally, divers collect aquarium trade species in Puerto Rico, principally in state waters.

Commercial landings data in the U.S. Caribbean have been collected since 1969 in Puerto Rico, and since 1974 in the USVI. In Puerto Rico and the USVI, trap fishing has been the traditional and most productive fishing method used (CFMC 2001b). In the late 1980s, hook and lines (hand, trot, etc.) became the most productive gear in Puerto Rico. Net fishing has been shown to be increasing (e.g., Valdés Pizzini *et al.* 1992) in Puerto Rico, and the trend has been reported for the USVI; in St. Croix nets are fished using SCUBA divers to herd fish into the nets, principally parrotfish (Tobias *et al.* 2000). The decline in the trap fishery is probably the most important factor contributing to the increase in the number and use of nets (re-direction of the fishery).

5.3.5.1 Puerto Rico

In Puerto Rico from 1997-2001, the commercially-caught fishes with the highest landings were snappers, groupers, grunts, jacks, and parrotfishes (Table 5). According to 1997-2001 commercial landings yellowtail snapper, silk snapper, lane snapper, and white grunt were especially important to the commercial fishery. In most years, the three main components of the reef fish landings in Puerto Rico have been snappers, groupers, and grunts, from the reef fish complex (CFMC 2001a). These species are found in both shallow and deep water. Other major fish groups taken commercially from reefs on the Puerto Rican platform (besides snappers and groupers) include jacks, parrotfishes, and boxfishes. Appeldoorn *et al.* (1992) reported that landings of all demersal fishes in Puerto Rico declined from a peak of 5,296,410 lbs in 1979 to 1,144,395 lbs in 1990.

The majority of the commercially caught reef fishes inhabit the insular shelf. The shallow-water reef fish fishery of Puerto Rico and the USVI extends from the shoreline of both States into the EEZ, though the fishery is generally limited to depths of 40 fathoms or less. Following the collapse of the Nassau grouper resource, red hind became an important species in the fishery; however, statistics show a decrease in the number of young fish in the population as concluded by the Stock Assessment Group (Appeldoorn *et al.*, 1992). Whenever possible, the Council relies upon closing aggregation sites during spawning seasons to enhance reproductive capacity. Most species that aggregate during spawning season are highly vulnerable to capture at that time. Fishermen have sometimes asked for the closure of spawning areas. Most commercial fishing occurs by hand-line fishermen in outboard-powered vessels less than 6 m in length; however, fish traps and most recently gill nets have been used to harvest mutton snapper in this area. Weather permitting, more than 30 fishing vessels can be seen nightly for one week after the full moon during the months of March through June. Fishing effort is most heavily concentrated at depths of 18-27 m. Mutton snapper appear to be especially vulnerable to harvest when aggregated for spawning.

In Puerto Rico during 1998-2001 (Matos-Caraballo 2002), the greatest commercial landings of yellowtail snapper were caught, ranked in order of landings, by vertical line gear, fish traps, gill nets, and longlines. The greatest commercial landings of lane snapper in Puerto Rico during 1998-2001, ranked in order of landings, were caught by fish traps, vertical line gear, gill nets, and longlines. This general pattern holds for the other shallow-water snapper species, except that SCUBA is used to take a substantial portion of some snapper landings (e.g., mutton snapper). The greatest commercial landings of red hind were caught during the same time period, ranked in order of landings, by vertical line gear, fish traps, and SCUBA. The highest landings of the other shallow-water grouper species are accomplished using these gears also. Grunts are harvested by, ranked in order of landings, fish traps, gill nets, vertical line gear, trammel nets, and beach seines. Jacks are captured mostly *via* bottom lines, gill nets, and also beach seines to a lesser extent. Parrotfishes are mostly caught by fish traps, gill nets, and SCUBA. Boxfishes are caught principally by fish traps, SCUBA, trammel nets, and gill nets.

The deep-water fishery ranges from the outer reaches of the shallow-water fishery (approximately 73 m) seaward to depths up to more than 550 m. Fishes inhabiting the deep-water reef areas of the slopes characterized by rocks, ledges, and corals generally are captured with heavy-duty traps, buoy gear, and by electronically-powered reels; bottom long-lines are deployed to a limited extent. The five major deep water reef fish species are silk snapper, queen snapper, vermilion snapper, misty grouper, and wenchman.

Commercial landings collected by the Fisheries Research Laboratory indicated that 8.1% of the total catch was comprised of silk snapper and blackfin snapper (Piñeiro *et al.* 2003). However, the importance of blackfin snapper may not be fully represented in the commercial landings (i.e., Table 5), but may be reported as "unclassified snapper." Vertical line gear accounts for the greatest amount of landing of deep water reef fish, though fish traps and longlines also harvest significant amounts of fish.

5.3.5.2 USVI

Trap-caught fish continue to make up the highest percentage of the USVI total catch but some changes have taken place since the late 1990s, at least in St. Croix. The DPNR has reported that 54 commercial fishermen from St. Thomas-St. John District were fishing 4,574 fish traps and 1,655 lobster pots, for a total of 6,229 traps/pots. The number of traps per fishermen ranged from a minimum of one to a maximum of 350, with 33% having less than 20 traps. The data available for the landings in the USVI (DPNR 1997) for the year 1995-1996 indicate that there were 182 commercial fishermen registered, of whom 149 reported landings from 4,909 trips made during the year. The average reported total catch per year in St. Thomas-St. John (1993-1996) was 367,788 lbs of fish and 64,668 lbs of lobster. The catch per trap (using the average for the last three years reported by DPNR) was 80 lbs per fish trap and 39 lbs of lobster per lobster pot, a combined average of 69 lbs per fish/lobster trap. However, mean catch per trip was reported to be of 110 lbs from 1993 through 1996. The estimated landings reported (over a million pounds per year from average for 3 years), result in an average of 130 lbs per trap. In the

1980s the CFMC had estimated the catch per trap to be less than 120 lbs. CPUE showed little variation through the 1980s and 1990s. The number of registered fishermen that did not report landings has consistently been decreasing since 1986-87 for St. John, and 1981-82 for St. Croix.

The CFMC currently prohibits the harvest of butterflyfish, seahorses, and juvenile red hind and mutton snapper for the aquarium trade (Reef Fish FMP Amendment 2, 1993). In state waters, both the Puerto Rico and USVI fishery agencies manage the take of aquarium trade species through a permit system, with associated reporting requirements. In USVI waters, collection for the commercial aquarium trade species is prohibited, but un-permitted collection of aquarium fishes can be made by individuals for their personal aquariums. Collection for educational purposes is authorized by permit. At present, the only permits active in the USVI are for educational facilities. Little activity is reported from federal waters off the USVI. In Puerto Rico, the trade and shipping lists for 1990-1991 indicate that over 150 species of fish (105 finfish) and invertebrates (45) were exported from Puerto Rico. Many of the species collected are juvenile species that are valued as adults in other fisheries, some of which are regulated. About 100 people are engaged in the marine aquarium trade in Puerto Rico. Most collectors are exporters, however, some collectors sell to exporters or to local shops. Major collectors have their own equipment, and collect from 3-4 days to 7 days a week depending on weather and demand. Collectors visit specific areas and generally rotate collecting sites to avoid overfishing an area. Collection are commonly made by SCUBA down to 20 m, but occasionally to 40 m for certain species; mask and snorkel are commonly used in shallow waters. Most collectors are based out of the northwest and southwest coastal regions; Isabela Aquadilla, Rincon, Cabo Rojo, La Parguera, and Ponce are the primary collecting areas (Ojeda-Serrano *et al.* 2001). The only allowable fishing gears for capturing aquarium-trade fish are hand-held dipnets, slurp guns, and barrier nets with a maximum length of 30 ft, a maximum height of 4 ft, and a minimum mesh size of 1/4 in. The use of poisons, drugs, other chemicals, and explosives is prohibited. Diver harvest in federal waters is probably limited to a small area of shelf-extension off southwestern Puerto Rico, while some deep water ornamentals may be taken by traps and also incidentally by commercial fishermen in federal waters. Puerto Rico implemented new regulations for the marine aquarium trade in 2004, which restricts the list of allowable species for harvest and also implements a quota for each allowable aquarium trade species.

From 1998-2000, 10 species accounted for 76% of all aquaria-trade fish exported from Puerto Rico, with the Royal Gramma (*Gramma loreto*) alone accounting for 42%. Other species on the list include yellowhead jawfish, blue chromis, redlip blenny, rock beauty, greenbanded goby, blue tang, longhorn blenny, bluehead wrasse, and cherubfish (Ojeda-Serrano *et al.* 2001). Most of the aquarium-trade exports (99.3%) during 1998-2000 went to the continental United States.

5.3.6 The coral reef fishery

The Coral FMP prohibits the harvest or possession of stony corals, soft corals, sea fans, gorgonians and any species in the fishery management unit if attached or existing upon live-rock; it prohibits the sale or possession of any prohibited species unless fully documented as to point of origin; it prohibits the use of chemicals, plants or plant derived toxins, and explosives for harvest (consistent with the Council's Reef Fish FMP); and it limits harvest of other invertebrates to dip nets, slurp guns, by hand and other non-habitat destructive gear. Most harvest of species under the Coral FMP goes to the aquarium trade. The description of the aquarium trade industry in Section 5.3.5 also applies to invertebrates of the Coral FMP. The local governments prohibit the harvest of corals from state waters.

Amendment 1 to the Coral FMP established the Hind Bank MCD southwest of St. Thomas, USVI. The area is closed to all fishing and harvesting activities, protecting populations of groupers, snappers, other reef fish, and spiny lobster from fishing mortality and protecting coral from fishery-related impacts.

5.3.7 The HMS fishery

The revised list of authorized fisheries (LOF) and fishing gear used in those fisheries became effective December 1, 1999 (64 FR 67511). The rule applies to all U.S. marine fisheries, including Atlantic HMS. As stated in the rule, "no person or vessel may employ fishing gear or participate in a fishery in the exclusive economic zone (EEZ) not included in this LOF without giving 90 days' advance notice to the appropriate Fishery Management Council (Council) or, with respect to Atlantic highly migratory species (HMS), the Secretary of Commerce (Secretary)." Acceptable commercial HMS fisheries and authorized commercial gear types for Atlantic tunas, swordfish, and sharks include: shark bottom longline fishery (longline); shark drift gillnet fishery (gillnet); pelagic longline fishery (longline); swordfish handgear fishery (rod and reel, harpoon, handline, bandit gear); shark handgear fishery (rod and reel, handline, bandit gear); tuna handgear fishery (rod and reel, harpoon, handline, bandit gear); tuna purse seine fishery (purse seine).

The predominant HMS fishery in the Virgin Islands and Puerto Rico that could be impacted by the proposed actions in this EIS, in particular the actions to minimize adverse effects on EFH due to the proposed prohibition on bottom longlines in currently existing seasonal closed areas and on Grammanik Bank, is the commercial shark fishery. However, available data indicate that only a small volume of shark landings was derived from this region in recent years. A brief description of the commercial shark fishery is provided below. More detailed information regarding the other HMS fisheries, including economic information, may be found in the HMS FMP (NMFS 1999b) and the 2004 HMS SAFE Report (NMFS 2004).

5.3.7.1 Commercial Shark Fishery

Atlantic sharks are targeted primarily through the use of bottom longline and drift gillnet gears, and are often taken incidentally with pelagic longline gear. Although discussions of other HMS fisheries have been broken down by gear type, the nature of the shark catch and the method of data collection lend themselves to a stock-based analysis.

5.3.7.1.1 Bottom Longline Fishery

The Atlantic shark bottom longline fishery targets LCS with landings dominated by sandbar and blacktip sharks. Bottom longlines were the primary commercial gear-type used to catch LCS in all regions in recent years. Gear characteristics vary slightly by region, but in general, a ten mile long monofilament bottom longline, containing about 750 hooks is fished on the bottom, overnight. Various baits are used, including skates, sharks, and finfishes. The gear typically consists of a heavy monofilament mainline with lighter weight monofilament gangions (NMFS 2003b)

5.3.7.1.2 Gillnet Fishery

Gillnet fishing for sharks in the southeast United States has existed for many years. The southeast shark drift gillnet fishery is comprised of about five vessels that have been observed to use nets 456 to 2,280 meters long and 6.1 to 15.2 meters deep, with stretched mesh from 12.7 to 22.9 cm (NMFS 2003b).

Shark gillnet fishermen also use gillnet gear in a stikenet fashion. This is generally done by actively setting the net around a school of sharks or by setting the net in the wake of a shrimp vessel. Vessels fishing in a strikenet fashion have been observed to use nets 364.8 meters long, 30.4 meters deep, and with stretched mesh measuring 22.9 cm (NMFS 2003b).

5.3.7.1.3 Pelagic Longline Fishery

The U.S. pelagic longline fishery for Atlantic HMS primarily targets swordfish and yellowfin tuna or bigeye tuna but also catches sharks incidentally. See the HMS FMP (NMFS 1999b) and 2004 HMS SAFE Report (NMFS 2004) for more information specific to the pelagic longline fishery.

5.3.7.2 Commercial Shark Landings

Total commercial landings of LCS in 2002 was 4,114,179 lbs; the total commercial landings of SCS in 2002 was 579,880 lb; and the total commercial landings of pelagic sharks was 305,637 lb (NMFS 2004). The total ex-vessel value of sharks (including fins) landed in 2002 was 8.4 million dollars (NMFS 2004). The value of sharks landed in Puerto Rico and the Virgin Islands from 1997 through 2002 was negligible. According to dealer weigh-out data, landings totaled less than 3,200 lbs. and consisted of 66 individual fish for that six year period (Table 5.3.7.2). However, these data may not be reflective of the actual value of the Caribbean shark fishery due to possible unreported landings.

YEAR	NUMBER OF SHARKS	TOTAL WEIGHT (LBS)
1997	59	2,925
1998	--	--
1999	--	--
2000	6	230
2001	--	--
2002	1	13
TOTAL	66	3,168

Table 5.3.7.2. Caribbean Shark Landings 1997 - 2002. Source: Domestic Landings System maintained by the SEFSC.

5.3.7.3 HMS permits

HMS Management Division continues to monitor capacity in HMS fisheries. Due to the large number of HMS permits, overcapacity remains a concern in HMS fisheries. The HMS FMP outlined several objectives of a program that would limit access to the swordfish, shark, and tuna longline fisheries. This program was designed to prevent further overcapitalization of the fisheries with a longer-range goal of reducing latent effort without significantly affecting the livelihoods of those who are dependent on the fisheries.

The program implemented in the HMS FMP set up six different limited access permit types: 1) directed shark, 2) incidental shark, 3) directed swordfish, 4) incidental swordfish, 5) swordfish handgear, and 6) tunas longline. To reduce bycatch concerns in the pelagic longline fishery, these permits were designed so that the swordfish directed and incidental permits are valid only if the permit holder also holds both a tuna longline and a shark permit. Similarly, the tuna longline permit is valid only if the permit holder also holds both a swordfish (directed or incidental, not handgear) and shark permit. Swordfish handgear and shark permits are valid with out another limited access permit.

As of October 2004, one shark incidental permit is held by a vessel in the USVI, and no shark limited access permits are held by vessels in Puerto Rico. As of October 2004, one dealer holds an Atlantic shark dealer permit in the USVI, and no Atlantic shark dealer permits are held in Puerto Rico.

5.3.8 Fishing communities

The information available to describe commercial fishing communities has been reviewed in the Council's Coral Reef, Queen Conch, Reef Fish, and Spiny Lobster FMPs. There is no continuous program that collects information to describe these communities in great detail.

Sporadic and targeted surveys are conducted in the U.S. Caribbean to answer specific questions. Caribbean commercial fisheries are complex and harvest multiple species with a variety of gears and seasonal harvesting patterns. This complexity has not been analyzed in detail.

Matos-Caraballo (1997) provided the latest commercial fishing census (1995) for Puerto Rico and detailed information concerning regional landings, U.S. census information, and fishing participants in various fisheries by region. The 1,758 full- and part-time fishermen were distributed fairly evenly around Puerto Rico: 428 on the North Coast, 427 on the East Coast, 442 on the South Coast, and 461 on the West Coast. Only two communities reported more than 100 fishermen: Cabo Rojo (213) and Humacao (108). The total number of active commercial fishermen reported by the Puerto Rico Fisheries Research Laboratory has fluctuated without long-term trend since 1974 (Matos-Caraballo 1997).

No comparable document is available for the USVI, although Downs and Petterson (1997) obtained information for USVI during evaluation of a proposed Marine Conservation District off St. John. They reported that the two traditional fishing communities of St.Thomas are Hull Bay on the north side and Frenchtown on the south side; however, northside fishermen tend to keep vessels in the east or south coast areas. Most St. Thomas fishermen are of French descent. On St. John, fishermen cluster in Cruz Bay on the west end and in Coral Bay on the east end. Most St. John fishermen are recent arrivals, or of West Indian descent.

The Heinz Center (2000) report on roundtable discussions for improving federal fisheries management both nationally and for the Caribbean specifically, calls for enhanced social science research including the development of long-term, comprehensive social science data collection programs. In the U.S. Caribbean, the panel recommended more proactive use of social and economic information in the fishery management process and providing transition assistance to displaced fishermen. Emphasis was placed on the need for long-term research to collect information on community infrastructure, how fishermen learn and produce knowledge, cultural perceptions and politics, socioeconomic development of fishing communities, gender issues, fishery histories, ethnic composition and background of fishery participants, rules and regulations, and systems of jurisdiction and conflicts. They also suggested moving away from surveys to gather data and towards the idea of getting fishermen to participate more extensively in the data collection and assessment process. The panel believed that Puerto Rico and the USVI should have both commercial and recreational socioeconomic research programs.

5.4 Administrative environment

Section 2 provides an overview of the administrative environment in the U.S. Caribbean, including the federal (Section 2.1.1) and state (Section 2.1.2) fishery management systems and applicable laws, international issues (Section 2.1.3), and the history of federal fisheries management (Section 2.2).

6 Environmental Consequences

6.1 Fishery management units and sub-units

The fishery management unit defined by each Council FMP identifies the specific fishery (or that portion thereof) that is relevant to the FMP's management objectives. 50 CFR §600.320(d)(1) provides that FMUs may be organized around biological, geographic, economic, technical, social, or ecological goals. Decisions about the composition of FMUs are an integral part of the plan development process, as FMUs define the specific species that are to be the target of conservation and management. Species may be included in an FMU for data collection (e.g., monitoring) purposes only if the Council determines there is not enough information available to specify biological reference points or to establish management measures for that species (50 CFR §600.320(d)(2)).

6.1.1 Defining fishery management units and sub-units

Modifying definitions of FMUs and FMU sub-units is an administrative action and, as such, would not directly affect the biological, ecological, social, or economic environment. However, the Council's authority to manage the take of specific species is dependent on their inclusion in an FMU. Thus, the alternative definitions of FMUs considered in this section could have indirect biological or socioeconomic effects associated with adding or removing species from the authority of federal fishery managers. The potential environmental consequences of each FMU alternative are explained below.

6.1.1.1 Alternative 1. No action. Retain the current FMUs designated by the original FMPs.

The current FMUs are defined at 50 CFR Part 622.2 and in associated appendices. The Caribbean spiny lobster FMU includes a single species, *Panulirus argus*. The Caribbean conch resource, reef fish, and coral reef FMUs are composed of multiple species, and are described in Tables 2-4, respectively.

6.1.1.1.1 Direct and indirect effects on physical environment and their significance

Fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing with bottom habitat, either through gear impacts to bottom habitat or through the direct harvest of bottom habitat. The degree to which a habitat is impacted by fishing gear depends largely on the vulnerability of the affected habitat to disturbance, and on the rate at which the habitat can recover from disturbance (Barnette 2001). For example, coral reef habitat is more vulnerable to adverse impacts from fishing gear than is sand and mud bottom habitat. The complex structure and vertical growth pattern of many species that characterize coral reef communities causes them to be easily snared or entangled by fishing gear (Barnette 2001). Additionally, fully restoring the ecological functions of these slow-growing communities may require tens to hundreds or thousands of years, particularly if underlying habitat structure is destroyed, or if prevailing environmental conditions have been chronically degraded over time (U.S. Coral Reef Task Force 2002).

The status quo definition of the Spiny Lobster, Caribbean Conch, and Reef Fish FMUs is not expected to indirectly affect the physical environment in a positive or negative way because these FMUs do not include species that provide EFH. However, the Caribbean coral reef resource FMU is currently defined to include a vast array of plants and invertebrates that provide habitats that are essential to the growth, development, and survival of managed finfish and other marine organisms. While these organisms could be adversely affected by fishing gear interactions, their inclusion in an FMU does not directly or indirectly affect the Council's ability to manage such interactions. Coral reef resources are currently identified as EFH (CFMC 1998) and would continue to be identified as EFH under the Council's preferred revision to the EFH definitiondescribed in Section 4.7.1 (EFH Alternative 2).

However, as previously noted, fisheries also may adversely affect habitat through direct harvest. Because the Council's authority to manage the direct harvest of marine species is dependent on their inclusion in an FMU, the current definition of the Caribbean coral reef resource FMU could be expected to indirectly benefit the physical environment by providing the Council with the authority to manage the take of these plants and invertebrates that constitute EFH for other managed species. Through the Coral FMP, the Council has prohibited the take, possession, and sale of gorgonians, stony corals, and any species in the Caribbean coral reef resource FMU if attached or existing upon live rock. Because these resources are generally sedentary, these regulations are believed to be effective in protecting those coral reef communities that occur in federal waters from the impacts of fishing. Therefore, this alternative is not expected to result in any direct or indirect impacts to the physical environment that are not already occurring under current fishery conditions.

6.1.1.1.2 Direct and indirect effects on biological and ecological environment and their significance

6.1.1.1.2.1 Caribbean spiny lobster

The Caribbean spiny lobster FMU is currently defined to include just one species, the Caribbean spiny lobster (*Panulirus argus*), which is targeted within the 100-fathom contour on the continental shelf surrounding Puerto Rico and the USVI (CFMC 1981). Including the Caribbean spiny lobster in an FMU is expected to indirectly benefit the biological and ecological environment by providing the Council the authority to manage the take of this species to sustain catches over time. The Council manages the spiny lobster fishery primarily through a minimum size limit and through a prohibition on the retention of egg-bearing (berried) lobsters (see Section 2.2.1).

The degree to which these management measures benefit the spiny lobster resource is unknown, but is believed to depend largely on the effectiveness of management measures established for this species in state and in international waters. State regulations managing the take of spiny lobster off Puerto Rico and the USVI are a critical component of spiny lobster management, as federal management measures affect only about 14% of the area within which the fishery occurs in the U.S. Caribbean (Figure 1). Additionally, studies suggest that the spiny lobster resource in the U.S. Caribbean recruits, at least in part, from larvae entering the area from areas to the south and southeast on the prevailing South Equatorial Current (CFMC/NMFS 1980). NMFS (1999a) has identified a need to identify the actual sources of all spiny lobster stocks (both U.S. and foreign) and to establish an international management regime to prevent overfishing.

6.1.1.1.2.2 Caribbean conch resource

The Caribbean Council defined the Caribbean conch resource FMU to include queen conch (*Strombus gigas*) and twelve other gastropods that are similar to queen conch and that the Council believed may need to be actively managed in the future (CFMC 1996a). The complete list of species representing this FMU is provided in Table 2.

Including the queen conch in the FMU is expected to indirectly benefit the biological and ecological environment by providing the Council the authority to manage the take of this species to sustain catches over time. The Council manages the queen conch fishery primarily through a minimum size limit, commercial catch limit, recreational bag limit, and an annual spawning season closure (see Section 2.2.2).

The degree to which these management measures benefit the queen conch is unknown, but it is believed to depend largely on the effectiveness of management measures established for this species in state and international waters, and on the availability of suitable habitat (CFMC 1996a). State regulations managing the take of queen conch off Puerto Rico and the USVI are a critical component of queen conch management, as federal management measures affect only about 14% of what is described as the "fishable habitat" (e.g., the 100 fathom contour) of the U.S. Caribbean (Figure 1). Further, Rivera (1999) reports that conch fishing in federal waters is very minor off Puerto Rico. While somewhat more pronounced in federal waters off the USVI due to disparity in state boundaries (i.e., 9 nm versus 3 nm), it is still rather limited, illustrated by the fact that total USVI queen conch harvest (including state waters) has averaged approximately 39,000 pounds (Table 5). Because queen conch are generally harvested by hand, fisheries for queen conch in federal waters are further constrained by the depth limitations confronted by divers. In general, conch is harvested in the shallower inshore waters of the U.S. Caribbean.

Rhines (2000) indicates that, in the Bahamas, deep water populations of queen conch may sustain smaller shallow water populations. If this is true for populations in the U.S. Caribbean, federal regulations also could make a substantial contribution to sustaining the queen conch resource. However, CFMC (1996a) reports that islands situated upstream in the Caribbean arc may provide the source for most conch settling off Puerto Rico and the USVI. Consequently, to the extent that larval transport occurs, pan-Caribbean efforts would be required to effectively manage queen conch resources.

Various international meetings have been held to discuss approaches for the assessment and management of this species, including the Queen Conch Stock Assessment and Management Workshop hosted by the Caribbean Council in 1999 (CFMC, CFRAMP 1999). The results from these studies have revealed that the resource is indeed heavily exploited (Valle-Esquivel 2002a). And the Council is considering in this amendment additional management measures to rebuild this overfished species.

The only federal regulation affecting the other twelve gastropods in the Caribbean conch resource FMU is the requirement that these species be landed with meat and shell intact. This regulation is not expected to benefit these species in a significant way, as they are believed to be landed in minimal numbers in federal waters, if at all. Information from the Academy of Natural Sciences of Philadelphia (2002) indicates that four of these species, including the Caribbean helmet, Caribbean vase, flame helmet, and whelk (West Indian top shell), probably do not occur in federal waters of the U.S. Caribbean.

6.1.1.1.2.3 Caribbean reef fish

The Caribbean reef fish FMU, as currently defined, contains virtually all reef fish species that are believed to be fished commercially, recreationally, for subsistence purposes, and for the aquarium trade. These species are identified in Table 3. Theoretically, defining the reef fish FMU to be all inclusive would be expected to provide indirect biological and ecological benefits, as it would provide the Council the authority to manage the take of all reef fish species to sustain catches over time.

The Council manages the reef fish fisheries through gear restrictions and prohibitions, areal and seasonal closures, and by establishing a minimum size limit on yellowtail snapper, and catch prohibitions on Nassau and Goliath grouper, seahorses, and foureye, banded, and longsnout butterflyfish (see Section 2.2.3). In reality, the degree to which reef fish benefit from federal management depends largely on the effectiveness of management measures established for these species in state waters. The distribution of catches between state and federal waters is unknown. However, the vast majority of catches are believed to derive from state waters, as only about 14% of the fishable habitat in the U.S. Caribbean occurs in the EEZ (Figure 1).

The current definition of the reef fish FMU does not identify complexes, or groups, of reef fish species that could be effectively managed as a unit. As a result, the status quo alternative requires that biological and management reference points, such as MSY, OY, MFMT, and MSST, be defined on a species-specific basis, or for the entire FMU, rather than tailored to the biology, ecology, and status of complexes of species that occur together, or are fished together and, thus, better managed as a unit.

Information on Caribbean fisheries is not adequate to define reliable management reference points on a species-specific basis. Defining management reference points to apply to the FMU as a whole would appear to present an unnecessary risk that, if taken, could be expected to have indirect adverse effects on the biological and ecological environment. Such an unrefined approach could prevent fishery managers from identifying "weak stocks," or specific species in the FMU that are overfished or experiencing overfishing, and that may be in need of special attention.

6.1.1.1.2.4 Caribbean coral reef resource

The Caribbean coral reef resource FMU, as currently defined, is sub-divided into two components. The first component includes coral reef-associated invertebrates and live rock that are marketed in the marine aquarium trade. The second component includes coral species that may not be marketed, but that support the coral reef communities of the U.S. Caribbean. Table 4 provides a complete list of species in the Caribbean coral reef resource FMU.

Defining the coral reef resource FMU to be all inclusive is believed to provide indirect biological and ecological benefits, as it provides the Council the authority to manage the take of ecologically important species that are marketable or that may be marketable in the future. The Council has prohibited the take, possession, and sale of gorgonians, stony corals, and any species in the coral reef resource FMU if attached or existing upon live rock, and has established regulations requiring that only dip nets, slurp guns, hands, and other non-habitat destructive gear types be used to harvest allowable corals. The Council also has required that those individuals harvesting allowable corals obtain a permit from the local or federal government. Because the affected species are generally sedentary, these regulations are believed to be effective in protecting those coral reef communities that occur in federal waters from the impacts of fishing.

6.1.1.1.2.5 Other affected species/resources

The potential adverse and/or beneficial indirect effects of FMU definitions to Caribbean Council-managed species described in Section 6.1.1 could ultimately affect species and resources that are not managed by the Council by impacting predator-prey relationships, competition, and other ecological functions/processes. For example, FMU alternatives that indirectly benefit Caribbean reef fish also could benefit sharks and other species that prey on reef fish. Conversely, these same alternatives could result in a reduction in abundance of species on which reef fish prey. Such an impact would not necessarily be perceived as adverse, but rather as beneficial, as it would indicate that the reef fish community is in the process of recovering a natural predatory-prey balance. Available information on predator-prey relationships, competition, and other ecological processes is summarized on a species-specific basis in Section 5.2.

6.1.1.1.3 Direct and indirect effects on social and economic environment and their significance

Retaining the current definitions of the Caribbean spiny lobster, Caribbean conch resource, and Caribbean reef fish FMUs in the Council's FMPs will likely have no significant direct effects on the social and economic environment since this alternative does not impact the resource, resource users, or current fishing practices (i.e., resource use patterns). Direct effects associated with changes in resource utilization rates would only occur with subsequent management measures. Maintaining the FMU designation simply preserves the universe of species that could be impacted by future management actions, and, as noted earlier, virtually all fisheries prosecuted by the commercial, recreational and subsistence sectors and/or for the aquarium and ornamental trade are included in the FMUs of the various FMPs. Thus, almost all species receive management protection.

Since Alternative 1 does not call for new resource use restrictions, no behavioral changes by the various fishing sectors and the communities dependent on or engaged in fishing are anticipated. Fishing sectors include, but are not limited to, commercial harvesters, charter sport-fishing, recreational and subsistence sectors. Similarly, fisher cooperatives, markets, marketing arrangements, support sector operations (e.g., marine industry operations, marinas, gear sale outlets, and other types of fishery support services), sport-fishing organizations and other related sectors such as diver operators may not experience changes either. The absence of likely behavioral changes by resource users and their communities suggests that there will be no significant indirect effects. No changes in historical, social and cultural dependency and engagement are anticipated either.

Since only 14% of fishable habitat in the U.S. Caribbean occurs in federal waters (Figure 1), granting the Council the authority to manage these stocks will likely have minimal indirect impacts on participants in the queen conch, reef fish, and spiny lobster fisheries. However, due to the difference in state boundaries between Puerto Rico and the USVI (i.e., 9 nm and 3 nm, respectively) and the USVI's greater dependence on federal waters, USVI fishermen may be more affected than Puerto Rico fishermen by any potential indirect effects resulting from this alternative.

6.1.1.1.4 Direct and indirect effects on administrative environment and their significance

Decisions about the composition of FMUs directly affect the administrative environment because FMUs define the specific species that are to be the target of conservation and management. The administrative effects of the status quo definitions of the Caribbean spiny lobster and coral reef resource FMUs are expected to positive in that they include those species that are believed to require federal protection.

Conversely, the administrative effects of the status quo definitions of the Caribbean conch resource and reef fish FMUs are expected to be negative because the Caribbean conch resource

FMU includes species that seldom (and possibly never) occur in federal waters (see Section 6.1.1.1.2.1.2) and the Caribbean reef fish FMU does not identify species that could be managed together as a unit based on the best available scientific information on an indicator species. These broad definitions could directly compromise the Council's and NMFS' ability to achieve legal mandates related to defining management reference points and preventing overfishing while achieving, on a continuing basis, the optimum yield from these fisheries.

The all-inclusive status quo definition of the Caribbean conch resource FMU could indirectly benefit federal fishery administrators by providing for their participation in fishery management decisionmaking at the state level. The Caribbean Council has a long history of making recommendations to the governments of Puerto Rico and the USVI related to better protecting threatened fish stocks and habitat.

6.1.1.2 Alternative 2 (Preferred). Redefine the FMUs and FMU sub-units in Council FMPs as detailed in Table 8. Delete from the Caribbean Conch Resource FMU the Caribbean helmet, *Cassis tuberosa*; Caribbean vase, *Vasum muricatum*; flame helmet, *Cassis flammea*; and whelk (West Indian top shell), *Cittarium pica*, leaving nine other species detailed in Table 2.

The FMUs and FMU sub-units that would be defined under this alternative are described in Table 8.

6.1.1.2.1 Direct and indirect effects on physical environment and their significance

With the exception of the Caribbean conch resource FMU, the composition of FMUs defined under this alternative would be consistent with the status quo. As discussed in Section 6.1.1.1.1, management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. The modification to the Caribbean conch resource FMU proposed by this alternative would not be expected to affect such interactions. Consequently, the effects of this alternative on the physical environment do not differ from those described in Section 6.1.1.1.1 for Alternative 1.

6.1.1.2.2 Direct and indirect effects on biological and ecological environment and their significance

6.1.1.2.2.1 Caribbean spiny lobster

This alternative for redefining FMUs would not affect the current definition of the Caribbean spiny lobster FMU. The potential direct and indirect effects of this definition to the biological and ecological environment are described in Section 6.1.1.1.2.1.

6.1.1.2.2.2 Caribbean conch resource

This alternative would retain queen conch (*Strombus gigas*) in the Caribbean conch resource FMU. It also would recognize as part of the FMU eight other species of gastropods which are identified in CFMC (1996a) and 50 CFR §622.2, but which were inadvertently excluded from the Council's previous Draft Comprehensive SFA Amendment. These are the:

- Atlantic triton's trumpet (*Charonia variegata*),
- Cameo helmet (*Cassis madagascarensis*),
- Green star shell (*Astrea tuber*),
- Hawkwing conch (*Strombus raninus*),
- Milk conch (*Strombus costatus*),
- Roostertail conch (*Strombus gallus*),
- True tulip (*Fasciolaria tulipa*), and
- West Indian fighting conch (*Strombus pugilis*).

The queen conch is the focal point of the Queen Conch FMP. This snail is a staple food in many Caribbean nations (including the U.S. Caribbean) and its shell is utilized in the ornamental trade. The other eight species are not believed to be of great commercial significance; there are no commercial landings of other conch species landed in Puerto Rico, but the USVI has averaged 1,616 lbs of "whelk" from 1994-2002, some of which could be species in the Queen Conch FMP (Table 5). But at least some may be occasionally marketed for food and/or as ornamentals. The Council included these species in the FMU thinking that they might be in need of management in the future (CFMC 1996a). Because these species are legally recognized as belonging to the Caribbean conch resource FMU, their retention in the FMU under this alternative would represent no change from the status quo.

This alternative would remove from the Caribbean conch resource FMU the remaining four species of conchs identified in 50 CFR §622.2, including the:

- Caribbean helmet (*Cassis tuberosa*)
- Caribbean vase (*Vasum muricatum*)
- Flame helmet (*Cassis flammea*), and
- Whelk (West Indian top shell) (*Cittarium pica*).

According to the Academy of Natural Sciences of Philadelphia (2002), the known depth distribution of these snails extends to only 27 m, and none have been recorded live in depths greater than 15 m. Consequently, it is not likely that they could be directly influenced by federal fishery management.

6.1.1.2.2.3 Caribbean reef fish

Preferred Alternative 2 does not add or delete any species from the Caribbean reef fish FMU. It does, however, formally recognize a number of distinct sub-units within the FMU. The first division of the FMU would separate "food fish" from "aquarium trade species." While the Caribbean Council made this distinction in Amendment 1 to the Reef Fish FMP (CFMC 1993), that amendment identified many species as belonging to both market categories. Furthermore, this distinction was not reflected in Table 2 of Appendix A (50 CFR §622.). This alternative classifies each species according to its primary use (i.e., food fish versus aquarium trade), in order to facilitate potential future management actions.

The following species would be moved from the aquarium trade species complex defined in CFMC (1993) to the "food fish complex," based on the determination that they are utilized primarily as food fish:

- *Holocentrus adscensionis* (squirrelfish)
- Holocentrids (unclassified squirrelfish)
- *Myripristis jacobus* (blackbar soldierfish)
- *Priacanthus arenatus* (bigeye)
- *Halichoeres radiatus* (puddingwife)
- *Bodianus rufus* (Spanish hogfish)
- *Sparisoma chrysopterum* (redtail parrotfish)
- *Scarus taeniopterus* (princess parrotfish)
- Scarids (unclassified parrotfish)
- *Pomacanthus paru* (French angelfish)
- *Pomacanthus arcuatus* (gray angelfish)
- *Holacanthus ciliaris* (queen angelfish)
- *Paranthias furcifer* (creole fish)
- *Epinephelus fulvus* (coney)
- *Epinephelus guttatus* (red hind)
- *Anisotremus virginicus* (porkfish)
- *Acanthurus coeruleus* (blue tang)
- *Acanthurus chirurgus* (doctorfish)
- *Balistes vetula* (queen triggerfish)
- *Xanthichthys ringens* (Sargassum triggerfish)
- *Canthidermes sufflamen* (ocean triggerfish)
- *Melichthys niger* (black durgon)
- *Aluterus scriptus* (scrawled filefish)
- *Cantherhines macrocerus* (whitespotted filefish)
- Monacanthids (unclassified filefishes)
- Ostracids (trunkfishes and cowfishes)

Refining the classification of these species to be consistent with more current data and information on how they are utilized is somewhat of a "house-keeping" task and, as such, is not expected to have direct impacts on the biological or ecological environment. However, when considered in concert with alternatives in Section 6.1.2 related to how aquarium trade species would be treated, this action could result in indirect impacts to the biological and ecological environment.

Under the current system, the Council has the authority to manage both food fish and aquarium trade species. With the adoption of Preferred Alternative 2 under Section 6.1.2, aquarium trade species would be moved to a "data collection only" category of the FMU. Consequently, current regulations that apply to aquarium species would be lifted. The potential impacts of removing those regulations are described in Section 6.1.2. They would not affect the species identified in the above list if this alternative were adopted because those species would be included in the food fish complex.

Additionally, this alternative sub-divides the "food fish complex" into various multispecies complexes based on biological, technical, social, economic, and other considerations (see Section 4.1.1.2; Table 8). This also is an administrative-type action, but is expected to indirectly benefit the biological and ecological environment by assisting managers in achieving biological goals.

Recognizing differences in the biology and status of species included in the Caribbean reef fish FMU and in the way in which they are harvested would help fishery scientists and managers to fine tune the definitions of biological reference points and stock status determination criteria required by the MSFCMA. For example, managers would have the flexibility to adopt a more conservative target control rule for stocks or complexes that are believed to be at risk because of their perceived status or because their life histories make them particularly vulnerable to fishing mortality. Under the current system, the poor condition of such "weak" stocks can be masked because the status of stocks in relationship to biological parameters is evaluated for the entire FMU as a whole.

Defining stock- or complex-specific biological parameters allows scientists and managers to better identify differences in the status of stocks and to tailor management measures in response. Managers also could consider the interactions of species in multispecies complexes to ensure that regulations do not promote bycatch. For example, if the status of silk snapper indicates that catch reductions are needed, measures to reduce catch could be applied to all species in Snapper Unit 1 (see Table 8) to ensure that silk snappers are not taken incidentally when targeting other species in that FMU sub-unit.

6.1.1.2.2.4 Caribbean coral reef resource

The preferred alternative removes the following species from the aquarium trade species sub-unit of the Caribbean coral reef resource FMU:

- Atlantic triton's trumpet (*Charonia tritonis*),
- Hawkwing conch (*Strombus raninus*),
- Milk conch (*Strombus costatus*),
- Roostertail conch (*Strombus gallus*), and
- West Indian fighting conch (*Strombus pugilis*).

The removal of these gastropods from the Caribbean coral reef resource FMU is intended to eliminate duplication among FMUs, as these species are already included in the Caribbean conch resource FMU. Consequently, it is not expected to have direct or indirect impacts on the biological or ecological environment. The selection of this alternative would make current regulations that restrict the take of aquarium trade species to hand-held dip nets and slurp guns no longer applicable to these species. But those regulations are not believed to benefit these gastropods, which generally are harvested by hand. The potential effects to the biological and ecological environment associated with retaining the remaining plants and invertebrates in the Caribbean coral reef resource FMU are described in Section 6.1.1.1.2.4.

6.1.1.2.2.5 Other affected species/resources

The potential adverse and/or beneficial indirect effects of FMU definitions to Caribbean Council-managed species described in Section 6.1.1.2.2.2 could ultimately affect the surrounding ecosystem by impacting the predator-prey relationships, competition, and other ecological functions/processes described in Section 5.2. For example, if the revision of the queen conch resource FMU described in Section 6.1.1.2.2.2.2 were to adversely affect the four gastropods proposed for deletion from the FMU under this alternative, prey species could increase in abundance. But it is important to reiterate that this alternative would not be expected to adversely affect those gastropods.

6.1.1.2.3 Direct and indirect effects on social and economic environment and their significance

6.1.1.2.3.1 Caribbean spiny lobster

This alternative for redefining FMUs would not affect the current definition of the Caribbean spiny lobster FMU. The potential direct and indirect effects of this definition to the social and economic environment are described in Section 6.1.1.1.3

6.1.1.2.3.2 Caribbean conch resource

Alternative 2 proposes removing Caribbean helmet (*Cassis tuberosa*), Caribbean vase (*Vasum muricatum*), Flame helmet (*Cassis flammea*), and Whelk (West Indian top shell) (*Cittarium pica*) from the current Caribbean conch FMU. This narrower definition of the conch resource FMU, would only include those species that have been documented to occur in federal waters.

Limiting the number of gastropod species in the conch resource FMU will likely have no direct effects on the social and economic environment because this is an administrative action that does not immediately impact the resource, resource users, or current fishing practices (i.e., resource use patterns). Removing some species from the FMU could have indirect social and economic effects because the Council's authority to manage the take of specific species is dependent on their inclusion in an FMU. But any indirect effects associated with this FMU alternative are expected to be minimal because the species it proposes to delete from the Caribbean conch resource FMU do not make up a significant share of the conch landings, particularly in federal waters (most of the conch resource is harvested at depths ranging between 45-95 feet). Rivera (1999) estimated that there are about 209 commercial conch fishers in Puerto Rico, 16 of them who fish in federal waters (beyond 9 nm); no full-time conch fishermen but 23 part-time conch fishermen from St. Thomas and St. John, with none of these fishing in federal waters; and 16 full-time and 12 part-time fishermen, with two of these working in federal waters off St. Croix. This further underscores that this alternative will likely have no (or a minimal) impact on fishers and fishing communities, unless Puerto Rico and the USVI impose future management measures that limit the harvest of these conch resources. Moreover, queen conch makes up the majority of the conch resource landings in both federal and state waters. Therefore, the Council forgoing the legal authority to manage take of these other conch species in federal waters will likely have no direct impact on the resource, current fishing practices, or fishing communities. However, the Council will retain the authority to manage the queen conch resource in the EEZ.

6.1.1.2.3.3 Caribbean reef fish resource

Alternative 2 proposes dividing the Caribbean reef fish FMU into two separate categories: "food fish" and "aquarium trade species." This alternative would categorize the reef fish resource according to the primary use of species as to facilitate future conservation and management actions. In addition, this alternative proposes to subdivide the "food fish" complex into different multispecies complexes (i.e., FMU sub-units).

The proposed re-classification of the Caribbean reef fish FMU will have no direct impacts on the resource, resource users, fishing practices, or fishing operations. Consequently, fishing communities, fisher cooperatives, market arrangements, support sector operations (e.g., marine industry operations, marinas, gear sale outlets, and other types of fishery support services), sport-fishing organizations, and other related sectors (e.g., dive operations) are not expected to experience any immediate effects.

However, this alternative will indirectly affect participants in the reef fish fishery by influencing the development and specification of management measures. Organizing food fish species into multispecies complexes is expected to indirectly benefit the socioeconomic environment by assisting fishery scientists and managers in developing more sustainable biological parameters and management measures. With adoption of Preferred Alternative 2 under Section 6.1.2, species included in the aquarium trade category defined by this alternative would be moved to a "data collection only" category of the Caribbean reef fish FMU, and current regulations that apply to aquarium trade species would be lifted. The potential socioeconomic impacts of rescinding those regulations are described in Section 6.1.2.1.3.

6.1.1.2.3.4 Caribbean coral reef resource

This alternative would remove the following species from the aquarium trade species sub-unit of the Caribbean coral reef resource FMU:

- Atlantic triton's trumpet (*Charonia tritonis*),
- Hawkwing conch (*Strombus raninus*),
- Milk conch (*Strombus costatus*),
- Roostertail conch (*Strombus gallus*), and
- West Indian fighting conch (*Strombus pugilis*).

The removal of these gastropods from the Caribbean coral reef resource FMU is intended to eliminate duplication among FMUs, as these species are already included in the Caribbean conch resource FMU. As a result, it will have no direct impacts on the resource, resource users, fishing practices, or fishing operations. Consequently, fishing communities, fisher cooperatives, market arrangements, support sector operations (e.g., marine industry operations, marinas, gear sale outlets, and other types of fishery support services), sport-fishing organizations, and other related sectors (e.g., dive operations) are not expected to experience any immediate effects.

However, this alternative may indirectly affect participants in the coral reef fishery by influencing the development and specification of management measures. Organizing food fish species into multispecies complexes is expected to indirectly benefit the socioeconomic environment by assisting fishery scientists and managers in developing more sustainable biological parameters and management measures. With the adoption of Preferred Alternative 2 under Section 6.1.2, species included in the aquarium trade category defined by this alternative would be moved to a "data collection only" category of the reef fish FMU, and current regulations that apply to aquarium trade species would be lifted. The potential socioeconomic impacts of rescinding those regulations are described in Section 6.1.2.2.3.

With the adoption of Preferred Alternative 2 under Section 6.1.3, species other than queen conch would be moved to a "data collection only" category of the Caribbean conch resource FMU, and current regulations that apply to those species would be lifted. The potential socioeconomic impacts of rescinding those regulations are described in Section 6.1.3.2.3.

6.1.1.2.4 Direct and indirect effects on administrative environment and their significance

Decisions about the composition of FMUs directly affect the administrative environment because FMUs define the specific species that are to be the target of conservation and management. This alternative would not change the current definition of the Caribbean spiny lobster FMU. This definition is expected to provide positive administrative effects in that it provides federal fishery managers the authority to manage the Caribbean spiny lobster, which is believed to require federal protection.

The new definitions of the Caribbean conch resource, reef fish, and coral reef resource FMUs proposed by this alternative also are expected to provide positive administrative effects. These new definitions would streamline and make more cost-effective the fishery management process by enabling fishery managers to focus their attention and limited resources only on those species that are believed to potentially benefit from federal fishery management. Additionally, they would identify species within each FMU that could be managed together with others in multispecies complexes to assist federal fishery managers in achieving legal mandates related to defining management reference points and preventing overfishing while achieving, on a continuing basis, the optimum yield from these fisheries.

Eliminating four gastropods from the Caribbean conch resource FMU could delay federal management action to conserve those species in the future should the need arise. Furthermore, such an action would likely reduce or eliminate the Council's ability to affect management of these species at the state level. But the need for federal involvement in the management of these four species is not anticipated.

6.1.1.3 Alternative 3. With the exception of the aquarium trade species sub-units in the Coral and Reef Fish FMPs, redefine the FMUs and FMU sub-units in Council FMPs to be consistent with those specified in Table 8. Redefine the aquarium trade species FMU sub-units to comprise those aquarium trade species recognized and managed by state governments, and that are not otherwise included in other sub-units of any FMU.

With the exception of the Caribbean reef fish and Caribbean coral reef resource FMUs, the FMUs defined under this alternative are consistent with the status quo. This alternative modifies the composition of the aquarium trade species sub-units within the Caribbean reef fish and Caribbean coral reef resource FMUs. That modification would not result in any additions to the current list of aquarium trade species. It would, however, result in a number of deletions. Species that would be deleted from the aquarium trade species sub-units of the Caribbean reef fish and coral reef resource FMUs if this alternative were to be adopted are identified in Tables 3 and 4, respectively .

6.1.1.3.1 Direct and indirect effects on physical environment and their significance

As discussed in Section 6.1.1.1.1, management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. The definitions of the Caribbean spiny lobster, conch resource, and reef fish FMUs proposed by this alternative would not be expected to affect such interactions (see Section 6.1.1.1.1).

Through the Coral FMP, the Council has prohibited the take, possession, and sale of gorgonians, stony corals, and any species in the Caribbean coral reef resource FMU if attached or existing upon live rock. This alternative would remove those organisms identified in Table 4 that might be attached to live rock from the purview of this prohibition. However, since those species would be illegal to harvest, posses, or export in Puerto Rico, it would not result in any jeopardy to those species; harvest of aquarium trade species is restricted to educational permits in the USVI.

6.1.1.3.2 Direct and indirect effects on biological and ecological environment and their significance

6.1.1.3.2.1 Caribbean spiny lobster

This alternative for redefining FMUs would not affect the current definition of the Caribbean spiny lobster FMU. The potential effects of this definition to the biological and ecological environment are described in Section 6.1.1.1.2.1.

6.1.1.3.2.2 Caribbean conch resource

This alternative for redefining FMUs would not affect the current definition of the Caribbean conch resource FMU. The potential effects of this definition to the biological and ecological environment are described in Section 6.1.1.1.2.2.

6.1.1.3.2.3 Caribbean reef fish

The effects of this alternative on the Caribbean reef fish FMU are the same as those described for FMU Alternative 2 (Section 6.1.1.2.2.3), with the exception that this alternative would remove the aquarium trade species identified in Table 3 from the purview of federal fishery management. As a result, current management measures regulating the take of these species in federal waters would no longer be applicable. These include a prohibition on the use of gear other than dip nets and slurp guns to harvest aquarium trade species, and a prohibition on the take and possession of seahorses, and of foureye, banded, and longsnout butterflyfish. The vast majority of these species are collected by divers in relatively shallow (< 40 m) waters, and, therefore, the fishery is predominantly, or entirely, prosecuted in state waters. Thus, the direct and indirect effects of removing these species from the purview of federal fishery management are believed to be minimal, but potentially beneficial since many species would be protected from harvest due to prohibitions in state waters.

6.1.1.3.2.4 Caribbean coral reef resource

The effects of this alternative on the Caribbean coral reef resource FMU are the same as those described for FMU Alternative 2 (Section 6.1.1.2.2.4), with the exception that this alternative would remove the aquarium trade species identified in Table 4 from the purview of federal fishery management.

Many of the species that this alternative proposes to eliminate are commonly encountered on coral habitat. If they were no longer included in the Caribbean coral reef resource FMU, they would no longer be subject to the Council's prohibition on the take, possession, and sale of species in the coral reef resource FMU that are attached or exist upon live rock. They also would no longer be subject to federal regulations requiring that only dip nets, slurp guns, hands, and other non-habitat destructive gear types be used to harvest allowable corals, or to regulations requiring that those individuals harvesting allowable corals obtain a permit from the local or federal government. These regulations are believed to be effective in protecting those coral reef communities that occur in federal waters from the impacts of fishing. However, since the USVI currently restricts the harvest of aquarium trade species to educational permits, and Puerto Rico prohibits the harvest, possession or exportation of all but eight invertebrates, in regard to the deletion of species from the Caribbean coral reef resource FMU, this alternative would not have any significant direct or indirect effect on the biological or ecological environment.

6.1.1.3.2.5 Other affected species/resources

The potential adverse and/or beneficial direct and indirect effects of the FMU definitions proposed by Alternative 3 to Caribbean Council-managed species described in Section 6.1.1.3.2 could ultimately affect the surrounding ecosystem by impacting the predator-prey relationships, competition, and other ecological functions/processes described in Section 5.2. However, it is expected that the alternative will not result in any significant direct or indirect effects.

6.1.1.3.3 Direct and indirect effects on social and economic environment and their significance

6.1.1.3.3.1 Caribbean spiny lobster

This alternative for redefining FMUs would not affect the current definition of the Caribbean spiny lobster FMU. The potential effects of this definition to the social and economic environment are described in Section 6.1.1.1.3.1.

6.1.1.3.3.2 Caribbean conch resource

This alternative for redefining FMUs would not affect the current definition of the Caribbean conch resource FMU. The potential effects of this definition to the social and economic environment are described in Section 6.1.1.1.3.2.

6.1.1.3.3.3 Caribbean reef fish

The effects of this alternative on the Caribbean coral reef resource FMU are the same as those described for FMU Alternative 2 (Section 6.1.1.2.3.3), with the exception that this alternative would remove the aquarium trade species identified in Table 3 from the purview of federal fishery management.

Removing these species from the purview of federal management will likely have no significant direct effect on the social and economic environment because, due to the fact that aquarium trade species are collected by divers, the majority of aquarium species' harvest occurs in state waters primarily due to water depth. Diver harvest in federal waters is probably limited to a small area of shelf-extension off southwestern Puerto Rico, while some deep water ornamentals may be taken by traps and also incidentally by commercial fishers in federal waters. However, specimens caught as bycatch in commercial gear are generally in poor condition, which does not facilitate their use in the aquarium trade. There is no commercial harvest of aquarium trade species in USVI waters. Presently, the only permits in USVI that allow the harvest of aquarium trade species have been granted to educational facilities.

While this alternative does not impose new resource use restrictions (which could potentially impact fisheries and fishing communities), it would establish consistent regulations with the states and introduce a *de facto* prohibition on aquarium trade species not specified in Puerto Rican fishery regulations. However, since those regulations are already in place for Puerto Rican waters where the majority of harvest occurs, no immediate behavioral changes by the resource users and their communities are anticipated. Likewise, fisher cooperatives, markets and market arrangements, support sector operations (e.g., marine industry operations, marinas, gear sale outlets, and other types of fishery support services), sport-fishing organizations and other related sectors such as diver operators will likely not be impacted either. The absence of likely behavioral changes by resource users and their communities suggests that there will likely be no significant indirect effects. No changes in historical, social and cultural dependency and engagement are for foreseen either.

6.1.1.3.3.4 Caribbean coral reef resource

The effects of this alternative on the Caribbean coral reef resource FMU are the same as those described for FMU Alternative 2 (Section 6.1.1.2.3.4), with the exception that this alternative would remove the aquarium trade species identified in Table 4 from the purview of federal fishery management. Further, the direct and indirect effects of this alternative is expected to be similar for aquarium trade species in the coral reef resource FMU to those documented in Section 6.1.1.3.3.3.

6.1.1.3.4 Direct and indirect effects on administrative environment and their significance

This alternative would not change the current definitions of the Caribbean spiny lobster or conch resource FMUs. Retaining the current definition of the queen conch resource FMU would fail to recognize that four of these species probably do not occur in federal waters. This is likely to compromise the Council's and NMFS' ability to achieve legal mandates related to defining management reference points, and to preventing overfishing while achieving, on a continuing basis, the optimum yield from each fishery.

This alternative would, however, remove a number of species in the aquarium trade species complex of the Caribbean reef fish and coral reef resource FMUs from the purview of federal fishery management, recognizing that many species currently managed by the Caribbean Council are captured primarily in state waters and, thus, are not likely to be influenced by federal fishery management.

Dividing the Caribbean reef fish FMU into sub-units for the purposes of conservation and management is expected to streamline and to make more cost-effective the fishery management process, by enabling fishery managers to focus their attention and limited resources on keystone, or indicator species. It also is expected to simplify fishery management by enabling fishery managers to develop and implement fishery management measures on a complex-specific basis.

6.1.1.4 Alternative 4. Delete the aquarium trade species from the Caribbean reef fish resource FMU.

This alternative would modify the definitions of the Caribbean reef fish FMU to exclude all species that are currently recognized as aquarium trade species in the Reef Fish FMP (Table 3).

6.1.1.4.1 Direct and indirect effects on physical environment and their significance

As discussed in Section 6.1.1.1.1, management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. The definition of the Caribbean reef fish FMU proposed by this alternative is not expected to affect such interactions (see Section 6.1.1.1.1). While this alternative would result in the elimination of regulations requiring that only dip nets and slurp guns be used to harvest aquarium trade species, coral habitat would continue to be protected by regulations prohibiting the use of poisons, drugs, and other chemicals and explosives to take reef fish, and by the MSFCMA mandate to minimize to the extent practicable the adverse effects of fishing gear on EFH.

6.1.1.4.2 Direct and indirect effects on biological and ecological environment and their significance

This alternative would not affect the current definition of the Caribbean spiny lobster, conch resource, and coral reef resource FMUs. A discussion on the potential effects to Caribbean reef fish and other resources follows.

6.1.1.4.2.1 Caribbean reef fish

This alternative would remove all aquarium trade species in the Caribbean reef fish FMU from the Council's jurisdiction. These species are identified in Table 3. As a result, current management measures regulating the take of these species in federal waters would no longer be applicable. These include a prohibition on the use of gear other than dip nets and slurp guns to harvest aquarium trade species, and a prohibition on the take and possession of seahorses, and of foureye, banded, and longsnout butterflyfish.

Removing these species from the purview of federal fishery management is not expected to result in a significant direct effect to the biological or ecological environment because the vast majority of aquarium trade collection activity off Puerto Rico occurs in state waters due to the depth limitations faced by divers. The aquarium trade species collection off the USVI is heavily regulated through that state's permit program. This alternative would in essence defer management of the aquarium trade to the respective states.

The marine ornamental fish industry exported 120 species of fish from Puerto Rico from 1998-2000, 47 of which are not included in the Caribbean Council's reef fish FMU. However, only 10 of those 120 species accounted for 76% of the exports, and only 17 of those species were harvested in numbers greater than 1,000 specimens during the three-year study period (Ojeda-Serrano *et al.* 2001). Furthermore, 2004 revisions to Puerto Rico's fishing regulations currently restricts harvest, possession, and exportation to only 20 reef fish species in the aquarium trade, all of which also have individual quotas.

Deleting the aquarium trade species from the Caribbean reef fish FMU could potentially result in an indirect effect by reducing the Council's ability to act in a timely fashion to conserve those species in the future should the need arise. However, the need for federal involvement in the management of these species is not anticipated.

6.1.1.4.2.2 Other affected species/resources

As discussed in Section 6.1.1.4.2.1, this alternative is not expected to directly or indirectly affect Caribbean-Council managed species in a positive or negative way. Consequently, it also is not expected to have a major impact on the predator-prey or other ecological relationships described in Section 5.2.

6.1.1.4.3 Direct and indirect effects on social and economic environment and their significance

Deleting the aquarium traded species categories from the Caribbean reef fish FMU will likely have no significant direct effects on the social and economic environment. While this alternative may impact the resource, resource users, current fishing practices (or resource use patterns), as well as potentially impacting various fishing sectors and the communities dependent on or engaged in fishing for aquarium trade species, and such effect is expected to be minor. Most of the ornamental fishery occurs in state waters rather than federal waters due to depth restrictions faced by divers collecting aquarium trade species. The USVI only allows fishing with special permit; these permits are reserved for research and educational uses.

While this alternative does not impose new resource use restrictions (which could potentially impact fisheries and fishing communities), it would establish consistent regulations with the states and introduce a *de facto* prohibition on aquarium trade species not specified in Puerto Rican fishery regulations. However, since those regulations are already in place for Puerto Rican waters where the majority of harvest occurs, no immediate behavioral changes by the resource users and their communities are anticipated. Likewise, fisher cooperatives, markets and market arrangements, support sector operations (e.g., marine industry operations, marinas, gear sale outlets, and other types of fishery support services), sport-fishing organizations and other related sectors such as diver operators will likely not be impacted either. The absence of likely behavioral changes by resource users and their communities suggests that there will likely be no significant indirect effects. No changes in historical, social and cultural dependency and engagement are for foreseen either.

6.1.1.4.4 Direct and indirect effects on administrative environment and their significance

Removing aquarium trade species from the purview of federal fishery management would relieve the Council and NMFS of the burden of defining management reference points and measures for these species based on limited, or no, catch data. However, the Council's Preferred Alternative 2 in Section 6.1.2 would grant this administrative relief without fully removing these species from the Caribbean reef fish FMU. Removing these species entirely from the Caribbean reef fish FMU could delay management action to conserve these species in the future should the need arise, although the need for federal involvement in the management of these species is not anticipated.

6.1.2 Additional options for aquarium trade species

Through the Coral FMP (CFMC, 1994), the Caribbean Council defined the coral FMU to include more than 160 species of coral, plants, and invertebrates that the Council was concerned could be adversely affected by increasingly serious anthropogenic impacts to coral reefs and potential impacts of the marine aquarium industry related to overfishing and habitat degradation. The Council implemented a number of management measures designed to address these problems, including a prohibition on the harvest of corals and on the use of explosives and chemicals in U.S. Caribbean fisheries and a regulation that limited the harvest of invertebrates (e.g., hard and soft corals, sponges, worms, mollusks, shrimps, crabs, starfish, sea urchins, sea squirts, marine algae, flowering plants) to gears that were demonstrated to be non-destructive to the associated habitat.

Through Amendment 2 to the Reef Fish FMP (CFMC 1993), the Council also assumed management responsibility for about 90 species of tropical fish, many of which were identified by Puerto Rico permit reports as being utilized by the marine aquarium industry. The vast majority of these species are collected by divers (via slurp gun, dip net, etc.) in relatively shallow (< 40 m) waters. Because the government of Puerto Rico has an extended jurisdiction over fisheries that extends nine nautical miles from the shoreline, and the 100-fathom (183 m) contour largely exists well within this boundary, most of the catch landed in Puerto Rico is assumed to be taken from state waters. However, there is a small area off southwest Puerto Rico where harvest by divers could occur in federal waters due to the extension of the shelf edge. There may also be a few species harvested from federal waters off Puerto Rico because the life stage at which they are collected for the aquarium trade is associated with deeper waters.

Additionally, some aquarium trade species caught incidental to the commercial fish trap fisheries operating off Puerto Rico and the USVI could enter the ornamental market. In contrast to Puerto Rico, the jurisdiction of the USVI extends only three miles from the shoreline, which broadens the area in federal waters in which the collection of tropicals could occur. But little if any aquarium trade activity has been reported in federal waters off the USVI (Uwate, pers. comm.). It is generally assumed that most of the tropical collection throughout the U.S. Caribbean occurs in state waters. The USVI fishery agency manages the take of aquarium trade species through a permit system, with associated reporting requirements. Currently, permits are limited to marine education facilities.

The marine ornamental fish industry exported 120 species of fish from Puerto Rico from 1998-2000, 47 of which are not included in the Caribbean Council's reef fish FMU. However, only 10 of those 120 species accounted for 76% of the exports, and only 17 of those species were harvested in numbers greater than 1,000 specimens during the three-year study period (Ojeda-Serrano *et al.* 2001). Furthermore, 2004 revisions to Puerto Rico's fishing regulations currently restricts harvest, possession, and exportation to only 20 reef fish species in the aquarium trade, all of which also have individual quotas.

Since USVI restricts the harvest of aquarium trade species to a limited number of permits, the majority of harvest likely occurs off Puerto Rico. Further, since these species are hand-harvested, harvest activities would be restricted to depths attainable by SCUBA. Therefore, it could be assumed that the vast majority of aquarium trade species are harvested from the shallower state waters within Puerto Rico's nine-mile boundary. This is also supported by the fact that the vast majority of reef habitat occurs in state waters off Puerto Rico (Figure 1).

6.1.2.1 Alternative 1. No action.

The list of aquarium trade fish species was identified in Amendment 2 to the Reef Fish FMP. However, current regulations broadly define a marine aquarium fish as a Caribbean reef fish that is smaller than 5.5 inches (14.0 cm), TL (§622.41(b)). Other regulations that pertain to the aquarium trade include the prohibition on gear aside from dip nets and slurp guns (§622.41(b)); a prohibition on the harvest and possession of foureye, banded, and longsnout butterflyfish, as well as seahorses (§622.32(b)(1)(ii)); and the prohibition on the sale or purchase of live red hind or mutton snapper for use in the marine aquarium trade (§622.45(b)).

6.1.2.1.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat, either through gear impacts to bottom habitat or through the direct harvest of bottom habitat. Retaining management authority over aquarium trade species in the Caribbean reef fish FMU would not be expected to affect such interactions (see Section 6.1.1.4.1).

6.1.2.1.2 Direct and indirect effects on biological and ecological environment and their significance

This alternative would not affect the definition or management of species in the Caribbean spiny lobster or Caribbean conch resource FMUs. Therefore, no significant direct or indirect impacts are expected pertaining to those FMUs. A discussion of the potential effects associated with a decision to continue managing aquarium trade species in the Caribbean reef fish and coral reef resource FMUs follows.

6.1.2.1.2.1 Caribbean reef fish

Theoretically, retaining management authority for the aquarium trade species in the Caribbean reef fish FMU would be expected to provide indirect benefits to the biological and ecological environment, as it would enable the Council to manage the take of these species to sustain catches over time. Current management measures regulating the take of aquarium trade species in federal waters include a prohibition on the use of gear other than dip nets and slurp guns to harvest aquarium trade species, and a prohibition on the take and possession of seahorses, and of foureye, banded, and longsnout butterflyfish.

In reality, the degree to which aquarium trade species benefit from federal management depends largely on the effectiveness of management measures established for these species in state waters. The distribution of catches between state and federal waters is unknown. However, the vast majority of catches are believed to derive from state waters, as only about 14% of the fishable habitat in the U.S. Caribbean occurs in the EEZ (Figure 1). As aquarium trade species are predominantly, if not entirely, harvested by SCUBA divers, such activities are significantly constrained by water depth. Therefore, the influence of federal fishery management on these species is believed to be limited.

6.1.2.1.2.2 Caribbean coral reef resource

Retaining management authority for the aquarium trade species in the Caribbean coral reef resource FMU would be expected to provide indirect benefits to the biological and ecological environment, as it would enable the Council to manage the take of these species. The Council has prohibited the take, possession, and sale of gorgonians, stony corals, and any species in the coral reef resource FMU if attached or existing upon live rock, and has established regulations requiring that only dip nets, slurp guns, hands, and other non-habitat destructive gear types be used to harvest allowable corals. The Council also has required that those individuals harvesting allowable corals obtain a permit from the local or federal government. Because the affected species are generally sedentary, these regulations are believed to be effective in protecting those coral reef communities that occur in federal waters from the impacts of fishing.

However, the states also have implemented regulations that afford protection to coral reef resources. The USVI requires permits for aquarium species collection, and have only issued such permits to educational entities. Furthermore, Puerto Rico amended their fishing regulations in 2004 that restricts the harvest, possession, and exportation of invertebrates included in the coral reef resource FMU to eight species.

6.1.2.1.2.3 Other affected species/resources

Should Caribbean reef fish and coral reef resources benefit from this alternative, the ecosystem that supports those resources would be expected to benefit as well. Healthy coral reef communities are characterized by healthy predator-prey relationships and other ecological functions/processes described in Section 5.2. As described in Section 6.1.2.1.2.1, the benefits of this alternative to reef fish are expected to be minimal, as the vast majority of the populations of managed species occur in state waters. Thus, the benefits to other affected species/resources associated with sustaining healthy reef fish communities are expected to be minimal as well. In contrast, the benefits of this alternative to coral reef resources described in Section 6.1.2.1.2.2 could be more significant. Thus, this alternative also could provide significant benefits to finfish and invertebrates that depend on healthy coral reef communities for their growth, development, and survival.

6.1.2.1.3 Direct and indirect effects on social and economic environment and their significance

Preserving the status quo will have no significant direct effects on the social and economic environment since this alternative does not impact the resource, resource users, current fishing practices (or resource use patterns) nor does it impact various fishing sectors and the communities dependent on or engaged in fishing. Fishing sectors include, but are not limited to, commercial harvesters, charter sport-fishing, recreational and subsistence sectors. Direct effects associated with changes in resource utilization rates would only occur with subsequent management measures.

However, since this alternative would require the development of stock status parameters, it could potentially lead to future management measures that could restrict resource use, resulting in potential behavioral changes by the resource users and their communities. Similarly, fisher cooperatives, markets and market arrangements, support sector operations (e.g., marine industry operations, marinas, gear sale outlets, and other types of fishery support services), sport-fishing organizations and other related sectors such as diver operators may be impacted, but those impacts, if any, are expected to be minor.

6.1.2.1.4 Direct and indirect effects on administrative environment and their significance

This alternative would require the Council and NMFS to define management reference points and status determination criteria for aquarium trade species based on limited catch data, and to manage those species consistent with defined biological goals. As noted previously, it is unlikely that federal management would have much effect on aquarium trade species in the Caribbean reef fish FMU due to the predominance of the species, and the fisheries that rely on those species, in state waters. Further, since the USVI strictly regulates aquarium trade collection to only two permit holders, and Puerto Rico recently amended their fishing regulations to permit the collection of only 20 reef fish species, the impact of any federal management on reef fish species in the aquarium trade is expected to be minor.

Retaining management authority for the aquarium trade species in the Caribbean coral reef resource FMU would theoretically be expected to provide indirect benefits to the administrative environment, as it would enable the Council to manage the take of these species and protect EFH. However, the states also have implemented regulations that afford protection to coral reef resources. The USVI requires permits for aquarium species collection, and have only issued such permits to educational entities. Furthermore, Puerto Rico amended their fishing regulations in 2004 that restricts the harvest, possession, and exportation of invertebrates included in the coral reef resource FMU to eight species. Therefore, and administrative effects related to EFH management stemming from this alternative are expected to be minor.

6.1.2.2 Alternative 2 (Preferred). Move aquarium trade species from a management to a data collection only category.

This alternative would acknowledge the Council's conservation mandate by retaining aquarium trade species in their respective FMUs, but would recognize that there is little need to manage these species in federal waters at this time because the majority of harvest activity occurs in state waters. There is a general lack of specific biological information on almost all of the 200 species in the aquarium trade. A decision to retain these species in the management unit for data collection purposes only (50 CFR §600.320(d)(2)) would acknowledge the need to obtain more data and information on these species and would be consistent with the objectives of the Coral and Reef Fish FMPs.

6.1.2.2.1 Direct and indirect effects on physical environment and their significance

The impacts of this alternative to the physical environment would be the same as those described in Section 6.1.1.4.1 under FMU Alternative 4. This alternative differs from FMU Alternative 4 only in that it would retain aquarium trade species in the Caribbean reef fish FMU for data-collection purposes only, rather than eliminate them entirely from the FMU.

6.1.2.2.2 Direct and indirect effects on biological and ecological environment and their significance

This alternative would not affect the definition or management of species in the Caribbean spiny lobster or Caribbean conch resource FMUs. Therefore, there would not be any direct or indirect impacts associated with this alternative expected relative to those FMUs. A discussion on the potential impacts to Caribbean reef fish, coral, and other resources follows

6.1.2.2.2.1 Caribbean reef fish

The effects of this alternative on the Caribbean reef fish FMU are identical to those described in Section 6.1.1.4.2.1.3 under FMU Alternative 4, with one exception. While FMU Alternative 4 would completely remove all aquarium trade species from the reef fish FMU, this alternative would retain those species in the FMU, but would relieve the Council of the responsibility to develop reference points and measures for their conservation and management. As explained in Section 6.1.1.4.2.1.3, removing these species from the purview of federal fishery management is not expected to result in a significant adverse effect to the biological or ecological environment because the vast majority of aquarium trade collection activity off Puerto Rico occurs in state waters. And aquarium trade species collection off the USVI is heavily regulated through that state's permit program.

A decision to retain aquarium species in a data-collection only category of the reef fish FMU would indicate that the Council believes these species may require more active conservation and management in federal waters in the future, or that it is likely to have more influence over state management of these species if it retains management authority over these species in federal waters.

While the Reef Fish FMP has included most species utilized in the aquarium trade in the reef fish FMU, the Council has implemented few management measures for the conservation and management of these species (i.e., species-specific limitations, quotas, daily species limits, etc.). This is because most aquarium species collection occurs in state waters due to the depth limitations confronted by divers in federal waters, and because reef habitat is more abundant in shallower, state waters.

As aquarium trade species are collected alive from the marine environment for the purposes of exhibition, observation, or to maintain them in captivity, it is paramount that they be collected in a manner that will insure their survival until sale and/or exportation. Therefore, it is unlikely that new gears would be employed to harvest these species that would result in significant direct or indirect biological impacts, aside from those associated with removing the target species.

Furthermore, aquarium trade collectors are highly selective, and typically pursue those species which are valued and demanded by aquarists.

For example, the *Gramma loreto* was the species most sought after by Puerto Rican collectors from 1998-2000. During that period of time, 37,560 specimens were exported from Puerto Rico, averaging approximately 12,500 fish per year. However, only 1,802 specimens of the tenth most sought after species, *Centropyge argi*, were collected over the same time period, an average of approximately 600 fish per year. While there were 120 aquarium trade species exported from Puerto Rico from 1998-2000, the vast majority (75%) of these are subject to harvest levels well under 100 specimens per year. Moreover, almost 50% of all aquarium trade species are subject to landings on the scale of 10 specimens per year (Ojeda-Serrano *et al.* 2001), assuming that the number of specimens exported is equivalent to specimens landed.

The industry can only expand at a rate that it can support, in that collectors would have to have sufficient storage facilities on land to maintain specimens in captivity before exportation or sale. Many times, specimens need to be isolated in individual tanks or compartments, to insure they are not harassed by competitive or predatory species. Therefore, there are economic constraints that aquarium trade collectors face, which may prevent uncontrolled expansion of the industry.

6.1.2.2.2.2 Caribbean coral reef resource

This alternative would retain coral reef species in the FMU, but would relieve the Council of the responsibility to develop reference points and measures for their conservation and management. As explained in Section 6.1.1.4.2.1.4, removing these species from the purview of federal fishery management could adversely affect the biological or ecological environment, as federal regulations are believed to be effective in protecting those coral reef communities that occur in federal waters from the impacts of fishing gear.

A decision to retain aquarium species in a data-collection only category of the coral reef resource FMU would indicate that the Council believes these species may require more active conservation and management in federal waters in the future, or that it is likely to have more influence over state management of these species if it retains management authority over these species in federal waters.

6.1.2.2.2.3 Other affected species/resources

Moving aquarium trade species in the reef fish FMU to a data-collection only category would not be expected to directly or indirectly affect the status of those species, or of other affected species.

6.1.2.2.3 Direct and indirect effects on social and economic environment and their significance

Moving from a management to a data collection category will likely not cause significant direct effects on the social and economic environment since this alternative does not impact the resource, resource users, or current fishing practices; nor does it impact various fishing sectors and the communities dependent on or engaged in fishing because most of the harvesting occurs in state waters. As noted earlier, harvesting in state waters requires a permit. Since most of the harvesting occurs in inshore waters, limiting the Council's ability to regulate these species will probably result in no behavioral changes. Resource users and their communities will continue to harvest as usual. The absence of likely behavioral changes suggests that there will probably be no significant indirect effects. No changes in historical, social and cultural dependency and engagement are anticipated either.

6.1.2.2.4 Direct and indirect effects on administrative environment and their significance

This alternative would acknowledge the Council's conservation mandate by retaining aquarium trade species in their respective FMUs, but would indicate that the Council believes there is little need to manage these species in federal waters at this time because the majority of harvest activity occurs in state waters. There is a general lack of specific biological information on almost all of the 200 species in the aquarium trade. These data deficiencies would make it virtually impossible to define reliable biological reference points and status determination criteria for aquarium trade species. Even the use of proxies or representative species would be complicated due to the biological diversity of the numerous species and the lack of knowledge of their respective life histories.

This alternative also would require the revocation of the legal definition of a "marine aquarium fish" as a Caribbean reef fish that is smaller than 5.5 inches (14.0 cm) TL (50 CFR §622.41(b)). This definition actually conflicts with the definition of aquarium trade species established by the Council through Amendment 2 to the Reef Fish FMP. Therefore, this alternative would rectify an existing regulatory issue, in that it would amend Table 2 of Appendix A to the Part 622 regulations to specify which species are aquarium trade species, based on the list provided by the Council in Amendment 2. Furthermore, this alternative would also require the revocation of the prohibition on the harvest and possession of foureye, banded, and longsnout butterflyfish, as well as seahorses (§622.32(b)(1)(ii)). These species-specific harvest limitations in §§622.32(b)(1)(ii) have little to no impact due to the fact that harvest of these species continues to occur in state waters, and that the majority of the habitat that these species depend on, and are harvested from, occurs in state waters.

Inclusion in a data collection only category would result in no specification of MSY, OY, or other stock status determination criteria for these species due to no real need for federal conservation and management of these species. Therefore, they are excluded from discussion in those sections. As mentioned before, due to the lack of need of conservation and management of these species, not specifying the various stock status determination criteria for aquarium trade species will not result in any effects to those species.

6.1.3 Additional options for Caribbean conch resources

While the Queen Conch FMP (CFMC 1996a) actively manages only queen conch, the plan includes 12 other species in the Caribbean Conch Resource FMU, as defined by 50 CFR §622.2. The Queen Conch FMP (CFMC 1993) cited the rationale for including these species as: "Since other marine gastropods are occasionally marketed, they must be included in the fishery management unit." This FMU includes the following species:

- Atlantic triton's trumpet, *Charonia variegata*
- Cameo helmet, *Cassis madagascarensis*
- Caribbean helmet, *Cassis tuberosa*
- Caribbean vase, *Vasum muricatum*
- Flame helmet, *Cassis flammea*
- Green star shell, *Astrea tuber*
- Hawkwing conch, *Strombus raninus*
- Milk conch, *Strombus costatus*
- Queen conch, *Strombus gigas*
- Roostertail conch, *Strombus gallus*
- True tulip, *Fasciolaria tulipa*
- West Indian fighting conch, *Strombus pugilis*
- Whelk (West Indian top shell), *Cittarium pica*

According to a citation in the Caribbean Council's Draft Essential Fish Habitat Environmental Impact Statement (Academy of Natural Sciences of Philadelphia 2002), several species have been documented strictly in state waters. These include:

- Caribbean helmet, *Cassis tuberosa* – depth range 0 to 27m (live 0 to 9m)
- Caribbean vase, *Vasum muricatum* – depth range 0 to 15m (live 0.3 to 15m)
- Flame helmet, *Cassis flammea* – depth range 1 to 12m (live 3 to 5m)
- Whelk (West Indian top shell), *Cittarium pica* – depth range 0 to 2m (live 0 to 0m)

6.1.3.1 Alternative 1. No action.

Data deficiencies would make it virtually impossible to define reliable biological reference points and stock status determination criteria for conch species aside from queen conch. Furthermore, the use of proxies or representative species would be complicated due to the biological diversity of the numerous species and the lack of knowledge of their respective life histories.

6.1.3.1.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with the sea floor. Since the primary fishing method for queen conch is through hand harvest, this alternative would not be expected to directly or indirectly affect the physical environment over the short or long term.

6.1.3.1.2 Direct and indirect effects on biological and ecological environment and their significance

This alternative would not affect (directly or indirectly) the definition or management of species in the Caribbean spiny lobster, reef fish, or coral reef resource FMUs. A discussion on the potential impacts to Caribbean queen conch and other resources follows.

6.1.3.1.2.1 Caribbean conch resource

Theoretically, retaining management authority for all gastropods in the Caribbean conch resource FMU would be expected to provide indirect benefits to the biological and ecological environment, as it would enable the Council to manage the take of these species to sustain catches over time. The Council manages the fishery for queen conch primarily through a minimum size limit, commercial catch limit, recreational bag limit, and an annual spawning season closure. As noted in Section 6.1.1.1.2.1.2, the degree to which these management measures benefit the resource is unknown, but is believed to depend largely on the effectiveness of management measures established for this species in state and international waters, and on the availability of suitable habitat (CFMC 1996a).

The only federal regulation affecting the remaining twelve gastropods in the Caribbean conch resource FMU is the requirement that these species be landed with meat and shell intact. This regulation is not expected to benefit these species in a significant way, as they are believed to be landed in minimal numbers, if at all. Information from the Academy of Natural Sciences of Philadelphia (2002) indicates that four of these species, including the Caribbean helmet, Caribbean vase, flame helmet, and whelk (West Indian top shell), probably do not occur in federal waters of the U.S. Caribbean.

6.1.3.1.2.2 Other affected species/resources

Any indirect benefits to the queen conch resource provided by this alternative could effect the surrounding ecosystem by influencing the predator-prey relationships, competition, and other ecological functions/processes described in Section 5.2.

6.1.3.1.3 Direct and indirect effects on social and economic environment and their significance

Preserving the status quo will have no significant direct effects on the social and economic environment since this alternative does not impact the resource, resource users, current fishing practices (or resource use patterns) nor does it impact various fishing sectors and the communities dependent on or engaged in fishing. Fishing sectors include, but are not limited to, commercial harvesters, charter sport-fishing, recreational and subsistence sectors. Direct effects associated with changes in resource utilization rates would only occur with subsequent management measures.

Since this alternative does not call for new resource use restrictions (which could potentially impact fisheries and fishing communities), no behavioral changes by the resource users and their communities are anticipated. Similarly, fisher cooperatives, markets and market arrangements, support sector operations (e.g., marine industry operations, marinas, gear sale outlets, and other types of fishery support services), sport-fishing organizations and other related sectors such as diver operators will likely not be impacted either. The absence of likely behavioral changes by resource users and their communities suggests that no there will likely be no significant indirect effects. No changes in historical, social and cultural dependency and engagement are anticipated either.

6.1.3.1.4 Direct and indirect effects on administrative environment and their significance

This alternative would require the Council and NMFS to define management reference points and status determination criteria for all gastropods in the queen conch resource FMU based on limited, or no, catch data, and to manage those species consistent with defined biological goals. Data deficiencies would make it virtually impossible to define reliable biological reference points and status determination criteria for conch species, excluding queen conch. Further, the use of representative species would be complicated due to the biological diversity of the numerous species and the lack of knowledge of their respective life histories.

On the other hand, assuming responsibility for species that are captured primarily (or totally) in state waters would provide federal fishery managers the incentive to influence fishery management decision-making at the state level. The Caribbean Council has a long history of making recommendations to the governments of Puerto Rico and the USVI related to better protecting threatened fish stocks and habitat.

6.1.3.2 Alternative 2 (Preferred). Move all species in the Caribbean conch resource FMU, with the exception of queen conch, from a management to a data collection only category.

There is a general lack of specific biological information on these species. Additionally, catches of those species are believed to be minor. A decision to retain these species in the FMU for monitoring purposes only (50 CFR §600.320(d)(2)) would acknowledge the need to obtain more data and information on these species, and would be consistent with the objectives of the Queen Conch FMP.

6.1.3.2.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with the sea floor. Therefore, this alternative would not be expected to directly or indirectly affect the physical environment over the short or long term.

6.1.3.2.2 Direct and indirect effects on biological and ecological environment and their significance

This alternative would not affect (directly or indirectly) the definition or management of species in the Caribbean spiny lobster, reef fish, or coral reef resource FMUs. A discussion on the potential impacts to Caribbean queen conch and other resources follows.

6.1.3.2.2.1 Caribbean conch resource

This alternative would make inapplicable to all conch species, excluding queen conch, the federal regulation requiring that all conch species be landed with meat and shell intact. This would not be expected to adversely affect the biological or ecological environment because these species are believed to be landed in minimal numbers, if at all. Information from the Academy of Natural Sciences of Philadelphia (2002) indicates that four of these species, including the Caribbean helmet, Caribbean vase, flame helmet, and whelk (West Indian top shell), probably do not occur in federal waters of the U.S. Caribbean.

While the Council originally included in the queen conch resource FMU virtually all conch species that could be harvested and marketed, including a species in an FMU due to a potential threat of exploitation may not always be warranted. Management is not automatically justified simply because a resource is utilized, especially if only at very low levels. In all likelihood, any exploitation of these species that does occur would be sporadic, at low levels, and confined to state waters. This is due to the fact that most of these conch species occur in shallow water, and the fisheries that may exploit them would be constrained due to the depth limitations confronted by divers in federal waters. Therefore, the placement of these lesser conch species into a data-collection only category of the queen conch resource FMU would be expected to have little direct or indirect effect on the biological or ecological environment, or on the species themselves.

6.1.3.2.2.2 Other affected species/resources

Should Caribbean conch resources be adversely affected by this alternative, predator-prey relationships and other ecological functions provided by these resources would be expected to be adversely affected as well. Available information on those relationships is summarized in Section 5.2.

6.1.3.2.3 Direct and indirect effects on social and economic environment and their significance

Re-classifying the conch resource FMU will likely have no direct effects on the social and economic environment because these species are not believe to make up a significant share the conch landings. Queen conch makes up the majority of the conch resource landings. Furthermore, since most of the commercial harvest of the conch resource, which also includes queen conch, is conducted in Commonwealth or Territorial waters (at depths between 45-95 feet), the proposed re-classification to a data collection category will likely have no impact on the resource, current fishing practices and fishing communities. Federal regulations only apply to waters in EEZ outside the Commonwealth of Puerto Rico and the Territory of the US Virgin Islands waters. However, the Council will continue to have the authority to manage the mainstay conch species, queen conch, in the EEZ. As noted earlier, Rivera (1999) estimated that are about 209 commercial conch fishers in Puerto Rico, 16 of them who fish in federal waters (beyond 9 nautical miles) and 51 commercial conch fishers in USVI, 2 of them who fish in federal waters (beyond 3 nautical miles), further underscoring that this alternative will have no (or a minimal) impact on fishers and fishing communities.

Similarly, the re-classification of the conch FMU will likely have no indirect impacts since no behavioral changes in fishing practices (or resource use patterns), which could impact various fishing sectors and the communities dependent on or engaged in fishing, are anticipated. For behavioral changes in existing fishing practices to occur, Commonwealth and Territorial regulations will likely have to be amended since the lion's share of the catch occurs in Commonwealth and Territorial waters. It is not anticipated that this proposed alternative would trigger regulatory changes at the Commonwealth and Territorial levels. No changes in historical, social and cultural dependency and engagement are anticipated either.

6.1.3.2.4 Direct and indirect effects on administrative environment and their significance

Data deficiencies would make it virtually impossible to define reliable biological reference points and stock status determination criteria for these minor conch species, should they be retained in the FMU for active management. There are no current regulations applicable to these conch species that would have to be revoked, should the Council opt to place these species into a data collection category.

Inclusion in a data collection only category would result in no specification of MSY, OY, or other stock status determination criteria for these species due to no real need for federal conservation and management of these species. Therefore, they are excluded from discussion in those sections. As mentioned before, due to the lack of need of conservation and management of these species, not specifying the various stock status determination criteria for aquarium trade species will not result in any effects to those species. This alternative is not expected to result in any significant direct or indirect impacts to the administrative environment.

6.2 Biological reference points and stock status determination criteria

6.2.1 Maximum sustainable yield (MSY)

Defining MSY would not directly affect the physical, biological and ecological, or social/economic environments because this is an administrative action that simply provides fishery managers with a reference point against which to measure the status and performance of a fishery. However, it could result in indirect environmental effects because MSY is used to determine the maximum rate of fishing mortality that can be applied to a fishery over the long term and the resultant allowable biological catch levels. This section describes the potential indirect effects of the various MSY alternatives on the environment.

6.2.1.1 Alternative 1. No action. Retain current definitions of MSY (if any).

6.2.1.1.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interaction of fishing gears with bottom habitat. MSY estimates can influence the degree of fishing gear interactions with bottom habitat by defining what constitutes a sustainable rate of fishing mortality. However, the number, nature, and extent of such interactions are more greatly influenced by the type of management measures implemented to manage the extent and distribution of fishing effort.

The major gear types used in the spiny lobster, conch, reef fish, and coral reef fisheries are described in Sections 5.3.3 through 5.3.6. These include vertical line gear, traps, gill and trammel nets, spear fishing, and hand harvest. Vertical line gear has the potential to snag and entangle bottom structures, which can result in breakage and abrasions (Barnette 2001). Traps can cause damage to coral habitat, which offers significant benthic structure in the U.S. Caribbean (Barnette 2001). Gill and trammel nets generally do not affect bottom habitat, but can snare and break off benthic structures if set near coral and other hard bottom habitats (Barnette 2001). Anchors set by fishing vessels can also potentially damage or alter benthic structure. According to Bohnsack (in Hamilton 2000), “favorite” fishing areas such as reefs are targeted and revisited multiple times. The cumulative effects of repeated anchoring could damage (e.g., reduce vertical relief) hard bottom areas where fishing occurs.

6.2.1.1.2 Direct and indirect effects on biological and ecological environment and their significance

MSY represents the largest average catch that can be sustained from a stock under average environmental conditions. If overestimated, this parameter could lead to overfishing. Because fisheries tend to remove the largest, fastest growing, oldest, and most genetically fit members of a population, continued heavy fishing pressure over many generations can reduce the size distribution of a population, depress the mean size at age and maturity, and decrease genetic diversity (PDT 1990). Overfishing also may result in changes in the size/age at sexual transition of hermaphroditic species, in growth overfishing, and/or in recruitment failure.

The number of young that are produced each year (recruitment) is generally highly variable due to natural variability in environmental factors that affect the survival of eggs and larvae. A stock maintained at a sustainable biomass level can withstand several years of poor recruitment that may occur due to natural factors. However, recruitment also depends on the abundance of adults. In addition to reducing stock biomass, heavy fishing pressure reduces the number of age classes in the stock. This can make it more difficult for stocks to recover from several years of poor recruitment that may occur due to natural environmental conditions.

Conversely, if MSY were underestimated, catches would likely be constrained to a level that would cause stock biomass to increase above B_{MSY}. Maintaining the stocks at high biomass levels would likely benefit the biological and ecological environment by reducing the potential for overexploitation due to scientific uncertainty, poor recruitment, and other environmental factors. Consequently, the age and size structure, sex ratio, and genetic integrity of a stock is expected to better approximate more natural levels as fishing pressure is reduced.

Council-managed species are part of a complex reef ecosystem, in which co-occurring species compete for resources, such as habitat and food. Consequently, any effects realized by one stock are likely to impact in some way the ecological community. For example, the abundance of piscivorous and herbivorous fishes could increase (or decrease) in response to a decrease (or increase) in the abundance of apex predators, such as the large groupers and jacks. This, in turn, could lead to a ripple effect, affecting the abundance of plants and invertebrates that are consumed by these piscivorous and herbivorous fishes.

6.2.1.1.2.1 Caribbean spiny lobster

The estimate defined by MSY Alternative 1 for the Caribbean spiny lobster (830,000 lbs; Table 9) is the highest of all those estimates considered. Consequently, this alternative would be expected to support the highest rate of fishing mortality on that species relative to the other alternatives.

6.2.1.1.2.2 Caribbean conch resource

The estimate defined by MSY Alternative 1 for the queen conch (738,000 lbs; Table 9) is the highest of all those estimates considered. Consequently, this alternative would be expected to support the highest rate of fishing mortality on that species relative to the other alternatives.

6.2.1.1.2.3 Caribbean reef fish

MSY Alternative 1 would retain the aggregate MSY estimate for all food fish species in the Caribbean reef fish FMU (7,700,000 lbs; Table 9). That estimate is much greater than those that would be defined by MSY Alternatives 2 (3,232,000 lbs; Table 9), 3 (0 lbs; Table 9), and 4 (3,894,000 lbs; Table 9). Consequently, this alternative would be expected to support the highest level of fishing mortality on food fish species in the reef fish FMU relative to the other alternatives.

Some of these species, including the graysby, coney, red hind, and red grouper, are protogynous, functioning first as females, then as males. This reproductive strategy may make them particularly vulnerable to fishing because fisheries that target older, larger individuals may reduce the number of males that enter the population. Reducing the density of a population (Bohnsack 1999) and the proportion of males in a population (Coleman *et al.* 1999) also reduces the genetic diversity of a population, making it less resilient to environmental change (Bohnsack 1999). Additionally, some species, such as the Goliath and Nassau groupers, aggregate in the same locations to spawn, making it easy for fishermen to target and to remove them in large numbers (Coleman et al. 2000).

Additionally, the aggregate MSY definition specified by Alternative 1 would make it difficult for fishery managers to identify weak, or particularly vulnerable, stocks that require special attention. Species- or unit-specific landings trends that would normally signal overexploitation or fishery instability would be less apparent if overall landings were within the desired level defined by the aggregate MSY.

6.2.1.1.2.4 Caribbean coral reef resource

MSY Alternative 1 would not provide fishery managers with an MSY reference point for species in the Caribbean coral reef resource FMU. This could have adverse environmental effects if it resulted in overfishing. However, this is unlikely to occur because catches of these species in federal waters have been limited over the years despite the lack of management reference points or of severe restrictions on the take of non-prohibited species.

6.2.1.1.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.1.1.3 Direct and indirect effects on social and economic environment and their significance

MSY is defined as the largest long-term average catch that can be taken continuously (sustained) from a stock under prevailing ecological and environmental conditions. MSY serves as a maximum limit on catch that, in the long run, cannot be exceeded. As a result, specifying or modifying MSY may result in more stringent regulations if current catches are too high to achieve the adopted MSY on a continuing basis. Conversely, it could result in relaxing catch restrictions that restrict expansion of effort and/or long-run catches if current catches are low relative to the adopted MSY definition.

Furthermore, while MSY is a biological, not an economic concept, underestimating MSY could result in classification of a stock as being overfished or undergoing overfishing when, in reality, the stock is not overfished and/or excessive fishing is not occurring. As a result of this classification error, actions may be taken to curtail effort and/or long-term catches. Depending on the restrictiveness of these actions, as well as the methods taken, economic losses and social disruptions will almost certainly be forthcoming. Certainly, the likelihood and potential extent of economic losses and social disruptions are likely to increase as the amount by which MSY is underestimated increases.

Conversely, overestimating MSY may result in relaxation of current catch restrictions or failure to implement new catch restrictions. To the extent that such actions result in overfishing, the potential exists for a reduction in economic benefits and/or social disruptions due to a long-run depletion in stock and a long-run catch level that is less than MSY. One might anticipate that long-term economic losses and social disruptions would be particularly acute in those instances where MSY is largely overestimated; hence, potentially leading to significant overfishing.

Finally, some other issues associated with the specification of MSY should be recognized. First, while temporarily exceeding the specified (modified) MSY triggers the need for more acute attention to the fishery, it does not necessarily require immediate increased restrictiveness of catch since temporary high catch rates may reflect natural variability of the resource and not necessarily an excessive fishing mortality rate. Second, while the specification of MSY has no immediate effects on fishing participants (i.e., no incremental effects beyond those currently existing), the regulatory measures designed to achieve MSY could have effects on these participants, such as changes in fishing effort and catch. The effects of the particular measures selected can, therefore, very from the effects of alternative regulatory measures. Third, one should recognize that MSY considers the entire resource, both in the EEZ and state waters, and encompasses landings by all fishing sectors. Therefore, the degree to which current practices and relationships will be altered by a new MSY definition may be minimized depending upon the amount of catch occurring in federal waters.

At one extreme, if no catch occurs in federal waters, specification (modification) of MSY will have no economic or social effects (i.e., no incremental effects) unless the states adopt a compatible definition. At the other end of the spectrum, if all catch occurs in federal waters, specification (modification) of MSY will have potentially large economic effects and social disruptions if catch restrictions are necessitated in order to rebuild stocks. Finally, negative economic impacts (costs) and social disruptions associated with any proposed catch restrictions will be forthcoming only to the extent that compliance is at an acceptable level. The expected level of compliance is positively related to the level of enforcement as well as the expected penalty if apprehended. Realistically, if either of these two factors is low, compliance will also likely be low. Low compliance translates directly to diminished economic effects and social disruptions beyond the baseline.

From the perspective that satisfactory specification of MSY parameters establishes a viable FMP and the platform for subsequent responsible management, the adoption of the appropriate benchmark facilitates the achievement of economic and social benefits associated with a healthy and prosperous fishery.

6.2.1.1.3.1 Caribbean spiny lobster

With respect to Caribbean spiny lobster, MSY in the Spiny Lobster FMP was established at 830,000 lbs (Table 9). Long-term catch (i.e., 1983-2001) averaged 613,000 lbs[1] while more recent catch (i.e., 1997-2001) averaged 547,000 lbs (Table 8). Hence, MSY under Alternative1 (no action) is 26% above long-term catch and 34% above the more recent catch. This could suggest (i.e., if the MSY under Alternative 1 is accurate) that the stock is not overfished and no regulatory measures are necessary to restrict fishing effort and catch of Caribbean spiny lobster.

If the current definition of MSY (830,000 lbs) is an overestimate, regulatory actions to prevent overfishing conditions may not be enacted. This may, in the long run, result in depletion of the stock.[2] Because long-run economic benefits are usually positively related to the size of the stock, one can surmise that significant overfishing would result in significantly lower than optimal long-run economic benefits.

Overfishing results in lower fishing opportunities in the fishing sector in the long-run, and correspondingly diminished job opportunities in related sectors (e.g., wholesale sector). Since about three-quarters of the reported Puerto Rico commercial spiny lobster catch is landed along the south and west coasts, one would expect these areas to be particularly impacted by job losses due to overfishing.

Conversely, if the current definition of MSY (830,000 lbs) is an underestimate, regulatory actions may be more restrictive than necessary and result in less than optimal fishing effort and catch.

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[1] MSY Alternative 4 is based on long-term (1983-2001) commercial landings; please refer to Table 9 under the column "MSY Alt 4" for long-term catch statistics for the various FMU sub-units under each FMP.

[2] This discussion is, of course, conditioned on spiny lobster fishing activities occurring in federal waters with adequate provisions to enforce any catch restrictions.

Unnecessary restrictions would provide less than optimal employment opportunities and preclude achievement of maximum benefits to the nation derived from the optimal yield of the resource.

6.2.1.1.3.2 Caribbean conch resource

With respect to Caribbean queen conch, MSY in the Queen Conch FMP was established at 738,000 lbs. Long-term catch (i.e., 1983-2001) averaged 567,000 lbs, while more recent catch (i.e., 1997-2001) averaged 439,000 lbs (Table 8). Hence, MSY under Alternative1 (no action) is 23% above long-term catch and 41% above the more recent catch. This could suggest (i.e., if the MSY under Alternative 1 is accurate) that the stock is not overfished and no regulatory measures are necessary to restrict fishing effort and catch of queen conch.[3]

If the current definition of MSY (738,000 lbs) is an overestimate, regulatory actions to prevent overfishing conditions may not be enacted. This may, in the long run, result in depletion of the stock.[4] Because long-run economic benefits are usually positively related to the size of the stock, one can surmise that significant overfishing would result in significantly lower than optimal long-run economic benefits.

Overfishing results in fewer fishing opportunities in the fishing sector in the long-run, and correspondingly diminished job opportunities in related sectors (e.g., wholesale sector). Since more than one-half of the reported Puerto Rico commercial queen conch landings occur along the west coast, one would expect this area to be particularly impacted by overfishing.

Conversely, if the current definition of MSY (738,000 lbs) is an underestimate, regulatory actions may be more restrictive than necessary and result in less than optimal fishing effort and catch of Caribbean queen conch. Unnecessary restrictions would provide less than optimal employment opportunities and preclude achievement of maximum benefits to the nation derived from the optimal yield of the resource.

6.2.1.1.3.3 Caribbean reef fish

Estimated Caribbean reef fish landings (commercial and recreational) during 1997-2001 averaged approximately 3,300,000 lbs annually (Table 8). MSY in the Reef Fish FMP was set at 7,700,000 lbs. Therefore, the present MSY is 57% above current catch levels. This definition of MSY was set for reef fish in aggregate and includes a wide variety of species (and FMU sub-units) within the reef fish complex. This broad MSY designation inhibits management because it can mask the condition of a particularly vulnerable stock or unit.

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[3] Under the preferred alternative in Section 6.2.4 (MSST), queen conch would be defined as overfished.

[4] This discussion is, of course, conditioned on queen conch activities occurring in federal waters with adequate provisions to enforce any catch restrictions. Analysis by Rivera (1999) suggests that commercial queen conch activities in federal waters off Puerto Rico are extremely limited. For St. Croix, where the majority of queen conch is captured in the USVI, approximately 35% of reported production (from trip tickets) came from federal waters (three miles or more) during 2000-2001.

Since the implementation of the Council's Reef Fish FMP, considerably more information has been collected that can assist in management of the reef fish complex, including discrete management of FMU sub-units (species) within the overall complex. For example, based on 2000-2001 trip ticket data for St. Croix, about 44% of the reported commercial grouper catch in federal waters, while about 55% of the commercial catch of snapper occurred in federal waters. Yet, while landings data from USVI differentiates between state and federal waters, little information exists which would help to ascertain the amount of reef fish fishing activities in federal waters off Puerto Rico.

Discrete and, hence, more effective management is predicated on defining MSY on a more refined basis (i.e., species or FMU sub-unit). If MSY for the various FMU sub-units/species is underestimated or overestimated, then the effects discussed in Sections 6.2.1.1.3 and 6.2.1.1.3 may be relevant. Regardless, maintaining the current definition of MSY would inhibit more effective management.

6.2.1.1.3.4 Caribbean coral reef resource

The Council enacted a complete prohibition on the catch or possession of stony corals, whether dead or alive (except for legally permitted research, education, and restoration programs), in federal waters of the U.S. Caribbean in 1995, *via* implementation of the Coral FMP. Given this situation, there has been no (legal) take of coral in federal waters since 1995 and, as such, no direct participation in the fishery. Hence, near-term indirect effects associated with the no action alternative would be negligible.

6.2.1.1.4 Direct and indirect effects on administrative environment and their significance

The relatively high MSY status quo estimates for the Caribbean spiny lobster, queen conch, and reef fish could result in direct adverse administrative effects if they resulted in overfishing, as the MSFCMA provisions related to ending overfishing and rebuilding overfished stocks are generally resource intensive. The aggregate MSY definition for Caribbean reef fish provided by the Reef Fish FMP would likely negatively affect the administrative environment because that definition is not consistent with the MSFCMA mandate to use the best available information in fishery management decision making. With improved species-specific landings information, it is possible to derive a reasonable MSY proxy for discrete units with that FMU.

6.2.1.2 Alternative 2. In the absence of MSY estimates, the proxy for MSY will be derived from recent average catch (C), and from estimates of the current biomass (B_{CURR}/B_{MSY}) and fishing mortality ($F_{CURR}/_{FMSY}$) ratios as: MSY = C / [(F_{CURR}/F_{MSY}) x (B_{CURR}/B_{MSY})]; where C is calculated based on commercial landings for the years 1997-2001 and on recreational landings for the years 2000-2001.

This alternative is preferred for Caribbean spiny lobster, queen conch, and reef fish, excluding those species retained for data collection purposes.

The MSY values that would be defined by this alternative relative to the Council's Preferred FMU Alternative 2 (Section 4.1.1.2) are detailed in Table 9 under the column "MSY Alt 2." These values were calculated using the preferred B and F ratio alternatives described in Section 4.2.2 and analyzed in Section 6.2.2. Details on the data and information used to develop this MSY proxy are described in Section 4.2.1.2.

6.2.1.2.1 Direct and indirect effects on physical environment and their significance

As explained in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. The estimates specified by MSY Preferred Alternative 2 for all four Caribbean FMUs are generally more conservative than those specified by MSY Alternatives 1 and 4, but less conservative than those specified by MSY Alternative 3. Consequently, this alternative would be expected to support a relatively low rate of fishing mortality and habitat interactions relative to the other alternatives. The potential effects of gear used in the spiny lobster, queen conch, reef fish, and coral reef fisheries are described in Section 6.2.1.1.1.

6.2.1.2.2 Direct and indirect effects on biological and ecological environment and their significance

6.2.1.2.2.1 Caribbean spiny lobster

The estimate defined by MSY Preferred Alternative 2 for the Caribbean spiny lobster (547,000 lbs; Table 9) is the lowest of all those MSY estimates considered, with the exception of MSY Alternative 3, which would require that federal fisheries for the spiny lobster be closed. Consequently, this alternative would be expected to support a relatively low rate of fishing mortality on that species relative to the other alternatives. Section 6.2.1.1.2 describes the potential effects of fishing on the biological and ecological environment.

6.2.1.2.2.2 Caribbean conch resource

The estimate defined by MSY Preferred Alternative 2 for the Caribbean queen conch (452,000 lbs; Table 9) is intermediate to all the MSY estimates considered for that species. Consequently, this alternative would be expected to support an intermediate rate of fishing mortality on that species relative to the other alternatives. Section 6.2.1.1.2 describes the potential effects of fishing on the biological and ecological environment.

6.2.1.2.2.3 Caribbean reef fish

The estimates defined by MSY Preferred Alternative 2 for food fish units in the Caribbean reef fish FMU are generally the lowest of all those MSY estimates considered, with the exception of MSY Alternative 3, which would require that federal reef fish fisheries be closed. Consequently, this alternative would be expected to support a relatively low rate of fishing mortality on Caribbean reef fish relative to the other alternatives. Section 6.2.1.1.2 describes the potential effects of fishing on the biological and ecological environment.

6.2.1.2.2.4 Caribbean coral reef resource

Because the status quo for coral species is the prohibition of their harvest, catch data are not available to calculate this MSY proxy for Caribbean coral reef resources. Furthermore, it would be problematic to estimate a biomass ratio due to the biological diversity of the numerous managed coral species and due to the influence of other environmental factors that influence coral biomass. Please refer to Section 6.2.1.3.2.4 for more discussion on this issue.

6.2.1.2.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.1.2.3 Direct and indirect effects on social and economic environment and their significance

6.2.1.2.3.1 Caribbean spiny lobster

The estimated recent (i.e., 1997-2001) catch of spiny lobster in the EEZ has averaged 547,000 lbs annually (Table 8). Under Preferred Alternative 2, MSY would be set at 547,000 lbs (MSY Alt 2; Table 9). Hence, there would be no direct economic or social effects associated with this alternative. However, if this MSY value is underestimated or overestimated, then the effects discussed in Section 6.2.1.1.4.1 may be relevant.

6.2.1.2.3.2 Caribbean conch resource

Under MSY Preferred Alternative 2, the MSY estimate would result in a determination that the queen conch is overfished and undergoing overfishing if the Council's preferred status determination criteria are adopted.

To the extent that management measures are imposed to end overfishing and rebuild the queen conch stock towards the optimal biomass, B_{MSY}, one would anticipate negative economic and social effects in the short term in the form of decreased catches and associated benefits. Until such time that specific measures are specified, one cannot conclusively state what the social and economic effects would be. The size of the impact is expected to be directly correlated with the amount of queen conch activity occurring in federal waters. Assuming the imposed regulations are successful at rebuilding the stock, long-term economic benefits could be achieved if a proper management regime is substituted for the largely open access regime currently in place. This discussion is, of course, premised on the accuracy of the proposed MSY definition. If this MSY value is underestimated or overestimated, then the effects discussed in Section 6.2.1.1.2 may be relevant.

6.2.1.2.3.3 Caribbean reef fish

Under Preferred Alternative 2, MSY would be defined for each FMU sub-unit (or species) in the Council's Reef Fish FMP. MSY levels associated with each of these FMU sub-units are provided in Table 9 (MSY Alt 2). For Snapper Unit 1 (including silk snapper, unclassified snapper, black snapper, vermilion snapper, and blackfin snapper), for example, MSY would be set at 520,000 lbs. Estimated recent catch (1997-2001) of this FMU sub-unit has averaged 504,000 lbs; approximately 3% below the MSY definition.[5] For other FMU sub-units, such as Snapper Unit 4, recent catch is greater than MSY as defined by Alternative 2.

While specification of MSY has no immediate effects on fishing participants, measures designed to achieve that level could have effects. Furthermore, the definition of MSY influences the definition of OY, status determination criteria, and control rules. This MSY definition would result in a determination that some reef fish FMU sub-units are overfished and undergoing overfishing if the Council's preferred status determination criteria are adopted.

To the extent that management measures are imposed to rebuild specific sub-units (species) of the Caribbean reef fish FMU towards optimal biomass, B_{MSY}, one would anticipate negative economic and social effects in the short term in the form of decreased catches and associated benefits. Until such time that specific measures are specified, one cannot conclusively state what the social and economic effects would be. The size of the impact is expected to be directly correlated with the amount of reef fish activity (by FMU sub-unit) occurring in federal waters. Assuming the imposed regulations are successful at rebuilding overfished stocks, long-term economic benefits could be achieved if a proper management regime is substituted for the largely open access regime currently in place.

This discussion is, of course, premised on the accuracy of the proposed MSY definitions. If these MSY values are underestimated or overestimated, then the effects discussed in Sections 6.2.1.1.2 and 6.2.1.1.3 may be relevant. The extent of the effects reflects, to a large extent, the amount of fishing activity in federal waters. If fishing activities in federal waters are negligible, underestimating or overestimating MSY would have only minor social and economic effects, unless the same definition was adopted by the state governments.

[5] Recent catch being below MSY definition is not meant to imply that overfishing is not occurring. Specifically, catch below MSY may occur as a result of long-term overfishing.

6.2.1.2.3.4 Caribbean coral reef resource

Because the status quo for coral species is the prohibition of their harvest, catch data are not available to calculate this MSY proxy for Caribbean coral reef resources. Furthermore, it would be problematic to estimate a biomass ratio due to the biological diversity of the numerous managed coral species and due to the influence of other environmental factors that influence coral biomass. Please refer to Section 6.2.1.3.2.4 for more discussion on this issue.

6.2.1.2.4 Direct and indirect effects on administrative environment and their significance

The MSY estimates proposed by Preferred Alternative 2 for the Caribbean spiny lobster, queen conch, and reef fish stocks would be expected to directly benefit the administrative environment by incorporating the best available information into fishery management decision making. These estimates would indicate that some immediate reductions in catches were needed to end overfishing in some cases, which would burden fishery administrators in the short term, however, long-term sustainability of these fisheries would improve, which would reduce the number of resource intensive actions required in the future. The MSY definitions would indicate that some immediate reductions in catches were needed to end overfishing, which would burden fishery administrators in the short term.

6.2.1.3 Alternative 3. Set MSY = 0.

This alternative is preferred for all species in the Caribbean coral reef resource FMU, excluding those species retained for data collection purposes.

6.2.1.3.1 Direct and indirect effects on physical environment and their significance

As explained in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. The definition provided by MSY Alternative 3 is far more conservative than that specified by MSY Alternatives 1, 2, and 4. In effect, any fishery for which this definition is adopted would have to be closed. Consequently, this alternative would be expected to indirectly benefit the physical environment by eliminating fishing gear interactions with benthic habitat. The potential effects of gear used in the spiny lobster, queen conch, reef fish, and coral reef fisheries are described in Section 6.2.1.1.1.

6.2.1.3.2 Direct and indirect effects on biological and ecological environment and their significance

6.2.1.3.2.1 Caribbean spiny lobster

Alternative 3 would define MSY as zero, effectively requiring that catches of the Caribbean spiny lobster be reduced to zero as well. As explained in Section 6.2.1.1.2, reducing (or in this case eliminating) fishing mortality would be expected to benefit the biological and ecological environment by helping to restore the natural age, size, and sex structure of the stock, and promoting genetic integrity. However, because federal fisheries represent only a small portion of the total fishing mortality on the Caribbean spiny lobster (Sections 5.2.1.1.1, 5.3.3), the realization of such effects would be largely influenced by the amount of fishing mortality applied to the stock in state waters.

Although populations characterized by natural age structures, size structures, and sex ratios are more resilient to anthropogenic and environmental perturbations, the yield they produce becomes reduced as they reach their carrying capacities and density-dependent effects become more dominant. At high population sizes, older, larger fish occupy the available habitat and use the available food. The presence of these older fish limits the survival of young and inhibits recruitment. Recruitment and production of younger fish can be enhanced with the removal of some of these older, larger fish. Therefore, fishing and density-dependence can have the effect of creating a "surplus production" of fish in the population that is available for capture. The type and magnitude of density- dependent effects that populations will experience as they grow in size are difficult to predict, as they vary from species to species and are based on available resources in a particular system (Wilson and Bossert 1971).

6.2.1.3.2.2 Caribbean conch resource

The effects of defining MSY as zero for stocks in the Caribbean conch resource FMU would be similar to those described for the Caribbean spiny lobster in Section 6.2.1.3.2.1.

6.2.1.3.2.3 Caribbean reef fish

The effects of defining MSY as zero for stocks in the Caribbean reef fish FMU would be similar to those described for the Caribbean spiny lobster in Section 6.2.1.3.2.1.

6.2.1.3.2.4 Caribbean coral reef resource

This alternative would be consistent with the Council's current management of coral reef species, that is, the harvest and possession of coral is prohibited in the EEZ. The biological and ecological environments would benefit from an MSY value of zero for species in the Caribbean coral reef resource FMU. Such benefits would be expected to be greater than those realized from applying this definition to the spiny lobster, conchs, and reef fish because many coral reef resources are more susceptible to disturbance and recover much more slowly from disturbance relative to other marine resources.

Currently, the most vulnerable coral reef species are protected from fishing pressure based on the Council's determination that their ecological or non-consumptive value exceeds their commercial value (CFMC 1994, 2004). While the National Standard Guidelines suggest that ecological factors be addressed in the specification of OY, rather than MSY, setting MSY equal to zero for those species which the Council has decided should never be captured in any amount would ensure the protection of those species over the long term.

The sheer number and diversity of species within the Caribbean coral reef resource FMU would make it difficult to develop biological reference points for the unit as a whole. And catch-based proxies cannot be calculated as long as current prohibitions on catch remain in effect. This alternative would be consistent with Council policy on coral resources, which recognizes that coral reefs provide habitat that is essential to the recruitment, survival, and growth of many species. Further, due to the very slow growth rates of many (stony) coral species, they are not capable of harvest at any level that would be considered sustainable. The Council has identified this MSY definition as the preferred for all species in the Caribbean coral reef resource FMU, with the exception of aquarium trade species.

6.2.1.3.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.1.3.3 Direct and indirect effects on social and economic environment and their significance

6.2.1.3.3.1 Caribbean spiny lobster

The MSY of spiny lobster is certainly greater than zero. Since MSY defines the upper limit on catch, setting MSY equal to zero would, by necessity, require closing the federal fishery to all fishing activities. Consequently, revenues and profits from spiny lobster catches in the EEZ would be reduced to zero.

A total closure of federal waters would be incapable of achieving a long-run yield equal to an MSY of zero, unless state governments also closed their waters. In absence of state closures, a spiny lobster fishermen could either: (a) move fishing activities from EEZ waters to state waters, (b) switch fishing behavior to other target species, and/or (c) cease fishing activities. To the extent that traditional fishing practices are simply transferred to state waters, catch per unit effort (CPUE) and, therefore, profits among those fishermen would likely be diminished.

This alternative also could result in significant declines in revenues because revenues (and profits) from spiny lobster catches in the EEZ would be reduced to zero. The estimated commercial catch of spiny lobster during the 1997-2001 period averaged 370,856 lbs annually (Table 5). The dockside price for this species averaged $5.265 per lb between 1998-2001

(Matos-Caraballo 2002[6]). This suggests dockside revenues of $1,952,557 annually (370,856 lbs x $5.265 per lb) and a loss of those revenues if all fishing activities (in both state and federal waters) were to cease. However, only a limited (potentially small) amount of the total catch is derived from federal waters so we expect a cessation of spiny lobster activities only in federal waters would result in only a portion (potentially small) of the total loss that would occur if all spiny lobster fishing activities were to cease.

6.2.1.3.3.2 Caribbean conch resource

The potential social and economic effects of defining MSY as zero for stocks in the Caribbean conch resource FMU would be similar to those described for the Caribbean spiny lobster in Section 6.2.1.3.3.1 (e.g., redistribution of fishing effort to state waters and to other species, reduced CPUE, diminished revenues and profits, and potential cessation of fishing activities). The estimated commercial catch of queen conch during the 1997-2001 period averaged 287,364 lbs annually (Table 5). The dockside price for queen conch averaged $2.285 per lb between 1998-2001 (Matos-Caraballo 2002). This suggests dockside revenues of $656,627 annually, which would be lost with complete prohibition of queen conch fishing (287,364 lbs x $2.285 per lb).

6.2.1.3.3.3 Caribbean reef fish

The effects of defining MSY as zero for stocks in the Caribbean reef fish FMU would be similar to those described for the Caribbean spiny lobster in Section 6.2.1.3.3.1 (e.g., redistribution of fishing effort to state waters and to other species, reduced CPUE, diminished profits, reduced revenues, potential cessation of fishing activities).

6.2.1.3.3.4 Caribbean coral reef resource

The highest value of all coral resources throughout the U.S. Caribbean may reflect non-consumptive and ecological services. Recognizing this fact, the Council enacted in 1995 a complete prohibition on the catch or possession of stony corals in federal waters, whether dead or alive (except for legally permitted research, education, and restoration programs). Given this situation, there has been no (legal) take of coral in federal waters since that time and, as such, no direct participation in the fishery. Hence, applying this alternative (MSY=0) to the Caribbean coral reef resource FMU would essentially have no impact on the social and economic environment in the near term. To the extent that landings, prior to 1995, exceeded any sustainable level, one could argue that benefits from the 1995 regulation will increase over time as the resource is allowed to repopulate.

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[6] Ex-vessel values for Puerto Rico were used for the entire U.S. Caribbean to determine economic impacts (i.e., value). While prices for USVI fish and shellfish and typically higher than those in Puerto Rico, the product is marketed differently between the two states. Fishermen in the USVI generally market their product directly to the consumer or to restaurants, so it does not reflect a true ex-vessel value. Therefore, for the purposes of the analyses herein, ex-vessel values for Puerto Rico have been applied to combined Puerto Rico and USVI landings.

This alternative would further demonstrate the Council's intent to prohibit catch and protect coral species, and would not be expected to impose any new impacts on fishermen and related communities. Little or no aquarium trade activity (i.e., coral reef resources) has been reported in federal waters off the USVI and most of the catch landed in Puerto Rico is assumed to be taken from state waters.

6.2.1.3.4 Direct and indirect effects on administrative environment and their significance

Defining MSY as zero would be expected to directly benefit the administrative environment by eliminating the need to develop fishery management measures to constrain catches to a specified level. Closing all federal fisheries to fishing also would reduce the administrative burden associated with enforcing minimum size limits, area closures, and other species-specific management measures. However, if fishing (i.e., for species in the Reef Fish, Spiny Lobster, and/or Queen Conch FMPs) were prohibited in federal, and not state, waters, dockside enforcement would be ineffective because fishermen could claim all of their catch came from state waters. Further, prohibiting fishing for all species (in the Reef Fish, Spiny Lobster, and Queen Conch FMPs) in the EEZ would be highly controversial.

6.2.1.4 Alternative 4. Set MSY equal to long-term average catch based on commercial landings data from 1983 to present and on recreational data provided by MRFSS for the years 2000-2001.

The MSY values that would be defined by this alternative relative to the Council's Preferred FMU Alternative 2 (Section 4.1.1.2) are detailed in Table 9 under the column "MSY Alt 4." These values were calculated using the preferred B and F ratio alternatives described in Section 4.2.2 and analyzed in Section 6.2.2. Details on the data and information used to develop this MSY proxy are described in Section 4.2.1.4.

6.2.1.4.1 Direct and indirect effects on physical environment and their significance

As explained in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. The estimates specified by MSY Alternative 4 for all four Caribbean FMPs are substantially more conservative than those specified by MSY Alternative 1, generally slightly less conservative than those specified by MSY Preferred Alternative 2, and much less conservative than those specified by MSY Alternative 3. Consequently, this alternative would be expected to support an intermediate rate of fishing mortality and habitat interactions relative to the other alternatives. The potential effects of gear used in the spiny lobster, queen conch, reef fish, and coral reef fisheries are described in Section 6.2.1.1.1.

6.2.1.4.2 Direct and indirect effects on biological and ecological environment and their significance

The catch-based MSY proxy proposed by this alternative differs from that used in Alternative 2 in that it calculates average catches using a longer time series of commercial catch data and that it does not incorporate estimates of stock status (B_{CURR}/B_{MSY}) and fishery status (F_{CURR}/F_{MSY}) during that period of time.

6.2.1.4.2.1 Caribbean spiny lobster

The estimate defined by MSY Alternative 4 for the Caribbean spiny lobster (613,000 lbs; Table 9) is intermediate to all those MSY estimates considered. Consequently, this alternative would be expected to support an intermediate rate of fishing mortality on that species relative to the other alternatives. Section 6.2.1.1.2 describes the potential effects of fishing on the biological and ecological environment.

6.2.1.4.2.2 Caribbean conch resource

The estimate defined by MSY Alternative 4 for the Caribbean queen conch (567,000 lbs; Table 9) is greater than to that defined by MSY Preferred Alternative 2, but less than Alternative 1, and therefore, is an intermediate MSY estimates. Consequently, this alternative would be expected to support an intermediate rate of fishing mortality on that species relative to the other alternatives or the status quo. Section 6.2.1.1.2 describes the potential effects of fishing on the biological and ecological environment.

6.2.1.4.2.3 Caribbean reef fish

The estimates defined by MSY Alternative 4 for food fish units in the Caribbean reef fish FMU are generally higher than those defined by MSY Preferred Alternative 2, and intermediate to those defined by Alternatives 1 and 3. Consequently, this alternative would be expected to support an intermediate rate of fishing mortality on Caribbean reef fish relative to the other alternatives. Section 6.2.1.1.2 describes the potential effects of fishing on the biological and ecological environment.

6.2.1.4.2.4 Caribbean coral reef resource

Catch data are not available to calculate this MSY proxy for species in the Caribbean coral reef resource FMU.

6.2.1.4.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.1.4.3 Direct and indirect effects on social and economic environment and their significance

6.2.1.4.3.1 Caribbean spiny lobster

Long-term catch (i.e., 1983-2001) averaged 613,000 lbs while more recent catch (i.e., 1997-2001) averaged 547,000 lbs (Table 8). MSY for Caribbean spiny lobster resource under Alternative 4 would be set at 613,000 lbs which is about 11% more then MSY as defined in Preferred Alternative 2 and about 26% less then MSY as defined in the status quo.

The definition of MSY influences the definition of OY, status determination criteria, and control rules. However, no measures to reduce catch would be required by this alternative because it defines MSY to be larger than the recent average catch of spiny lobster (Table 7).

If this MSY value is underestimated or overestimated, then the effects discussed in Section 6.2.1.1.4.1 may be relevant. The degree of these effects is expected to be directly correlated with the amount of spiny lobster activity occurring in federal waters. If fishing activities are negligible, underestimating or overestimating MSY would have only minor social and economic effects, unless the state governments also adopted that definition.

6.2.1.4.3.2 Caribbean conch resource

MSY for the Caribbean queen conch resource under Alternative 4 would be set at 567,000 lbs, which is 20% more than the MSY defined by Preferred Alternative 2 and 33% less then MSY as defined by the status quo.

The definition of MSY influences the definition of OY, status determination criteria, and control rules. However, no measures to reduce catch would be required by this alternative because it defines MSY to be larger than the recent average catch of queen conch (Table 7).

If this MSY value is underestimated or overestimated, then the effects discussed in Section 6.2.1.1.2 may be relevant. The degree of these effects is expected to be directly correlated with the amount of queen conch activity occurring in federal waters. If fishing activities are negligible, underestimating or overestimating MSY would have only minor social and economic effects, unless the state governments also adopted that definition.

6.2.1.4.3.3 Caribbean reef fish resource

Under Alternative 4, MSY would be defined for each sub-unit in the Caribbean reef fish FMU based on the long-term average catch (commercial catch from 1983 to present, and recreational catch provided by MRFSS for the years 2000-2001). Comparison of MSY under Alternative 4 to that provided in Alternative 1 (no action) has little relevancy because the latter definition applies to the unit as a whole; other then stating that if MSY specifications at the FMU sub-unit level are accurate, such specification could greatly assist in a more refined management process of the reef fish resources of the U.S. Caribbean.

The estimates specified by MSY Alternative 4 for reef fish FMU sub-units are generally slightly less conservative than those specified by MSY Preferred Alternative 2. Consequently, one might anticipate less severe management measures (if any) than those which would be imposed under Alternative 2. Until such time that specific measures are specified, one cannot conclusively state what the social and economic effects would be.

6.2.1.4.3.4 Caribbean coral reef resource

Catch data are not available to calculate this MSY proxy for species in the Caribbean coral reef resource FMU. However, since harvest of coral species is currently prohibited, no social and economic impacts are expected from this alternative.

6.2.1.4.4 Direct and indirect effects on administrative environment and their significance

The MSY estimates proposed by Alternative 4 for the Caribbean spiny lobster, queen conch, and reef fish stocks would be expected to adversely affect the administrative environment by failing to comply with the MSFCMA mandate to use the best available scientific information in fishery management decision making. The reliability of catch data collected in the early years of the state trip ticket programs has been compromised by a series of periodic lapses in the programs over the years, as well as significant under and/or misreporting, and changes in the type of data collected (Valle-Esquivel 2002). Landings in the USVI were historically reported by gear group (e.g., pot fish, net fish), while those in Puerto Rico were reported by species or species groups (e.g., Nassau grouper, grouper).

6.2.2 Fishing mortality (F) and biomass (B) ratios

MSY Preferred Alternative 2 (Sections 4.2.1.2; 6.2.1.2) requires quantitative definitions of stock status and of fishery status, defined as the relationship between B_{CURR} and B_{MSY} (B ratio) and between F_{CURR} and F_{MSY} (F ratio), respectively. The larger the F ratio (i.e., higher F_{CURR} as compared to F_{MSY}), the more exploited the stock or unit. Conversely, the smaller the B ratio (i.e., lower B_{CURR} as compared to B_{MSY}), the more depressed the biomass of the stock or unit. Incorporating these ratios into catch-based MSY proxies allows scientists to consider scenarios where stock biomass and/or fishing mortality rates were not at desirable levels during the period over which catch data used in the calculations were collected. An F ratio larger than 1.00 indicates that the fishing mortality rate during that period was above F_{MSY}, and would generally adjust the MSY estimate downward. A B ratio smaller than 1.00 indicates that the stock biomass was below B_{MSY} during that period, and would generally adjust the MSY upward. These estimates of stock status and fishery status also are incorporated in several of the control rule alternatives described and evaluated in Sections 4.2.5 and 6.2.5.

Defining F and B ratios would not directly affect the physical, biological and ecological, or social/economic environments because this is an administrative action that simply provides fishery managers with estimates of stock status and fishery status that can be used to calculate management reference points. However, it could result in indirect environmental effects by affecting the MSY estimate and, therefore, decisions about the maximum rate of fishing mortality that can be applied to the fisheries over the long term. This section describes the potential indirect effects of the various F and B ratio alternatives.

6.2.2.1 Alternative 1. No action. Do not define F and B ratios for managed stocks.

This alternative is preferred for all species in the Coral Reef FMP, excluding those species retained for data collection purposes.

6.2.2.1.1 Direct and indirect effects on physical environment and their significance

As explained in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. Alternative 1 would not provide fishery managers with F and B ratios for Council-managed species. As a result, this alternative would not be compatible with MSY Preferred Alternative 2, which is the Council's preferred for most stocks. It would require the Council to select from MSY Alternatives 1, 3, and 4. The potential indirect effects on the physical environment associated with the remaining MSY alternatives are described in Section 6.2.1.

6.2.2.1.2 Direct and indirect effects on biological and ecological environment and their significance

6.2.2.1.2.1 Caribbean spiny lobster

Alternative 1 would not be compatible with the Council's preferred MSY alternative for the Caribbean spiny lobster, which requires that F and B ratios be defined for that species. This would force the Council to select from MSY Alternatives 1, 3 and 4. Section 6.2.1 describes the potential indirect effects of those MSY alternatives on the biological and ecological environments.

6.2.2.1.2.2 Caribbean conch resource

Alternative 1 would not be compatible with the Council's preferred MSY alternative for the queen conch, which requires that F and B ratios be defined for that species. This would force the Council to select from MSY Alternatives 1, 3 and 4. Section 6.2.1 describes the potential indirect effects of those MSY alternatives on the biological and ecological environments.

6.2.2.1.2.3 Caribbean reef fish

Alternative 1 would not be compatible with the Council's preferred MSY alternative for food fish species in the Caribbean reef fish FMU, which requires that F and B ratios be defined for those species. This would force the Council to select from MSY Alternatives 1, 3 and 4. Section 6.2.1 describes the potential indirect effects of those MSY alternatives on the biological and ecological environments.

6.2.2.1.2.4 Caribbean coral reef resource

Alternative 1 would be compatible with the Council's preferred MSY alternatives for species in the Caribbean coral reef resource FMU. Those alternatives do not require that F and B ratios be specified. The status quo for coral species is the complete prohibition of harvest (i.e., F equal to zero). In regard to the B ratio proxy, it would be problematic to estimate a biomass ratio due to the biological diversity of the numerous managed coral species and due to the influence of other environmental factors that influence coral biomass.

6.2.2.1.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.2.1.3 Direct and indirect effects on social and economic environment and their significance

To the extent that these ratios contribute to the determination of MSY and control rules, taking no action (Alternative 1) would inhibit the development of measures which could, in theory, assist in more rational management of the fishery. Taking no action in specifying F and B ratios may indirectly and in the long run result in management strategies that are sub-optimal to those that would be forthcoming if F and B ratios are specified. This finding, however, is premised on the use of accurate ratios when implementing management actions. If the ratios adopted are overly optimistic or pessimistic regarding the status of the fisheries, taking no action (Alternative 1) may be preferable to any of the alternatives.

6.2.2.1.3.1 Caribbean spiny lobster

Alternative 1 would not be compatible with the Council's preferred MSY alternative for the Caribbean spiny lobster, which requires that F and B ratios be defined for that species. This would force the Council to select from MSY Alternatives 1, 3 and 4. Section 6.2.1 describes the potential indirect effects of those MSY alternatives on the social and economic environments.

6.2.2.1.3.2 Caribbean conch resource

Alternative 1 would not be compatible with the Council's preferred MSY alternative for the queen conch, which requires that F and B ratios be defined for that species. This would force the Council to select from MSY Alternatives 1, 3 and 4. Section 6.2.1 describes the potential indirect effects of those MSY alternatives on the social and economic environments.

6.2.2.1.3.3 Caribbean reef fish

Alternative 1 would not be compatible with the Council's preferred MSY alternative for food fish species in the Caribbean reef fish FMU, which requires that F and B ratios be defined for those species. This would force the Council to select from MSY Alternatives 1, 3 and 4. Section 6.2.1 describes the potential indirect effects of those MSY alternatives on the social and economic environments.

6.2.2.1.3.4 Caribbean coral reef resource

Alternative 1 would be compatible with the Council's preferred MSY alternatives for species in the Caribbean coral reef resource FMU. Those alternatives do not require that F and B ratios be specified.

6.2.2.1.4 Direct and indirect effects on administrative environment and their significance

This alternative would have direct adverse effects on the administrative environment if the Council retains MSY Alternative 2 as the preferred alternative for the Caribbean spiny lobster, queen conch, and reef fish resources (excluding aquarium trade species). The proxy proposed by that MSY alternative requires that F and B ratios be defined for each stock or FMU sub-units; the Council FMPs require MSY proxies to comply with the MSFCMA.

6.2.2.2 Alternative 2. For each FMU sub-unit for which B_{CURR}/B_{MSY} and F_{CURR}/F_{MSY} have not been estimated through a stock assessment or other scientific exercise (i.e., stock status unknown), the following estimates will be used for the B_{CURR}/B_{MSY} and F_{CURR}/F_{MSY} proxies: 1) For species that are not believed to be at risk based on the best available information, the F_{CURR}/F_{MSY} proxy is estimated as 0.75 and the B_{CURR}/B_{MSY} proxy is estimated as 1.25; 2) For species for which no positive or negative determination can be made on the status of their condition, the default proxies for F_{CURR}/F_{MSY} and B_{CURR}/B_{MSY} are estimated as 1.00; and 3) For species that are believed to be at risk based on the best available information, the F_{CURR}/F_{MSY} proxy is estimated as 1.50 and the B_{CURR}/B_{MSY} proxy is estimated as 0.75.

This alternative is preferred for Caribbean spiny lobster, queen conch, and all reef fish, excluding those species retained for data collection purposes.

The F and B ratios that would be assigned to Council-managed stocks and units if this alternative were selected are detailed in Table 9 under the column "F and B Ratio Alt 2." These ratios are described relative to the Council's Preferred FMU Alternative 2 (Section 4.1.1.2) and are based on status determinations made by the SFA Working Group. The information considered in those determinations is described in Section 4.2.2.

6.2.2.2.1 Direct and indirect effects on physical environment and their significance

As explained in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. The F ratio assigned by Alternative 2 to those species believed to be at risk is the same as that assigned by Alternative 3, but more conservative than that assigned by Alternative 4. The B ratio assigned by Alternative 2 to those species believed to be at risk is generally less conservative than that assigned by Alternatives 3 and 4. Consequently, this alternative would be expected to support a higher rate of fishing mortality, and the greatest amount of habitat interactions, relative to the other alternatives when stock biomass is below B_{MSY}. However, the B and F ratios proposed by this alternative would adjust MSY estimates downward, serving to reduce the rate of fishing and habitat interactions over the long term. The potential effects of the major gear types used in Caribbean fisheries on the physical environment are described in Section 6.2.1.1.1.

6.2.2.2.2 Direct and indirect effects on biological and ecological environment and their significance

The B ratio defined by Alternative 2 would support increasing the fishing mortality rate applied to stocks or units that are not believed to be at risk, based on the assumptions that stock biomass is above B_{MSY} and the current fishing mortality rate is below F_{MSY}. However, at present, no stocks or units fall into this "healthy" category. Alternative 2 would support maintaining the status quo fishing mortality rate for those stocks or units of unknown status, based on the assumptions that stock biomass is at B_{MSY} and that the fishing mortality rate is at F_{MSY}. Finally, Alternative 2 would require that the current fishing mortality rate applied to those stocks or units that have been determined to be at risk be decreased, based on the assumptions that stock biomass is at 75% of B_{MSY} and that the fishing mortality rate is at 150% of F_{MSY}.

The reduction in F required by this alternative under such a scenario is generally less than what would be required by F and B Ratio Alternatives 3 and 4. Consequently, Alternative 2 is likely to support a higher rate of fishing mortality on "at risk stocks" relative to the other alternatives when stock biomass is below B_{MSY}. However, the B and F ratios proposed by this alternative would adjust MSY estimates downward, serving to reduce the rate of fishing mortality applied to the fishery over the long term.

Section 6.2.1.1.2 describes the potential effects of fishing on the biological and ecological environments. In summary, overfishing could jeopardize the long-term viability of the stocks and adversely affect the ecosystem of which they are a part. Maintaining the stock at a high biomass level would be expected to reduce the potential for overexploitation due to scientific uncertainty, poor recruitment, and other environmental factors. However, the available yield associated with leaving more fish in the water becomes reduced as populations reach their carrying capacities and density-dependent effects become more dominate.

6.2.2.2.2.1 Caribbean spiny lobster

The F and B ratios defined by Alternative 2 for the Caribbean spiny lobster (1.00; Table 9) do not differ from those proposed by Alternatives 3 and 4 because the status of that species is unknown. These ratios would result in an MSY definition for that species that is equal to the recent average catch if the Council retains MSY Alternative 2 as its preferred.

If the spiny lobster were determined to be at risk, Alternative 2 would allow a higher rate of fishing on this species relative to F and B Ratio Alternatives 3 and 4 when stock biomass was below B_{MSY}. However, the B and F ratios proposed by this alternative would adjust the MSY estimate downward, serving to reduce the rate of fishing mortality applied to the fishery over the long term.

6.2.2.2.2.2 Caribbean conch resource

The Caribbean queen conch does not fall into one of the three categories (e.g., not at risk, unknown, at risk) on which the F and B ratios assigned by Alternative 2 are based. That stock has been formally declared "overfished" and "undergoing overfishing" by NMFS (NMFS 2002). However, the relationship between B_{CURR} and B_{MSY} and between F_{CURR} and F_{MSY} has not been quantified. Consequently, the F and B ratios assigned to this stock are defined simply as "greater than one" and "less than one," respectively. This approach allows fishery managers to recognize the need to end overfishing and rebuild this stock, without requiring precise estimates of the B and F ratios.

6.2.2.2.2.3 Caribbean reef fish

The F and B ratios defined by Alternative 2 for reef fish stocks or units of unknown status do not differ from those proposed by Alternatives 3 and 4. These ratios would result in MSY estimates that are equal to recent average catches if the Council retains MSY Alternative 2 as its preferred for those stocks or units. The F and B ratios defined by this alternative for those reef fish stocks or units that are determined to be at risk (e.g., Snapper Unit 1, Grouper Unit 4, and Parrotfish) would support a higher rate of fishing on those stocks or units relative to F and B Ratio Alternatives 3 and 4 when stock biomass was below B_{MSY}. However, the B and F ratios proposed by this alternative would adjust MSY estimates downward, serving to reduce the rate of fishing mortality applied to these stocks or units over the long term.

6.2.2.2.2.4 Caribbean coral reef resource

The F and B ratios defined by Alternative 2 for Caribbean coral reef resources (1.00; Table 9) do not differ from those proposed by Alternatives 3 and 4 because the status of those species is unknown. If coral reef resources were determined to be at risk, Alternative 2 would allow a higher rate of fishing on these species relative to F and B Ratio Alternatives 3 and 4 when stock biomass was below B_{MSY}. However, the B and F ratios proposed by this alternative would adjust MSY estimates downward, serving to reduce the rate of fishing mortality applied to these stocks over the long term. F and B ratios do not need to be defined for these species if the Council retains MSY Alternative 3 as preferred alternative.

6.2.2.2.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.2.2.3 Direct and indirect effects on social and economic environment and their significance

Defining F and B ratios could provide indirect long-term benefits to fishing participants and the nation, though there could be short-term negative effects if the chosen F and B ratios for managed stocks lead to the implementation of more restrictive management measures in the short term.

6.2.2.2.3.1 Caribbean spiny lobster

Under Alternative 2, the B and F ratios would equal 1.00 (Table 9), indicating that no positive or negative determination can be made about the condition of the Caribbean spiny lobster stock. These ratios would result in an MSY definition for that species that is equal to the recent average catch if the Council retains MSY Alternative 2 as its preferred. Consequently, no social or economic effects that differ from the status quo would be expected.

6.2.2.2.3.2 Caribbean conch resource

Under preferred Alternative 2, the B and F ratios for the queen conch stock would be <<1 and >1, respectively (Table 9). These figures would indicate that the stock is overfished and undergoing overfishing. This provides an indication that additional management measures will be forthcoming. If these management measures pertain only to fisheries in federal waters, one might anticipate that any effects to fishing participants in the USVI would exceed those in Puerto Rico since, apparently, a much higher proportion of queen conch is taken in federal waters in the USVI than in Puerto Rico.

When additional management measures are imposed, one might anticipate direct, short-term social and economic effects on fishing participants, such as loss in revenue stemming from catch limits. However, to the extent that these management measures protect (rebuild) the queen conch stock, they will translate into long-term benefits, including increased job opportunities in the fishing and related sectors as well as increased recreational activities. From an economic perspective, protected (rebuilt) stocks will yield only modest (if any) benefits to commercial fishermen since rents tend to be dissipated in an open-access system (a more rational management system, however, could yield significant sustainable rents). The increased stocks (and long-term catch) may, to some extent, benefit consumers in the form of lower prices and more conch to consume. Given that conch imports into Puerto Rico dominate domestic production, one might question whether the level of domestic landings influence price in any meaningful manner because domestic and imported queen conch are essentially the same commodity.

6.2.2.2.3.3 Caribbean reef fish resource

Under Alternative 2 (preferred), some of the sub-units in the Caribbean reef fish FMU would be considered at risk, while the status of other FMU sub-units would be classified as unknown. None of the FMU sub-units would be assigned to the "not at risk" category. Those stocks that have already been declared overfished (e.g., Nassau grouper, Goliath grouper, and queen conch) would not be affected by this alternative because, as overfished, they are already considered at risk. It should be noted that species classified as "at risk" are not overfished, as described in Section 4.2.2.

The effects of the B and F ratio assigned to stocks of unknown status are described in Section 6.2.2.2.3.1. If the specified B and F ratios are overly pessimistic, they could result in adverse short-term effects, with little or no long-term benefits. If the specified F and B ratios are overly optimistic, they could result in overfishing and stock depletion. Overfishing, through time, would negatively impact fishery participants and reduce employment opportunities in the fishing and related sectors over the long term. The B and F ratio assigned to "at risk" stocks may trigger corrective management actions leading to catch reductions in the short term. However, if the ratios are estimated correctly, the corrective management actions, though imposing short-term adverse effects on fishing participants, would provide long-term benefits in terms of ending overfishing and/or rebuilding the stock.

6.2.2.2.3.4 Caribbean coral reef resource

Under Alternative 2, the B and F ratios would equal 1.00 (Table 9) indicting that the current biomass of those resources is equal to B_{MSY} and the current fishing mortality rate on those resources is equal to F_{MSY}. F and B ratios do not need to be defined for these species if the Council retains MSY Alternatives 1 and 3 as preferred alternatives.

6.2.2.2.4 Direct and indirect effects on administrative environment and their significance

This alternative would directly benefit fishery administrators by providing them information that allows proxy definitions of management reference points to be fine tuned to reflect the best available information on managed stocks or units. This, in turn, would improve management of the resources.

6.2.2.3 Alternative 3. For each FMU sub-unit for which B_{CURR}/B_{MSY} and F_{CURR}/F_{MSY} have not been estimated through a stock assessment or other scientific exercise (i.e., stock status unknown), the following estimates will be used for the B_{CURR}/B_{MSY} and F_{CURR}/F_{MSY} proxies: 1) For species that are not believed to be at risk based on the best available information, the F_{CURR}/F_{MSY} proxy is estimated as 0.75 and the B_{CURR}/B_{MSY} proxy is estimated as 1.25; 2) For species for which no positive or negative determination can be made on the status of their condition, the default proxies for F_{CURR}/F_{MSY} and B_{CURR}/B_{MSY} are estimated as 1.00; and 3) For species that are believed to be at risk based on the best available information, the F_{CURR}/F_{MSY} proxy is estimated as 1.50 and the B_{CURR}/B_{MSY} proxy is estimated as 0.50.

The F and B ratios that would be assigned to Council-managed stocks and units if this alternative were selected are detailed in Table 9 under the column "F and B Ratio Alt 3." These ratios are described relative to the Council's Preferred FMU Alternative 2 (Section 4.1.1.2) and are based on status determinations made by the SFA Working Group. The information considered in those determinations is described in Section 4.2.2.

6.2.2.3.1 Direct and indirect effects on physical environment and their significance

As explained in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. The F ratio assigned by Alternative 3 to those species believed to be at risk is the same as that assigned by Alternative 2, but more conservative than that assigned by Alternative 4. The B ratio assigned by Alternative 3 to those species believed to be at risk is more conservative than that assigned by Alternative 2, and generally less conservative than that assigned by Alternative 4. Consequently, this alternative would be expected to support an intermediate rate of fishing mortality and habitat interactions relative to the other alternatives when stock biomass is below B_{MSY}. However, the B and F ratios proposed by this alternative would adjust MSY estimates upward, serving to increase the rate of fishing mortality and habitat interactions in the fishery over the long term. The potential effects of the major gear types used in Caribbean fisheries on the physical environment are described in Section 6.2.1.1.1.

6.2.2.3.2 Direct and indirect effects on biological and ecological environment and their significance

The F and B ratios defined by Alternative 3 are the same as those defined by Alternative 2 for those stocks or units that are not believed to be at risk (e.g., healthy) or that are of unknown status. At present, no stocks or units fall into the "healthy" category. The status of most stocks or units is unknown. Alternative 3 differs from Alternative 2 in that it would assume that the biomass of those stocks or units that have been determined to be at risk is at just 50% of B_{MSY}, rather than at 75% of B_{MSY}. The B ratios proposed by Alternative 4 are generally even less optimistic. In effect, Alternative 3 is likely to support a lower rate of fishing mortality on "at risk stocks" relative to Alternative 2 when stock biomass is below B_{MSY}, but a higher rate of fishing mortality on "at risk stocks" relative to Alternative 4. The B and F ratios proposed by this alternative would adjust MSY estimates upward, which would serve to increase the rate of fishing mortality applied to the fishery over the long term relative to Alternatives 2 and 4.

Section 6.2.1.1.2 describes the potential effects of fishing on the biological and ecological environments. In summary, overfishing could jeopardize the long-term viability of the stocks and adversely affect the ecosystem of which they are a part. Maintaining the stock at a high biomass level would be expected to reduce the potential for overexploitation due to scientific uncertainty, poor recruitment, and other environmental factors. However, the available yield associated with leaving more fish in the water becomes reduced as populations reach their carrying capacities and density-dependent effects become more dominate.

6.2.2.3.2.1 Caribbean spiny lobster

The F and B ratios defined by Alternative 3 for the Caribbean spiny lobster (1.00; Table 9) do not differ from those proposed by Alternatives 2 and 4 because the status of that species is unknown. These ratios would result in an MSY definition for that species that is equal to the recent average catch if the Council retains MSY Alternative 2 as its preferred.

If the spiny lobster were determined to be at risk, Alternative 3 would support an intermediate rate of fishing on this species relative to F and B Ratio Alternatives 2 and 4 when stock biomass was below B_{MSY}. However, the B and F ratios proposed by this alternative would adjust the MSY estimate upward, serving to increase the rate of fishing mortality applied to the fishery over the long term relative to Alternatives 2 and 4.

6.2.2.3.2.2 Caribbean conch resource

The Caribbean queen conch does not fall into one of the three categories (e.g., not at risk, unknown, at risk) on which the F and B ratios assigned by Alternative 3 are based. That stock has been formally declared "overfished" and "undergoing overfishing" by NMFS (NMFS 2002). However, the relationship between B_{CURR} and B_{MSY} and between F_{CURR} and F_{MSY} has not been quantified. Consequently, the F and B ratios assigned to this stock are defined simply as "greater than one" and "less than one," respectively. This approach allows fishery managers to recognize the need to end overfishing and rebuild this stock, without requiring precise estimates of the B and F ratios.

6.2.2.3.2.3 Caribbean reef fish

The F and B ratios defined by Alternative 3 for reef fish stocks or units of unknown status do not differ from those proposed by Alternatives 2 and 4. These ratios would result in MSY estimates that are equal to recent average catches if the Council retains MSY Alternative 2 as its preferred for those stocks or units.

The F and B ratios defined by this alternative for those reef fish stocks or units that are determined to be at risk (e.g., Snapper Unit 1, Grouper Unit 4, and Parrotfish) would support an intermediate rate of fishing on those stocks or units relative to F and B Ratio Alternatives 2 and 4 when stock biomass was below B_{MSY}. However, the B and F ratios proposed by this alternative would adjust the MSY estimate upward, serving to increase the rate of fishing mortality applied to those stocks or units over the long term relative to Alternatives 2 and 4.

6.2.2.3.2.4 Caribbean coral reef resource

The F and B ratios defined by Alternative 3 for Caribbean coral reef resources (1.00; Table 9) do not differ from those proposed by Alternatives 2 and 4 because the status of those species is unknown. If coral reef resources were determined to be at risk, Alternative 3 would support an intermediate rate of fishing on these species relative to F and B Ratio Alternatives 2 and 4 when stock biomass was below B_{MSY}. However, the B and F ratios proposed by this alternative would adjust the MSY estimate upward, serving to increase the rate of fishing mortality applied to the fishery over the long term relative to Alternatives 2 and 4. F and B ratios do not need to be defined for these species if the Council retains MSY Alternative 3 as preferred alternative.

6.2.2.3.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.2.3.3 Direct and indirect effects on social and economic environment and their significance

6.2.2.3.3.1 Caribbean spiny lobster

The ratios for Caribbean spiny lobster, because no negative or positive determination of risk can be made, would not differ from those given in Alternative 2. Therefore, the reader is referred to Section 6.2.2.2.3.1 for relevant discussion of effects.

6.2.2.3.3.2 Caribbean conch resource

Under preferred Alternative 3, the B_{CURR}/B_{MSY} and F_{CURR}/F_{MSY} proxies for the queen conch resource of the U.S. Caribbean would be <<1 and >1, respectively (Table 9). These are the same ratios used in Alternative 2 and, hence, the reader is referred to section 6.2.2.2.3.2 for a discussion of social and economic effects on the human environment.

6.2.2.3.3.3 Caribbean reef fish resource

The B ratio defined by Alternative 3 for those FMU sub-units believed to be at risk (e.g., Snapper Unit 1, Grouper Unit 4, and Parrotfish) would be set at 0.50, while the ratio would be set at 0.75 under Alternative 2. Hence, a greater depletion of the stock relative to its size at MSY is assumed under Alternative 3 than under Alternative 2. This could result in more severe short-term social and economic effects in the short term if management measures are enacted to end overfishing and/or rebuild the "at risk" stocks. See Section 6.2.2.2.3.3 for a general discussion of the potential effects associated with the proposed definitions for at risk species.

6.2.2.3.3.4 Caribbean coral reef resource

The ratios for Caribbean coral reef resources, because no negative or positive determination of risk can be made, would not differ from those given in Alternative 2. Therefore, the reader is referred to Section 6.2.2.2.3.4 for relevant discussion of effects.

6.2.2.3.4 Direct and indirect effects on administrative environment and their significance

This alternative would directly benefit fishery administrators by providing them information that allows proxy definitions of management reference points to be fine tuned to reflect the best available information on managed stocks or units. This, in turn, would improve management of the resources.

6.2.2.4 Alternative 4. For each FMU sub-unit for which B_{CURR}/B_{MSY} and F_{CURR}/F_{MSY} have not been estimated through a stock assessment or other scientific exercise (i.e., stock status unknown), the following estimates will be used for the F_{CURR}/F_{MSY} and B_{CURR}/B_{MSY} proxies: 1) The default proxies for F_{CURR}/F_{MSY} and B_{CURR}/B_{MSY} are estimated as 1.00; 2) For species that are believed to be at risk based on the best available information, the F_{CURR}/F_{MSY} proxy is estimated as 1.33 and the B_{CURR}/B_{MSY} proxy = c, whereas c is equal to the natural mortality rate (M) or 0.50, whichever is smaller; and 3) For species that are overfished, the F_{CURR}/F_{MSY} proxy is estimated as 2.0 and the B_{CURR}/B_{MSY} proxy = 0.67c, whereas c is equal to the natural mortality rate (M) or 0.50, whichever is smaller.

The F and B ratios that would be assigned to Council-managed stocks and units if this alternative were selected are detailed in Table 9 under the column "F and B Ratio Alt 4." These ratios are described relative to the Council's Preferred FMU Alternative 2 (Section 4.1.1.2) and are based on status determinations made by the SFA Working Group. The information considered in those determinations is described in Section 4.2.2.

6.2.2.4.1 Direct and indirect effects on physical environment and their significance

As explained in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. The F ratio assigned by Alternative 4 to those species believed to be at risk is less conservative than that assigned by Alternatives 2 and 3. However, the B ratios assigned by Alternative 4 to those species believed to be at risk are generally more conservative than those assigned by Alternatives 2 and 3. Alternative 4 would assign more conservative F and B ratios to overfished stocks, including the Nassau and goliath groupers and the queen conch, relative to Alternatives 2 and 3. Consequently, this alternative would be expected to result in the lowest rate of fishing mortality and habitat interactions relative to the other alternatives when stock biomass is below B_{MSY}. However, because the B and F ratios proposed by this alternative would adjust MSY estimates upward, this alternative would support an intermediate rate of fishing mortality and habitat interactions in the fishery over the long term relative to Alternatives 2 and 3. The potential effects of the major gear types used in Caribbean fisheries on the physical environment are described in Section 6.2.1.1.1.

6.2.2.4.2 Direct and indirect effects on biological and ecological environment and their significance

Alternative 4 would define F and B ratios of 1.00 for those stocks or units that are not believed to be at risk (e.g., healthy) or that are of unknown status. At present, no stocks or units fall into the "healthy" category. The status of most stocks or units is unknown. Both the F and B ratios defined by this alternative for those stocks or units that have been determined to be at risk are generally lower relative to Alternatives 2 and 3. In effect, this means that this alternative would presume that "at risk" stocks are experiencing a rate of fishing mortality that is lower than that presumed by Alternatives 2 and 3 (e.g., F_{CURR} is closer to F_{MSY}). However, this alternative also would presume that the biomass of "at risk stocks" is more depressed than what is presumed by Alternatives 2 and 3 (e.g., B_{CURR} is farther below B_{MSY}). Additionally, Alternative 4 would assign more conservative F and B ratios to overfished stocks, including the Nassau and goliath groupers and the queen conch, relative to Alternatives 2 and 3. As a result, this alternative would be expected to result in the lowest rate of fishing mortality relative to the other alternatives when stock biomass is below B_{MSY}, and an intermediate rate of fishing mortality over the long term.

Section 6.2.1.1.2 describes the potential effects of fishing on the biological and ecological environments. In summary, overfishing could jeopardize the long-term viability of the stocks and adversely affect the ecosystem of which they are a part. Maintaining the stock at a high biomass level would be expected to reduce the potential for overexploitation due to scientific uncertainty, poor recruitment, and other environmental factors. However, the available yield associated with leaving more fish in the water becomes reduced as populations reach their carrying capacities and density-dependent effects become more dominate.

6.2.2.4.2.1 Caribbean spiny lobster

The F and B ratios defined by Alternative 4 for the Caribbean spiny lobster (1.00; Table 9) do not differ from those proposed by Alternatives 2 and 3 because the status of that species is unknown. These ratios would result in an MSY definition for that species that is equal to the recent average catch if the Council retains MSY Alternative 2 as its preferred. If the spiny lobster were determined to be at risk, Alternative 4 would support the lowest rate of fishing mortality relative to the other alternatives when stock biomass is below B_{MSY}, and an intermediate rate of fishing mortality over the long term.

6.2.2.4.2.2 Caribbean conch resource

Alternative 4 would define an F ratio of 2.0 for the Caribbean queen conch and a B ratio of 0.20. These definitions are difficult to compare with those provided by F and B Ratio Alternatives 2 and 3, which simply acknowledge that the stock is overfished and experiencing overfishing as reported by NMFS in the 2003 Report to Congress (NMFS 2002). Although this stock was formally declared overfished, the relationship between B_{CURR} and B_{MSY} and between F_{CURR} and F_{MSY} has not been quantified. Any of these approaches would allow fishery managers to recognize the need to end overfishing and rebuild this stock. Alternative 4 would provide precise estimates of the B and F ratios, which were proposed during the scoping process.

6.2.2.4.2.3 Caribbean reef fish

The F and B ratios defined by this alternative for those reef fish stocks or units that are determined to be at risk (e.g., Snapper Unit 1, Grouper Unit 4, and Parrotfish) would support the lowest rate of fishing mortality relative to F and B Ratio Alternatives 2 and 3 when stock biomass was below B_{MSY}. However, the B and F ratios proposed by this alternative would adjust the MSY estimate upward, which would likely result in an intermediate fishing mortality rate over the long term relative to Alternatives 2 and 3.

6.2.2.4.2.4 Caribbean coral reef resource

The F and B ratios defined by Alternative 4 for Caribbean coral reef resources (1.00; Table 9) do not differ from those proposed by Alternatives 2 and 3 because the status of those species is unknown. If coral reef resources were determined to be at risk, Alternative 4 would support the lowest rate of fishing mortality relative to the other alternatives when stock biomass is below B_{MSY}, and an intermediate rate of fishing mortality over the long term. F and B ratios do not need to be defined for these species if the Council retains MSY Alternative 3 as a preferred alternative.

6.2.2.4.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.2.4.3 Direct and indirect effects on social and economic environment and their significance

6.2.2.4.3.1 Caribbean spiny lobster

Because the status of spiny lobster is unknown, this alternative would set the F and B ratio for this species equal to 1.0. Therefore, the effects on the social and economic environment associated with this alternative are identical to those presented in 6.2.2.2.3.1 and are not repeated here. The F and B ratios proposed by Alternative 4 would adjust the MSY estimate upward, which would likely result in an intermediate fishing mortality rate over the long term relative to Alternatives 2 and 3.

6.2.2.4.3.2 Caribbean conch resource

Under Alternative 4, the B and F ratio for the Caribbean queen conch would be set at 0.20 and 2.0, respectively (Table 9). This would indicate that the fishing mortality rate applied to the stock is twice that which would produce MSY, and that the biomass of the stock is at just 20% of that needed to produce MSY. These definitions are not directly comparable with those provided by F and B Ratio Alternatives 2 and 3, which simply acknowledge that the stock is overfished and experiencing overfishing as reported by NMFS in the 2003 Report to Congress (NMFS 2002). Any of these approaches would allow fishery managers to recognize the need to end overfishing and rebuild this stock. Alternative 4 would provide precise estimates of the B and F ratios, which were proposed during the scoping process. The F and B ratios proposed by Alternative 4 would adjust the MSY estimate upward, which would likely result in an intermediate fishing mortality rate over the long term relative to Alternatives 2 and 3.

6.2.2.4.3.3 Caribbean reef fish resource

For those reef fish FMU sub-units for which no determination of risk can be made, the effects on the human environment associated with this alternative would be the same as those identified in Alternatives 2 and 3. The F and B ratios defined by Alternative 4 for those FMU sub-units believed to be at risk would support the lowest fishing mortality rate relative to Alternatives 2 and 3 when stock biomass was below B_{MSY}. This could result in more severe short-term social and economic effects in the short term if management measures are enacted to end overfishing and/or rebuild the "at risk" stocks. See Section 6.2.2.2.3.3 for a general discussion of the potential effects associated with the proposed definitions for at risk species. The F and B ratios proposed by Alternative 4 would adjust the MSY estimate upward, which would likely result in an intermediate fishing mortality rate over the long term relative to Alternatives 2 and 3.

6.2.2.4.3.4 Caribbean coral reef resource

The ratios for Caribbean coral reef resources, because no negative or positive determination of risk can be made, would not differ from those given in Alternative 2. Therefore, the reader is referred to Section 6.2.2.2.3.4 for relevant discussion of effects.

6.2.2.4.4 Direct and indirect effects on administrative environment and their significance

This alternative would directly benefit fishery administrators by providing them information that allows proxy definitions of management reference points to be fine tuned to reflect the best available information on managed stocks or units. This, in turn, would improve management of the resources.

6.2.3 Optimum yield (OY)

Defining OY would not directly affect the physical, biological and ecological, or social/economic environments because this is an administrative action that simply provides fishery managers with a benchmark against which to measure fishery performance. However, it could result in indirect environmental effects because OY is used to determine the optimum rate of fishing mortality to be applied to a fishery over the long term. In this way, the definition of OY can influence decisions about total allowable catch levels.

OY represents the amount or yield of a stock that provides the greatest overall benefit to the Nation. It is to incorporate economic and social factors, but may not be defined as an amount that is greater than MSY. The smaller the buffer between OY and MSY, the greater the risk to the long-term sustainability of the fishery and its surrounding ecosystem. However, short-term social and economic benefits become reduced as the buffer between OY and MSY increases. This section describes the potential indirect effects of the various OY alternatives.

6.2.3.1 Alternative 1. No action. Retain current definitions of OY (if any).

The OY values that would be defined by this alternative relative to the Council's Preferred FMU Alternative 2 (Section 4.1.1.2) are detailed in Table 9 under the column "OY Alt 1."

6.2.3.1.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. OY estimates can influence the degree of fishing gear interactions with bottom habitat by defining what constitutes an optimum rate of fishing mortality. However, the number, nature, and extent of such interactions are more greatly influenced by the type of management measures implemented to manage the extent and distribution of fishing effort.

The estimates defined by OY Alternative 1 for the Caribbean spiny lobster and for queen conch are the highest of all those estimates considered in OY Alternatives 1-4. Consequently, this alternative would be expected to support the highest rate of fishing mortality on those species, and the greatest amount of habitat interactions, relative to the other alternatives. OY Alternative 1 would retain the aggregate OY estimate for Caribbean reef fish. That estimate is much greater than those which would be defined by OY Alternatives 2-4. Consequently, this alternative would be expected to support the highest rate of fishing mortality on reef fish, and the greatest amount of habitat interactions, relative to the other alternatives.

6.2.3.1.2 Direct and indirect effects on biological and ecological environment and their significance

6.2.3.1.2.1 Caribbean spiny lobster

The estimate defined by OY Alternative 1 for the Caribbean spiny lobster (582,000 - 830,000 lbs; Table 9) is the highest of all those estimates considered in OY Alternatives 1-4. Consequently, this alternative would be expected to support the highest rate of fishing mortality on that species relative to the other alternatives. Section 6.2.1.1.2 describes the potential effects of fishing on the biological and ecological environment.

6.2.3.1.2.2 Caribbean conch resource

The OY for queen conch is current defined as all those queen conch that can be landed by commercial and recreational fisheries consistent with management measures set forth in the Queen Conch FMP under a goal of allowing 20% of the spawning stock biomass to remain intact. This OY definition is the least conservative of all those considered in OY Alternatives 1-4. Consequently, this alternative would be expected to support the highest rate of fishing mortality on that species relative to the other alternatives. Section 6.2.1.1.2 describes the potential effects of fishing on the biological and ecological environment.

6.2.3.1.2.3 Caribbean reef fish

OY Alternative 1 would retain the aggregate OY estimate for species in the Caribbean reef fish FMU (7,700,000 lbs; Table 9). That estimate is equal to the status quo MSY estimate and is considerably larger than the estimates provided by OY Alternatives 2-4. The life history (e.g., hermaphroditism), behavioral (e.g., aggregation) characteristics, and ecological functions of a number of species in the reef fish FMU described in Section 6.2.1.1.2 indicate that a more conservative OY definition could be warranted.

Additionally, the aggregate OY definition specified by Alternative 1 would make it difficult for fishery managers to manage and monitor catches of individual species or species groups that require special attention due to life history traits or to a particularly depressed stock biomass.

This is because species- or unit-specific landings trends would be less apparent if overall landings were within the desired level defined by the aggregate OY.

6.2.3.1.2.4 Caribbean coral reef resource

OY Alternative 1 would not provide fishery managers with an OY reference point for species in the Caribbean coral reef resource FMU. Theoretically, failing to define an OY benchmark for these species could adversely affect the biological and ecological environment if biological and ecological goals and objectives were not accounted for (and monitored through) other management reference points. However, the Council has prohibited the take of the most vulnerable coral reef resources since 1995.

6.2.3.1.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.3.1.3 Direct and indirect effects on social and economic environment and their significance

6.2.3.1.3.1 Caribbean spiny lobster

In the Council's Spiny Lobster FMP, OY is defined as "all the non-berried spiny lobsters in the management area having a carapace length of 3.5 inches or greater that can be harvested on an annual basis." One feature of this OY value (i.e., the status quo OY definition) is the absence of any explicit economic or social considerations. Understandably, the biological component needs to be considered, as required by the MSFCMA. However, a simple specification of OY in biological terms is deficient, particularly when management measures are developed to achieve OY.

A second feature of this OY definition is that it does not appear to take a precautionary approach to its specification. In discussing the MSFCMA, Restrepo *et al.* (1998) note that the National Standard Guidelines, in paragraph (f)(5) call for the use of a precautionary approach in specifying OY. In essence, since females will be berried for only part of a year, OY allows for the capture of all spiny lobsters having a carapace length of 3.5 inches or more. Finally, this definition of OY does not consider ecological factors, such as the interaction of fishing gear with habitat. If the capture of spiny lobster using the preferred gear causes any significant habitat degradation, one could argue that OY should be reduced accordingly. Traps account for the majority of spiny lobster landings in the U.S. Caribbean (Section 5.3.3). In 2002, almost one-half of the reported commercial spiny lobster catch in Puerto Rico was taken with fish traps and lobster traps, while most of the remaining catch was taken with SCUBA gear.

OY, as stated in the Council's Spiny Lobster FMP was estimated to range from 582,000 to 830,000 lbs per year. Total catches of this species have averaged 546,640 lbs, annually, during recent years (Table 7). Since current catch is within the range of OY, one would anticipate no indirect effects on the social or economic environment associated with this alternative.

6.2.3.1.3.2 Caribbean conch resource

In the Council's Queen Conch FMP, OY is defined as "all queen conch commercially and recreationally harvested from the EEZ landed consistent with the management measure set forth in this FMP under a goal of allowing 20% of the spawning stock biomass to remain intact." Because scientists do not know whether 20% of the spawning stock biomass is remaining intact, one can not state with any certainty that the OY goal is being achieved. However, the overfished determination provided by NMFS (2002) provides an indication that it is not.

One feature of this definition of OY, which would be retained under Alternative 1, is that it is not specified relative to MSY. A second feature is that it does not explicitly consider social or economic considerations. Third, this OY definition is specified relative to only the EEZ fisheries. One could argue that this may not be consistent with National Standard 3, which states that "to the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination."

Finally, one could argue that this alternative is not precautionary since the OY definition does not appear to be risk averse. Specifically, a spawning stock biomass of 20% tends to be at the low end of the current range of estimates for species similar to queen conch. This factor, in conjunction with the known problems associated with management of the queen conch stock in state waters (particularly Puerto Rico), would tend to suggest that a risk averse goal would call for substantially more than "20% of the spawning stock biomass to remain intact." SCUBA represents the predominate queen conch capture method in both Puerto Rico (accounting for almost 95% of catch in recent years) and the USVI (approximately 90%). Consequently, there appears to be no rationale for adjusting OY to account for ecological factors unless there is some significant (and unknown) predator-prey relationship.

Because the current definition of OY for queen conch would be retained under this alternative, it would not be expected to result in significant indirect social and economic effects unless the status of the stock continues to deteriorate as a result of maintaining the status quo definition of OY.

6.2.3.1.3.3 Caribbean reef fish resource

Under the Council's Reef Fish FMP, OY is defined as "all of the fishes in the management unit that can be harvested by U.S. fishermen under the provisions of the FMP...." This amount was estimated at 7,700,000 lbs. One feature of the status quo OY definition is the absence of any economic or social considerations. Understandably, the biological component needs to be considered, as required by the MSFCMA. However, a simple specification of OY in biological terms is deficient, particularly when management measures are developed to achieve OY. A second feature of this OY definition is that it does not appear to take a precautionary approach to its specification. Specifically, OY is set equal to MSY. Such a setting would not be considered risk averse.

Third, this definition of OY does not consider ecological factors, such as the interaction of fishing gear with habitat. According to trip ticket data, almost 60% of the commercial reef fish catch taken in 2002 was taken by vertical line gear, while another 18% was taken by fish pots. One can surmise from limited catch data on USVI fisheries that the percentage of commercial reef fish catch derived from traps in the USVI exceeds that reported in Puerto Rico. For example, more than 55% of the reported commercial catch of grunts in St. Croix was taken by traps in 2001-2002. But only 16% of the grouper catch was taken with traps. In St. Thomas, more than 85% of the grouper catch was derived from traps, compared to about 27% for snappers. To the extent that fishing gear interactions alter bottom habitat, one could argue that OY should be modified accordingly.

Finally, the current OY definition pertains to the reef fish FMU in aggregate. To the extent that MSY is specified for FMU sub-units (assuming the preferred alternatives in Sections 6.1.1 and 6.2.1 are selected), specification of OY in aggregate would be inconsistent with a desire to manage at a FMU sub-unit basis. Considering all of these factors, one can conclude that the OY definitions provided by Alternative 1 for food fish in the Caribbean reef fish FMU would be inconsistent with MSFCMA guidelines and would result in sub-optimal benefits when compared to other alternatives in this section.

6.2.3.1.3.4 Caribbean coral reef resource

The Council has prohibited the take or possession of all coral resources, other than aquarium trade species, since the implementation of the Coral FMP. Since participation in the fishery, other than the taking of aquarium trade species is prohibited, maintaining the no action alternative (i.e., Alternative 1) is not expected to have any effects on the social or economic environment. The Council would not be required to specify OY for aquarium trade species if the preferred alternative for managing these resources is implemented (Section 4.1.2.2).

6.2.3.1.4 Direct and indirect effects on administrative environment and their significance

The relatively high OY estimates provided by Alternative 1 for the Caribbean spiny lobster, queen conch, and for food fish species in the reef fish FMU could adversely affect the administrative environment if they failed to sustain the fisheries over the long term, as the MSFCMA provisions related to ending overfishing and rebuilding overfished stocks are generally resource intensive. The aggregate OY definition for Caribbean reef fish provided by Alternative 1 would likely negatively affect the administrative environment because that definition is not consistent with the MSFCMA mandate to use the best available information in fishery management decision making. With improved species-specific landings information, it is possible to derive reasonably valid OY estimates for discrete units within that FMU.

6.2.3.2 Alternative 2. Set OY = 0.75(MSY).

The OY values that would be defined by this alternative relative to the Council's Preferred FMU Alternative 2 (Section 4.1.1.2) are detailed in Table 9 under the column "OY Alt 2." These values were calculated using the Council's preferred MSY (Sections 4.2.1 and 6.2.1) and B and F ratio (Sections 4.2.2 and 6.2.2) definitions. They are generally more conservative than those specified by OY Alternatives 1 and 4, but less conservative than those specified by OY Alternative 3. In effect, this alternative would reduce short-term social and economic benefits in favor of ensuring the long-term sustainability of the stocks and associated long-term biological, ecological, social, and economic benefits. The F_{OY} proxy associated with a yield that is equal to (0.75)(MSY) would be defined as $0.5F_{MSY}$, based on assumptions of the logistic growth equation.

6.2.3.2.1 Direct and indirect effects on physical environment and their significance

As explained in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. This alternative would be expected to support a relatively low rate of fishing mortality and habitat interactions relative to the other alternatives. The potential effects of gear used in the spiny lobster, queen conch, reef fish, and coral reef fisheries are described in Section 6.2.1.1.1.

6.2.3.2.2 Direct and indirect effects on biological and ecological environment and their significance

6.2.3.2.2.1 Caribbean spiny lobster

The estimate defined by OY Alternative 2 for the Caribbean spiny lobster (410,000 lbs; Table 9) is the lowest of all those OY estimates considered, with the exception of OY Alternative 3. Consequently, this alternative would be expected to support a relatively low rate of fishing mortality on that species relative to the other alternatives. Section 6.2.1.1.2 describes the potential effects of fishing on the biological and ecological environment.

6.2.3.2.2.2 Caribbean conch resource

The estimate defined by OY Alternative 2 for the Caribbean queen conch (339,000 lbs; Table 9) is the lowest of all those OY estimates considered, with the exception of OY Alternative 3. Consequently, this alternative would be expected to support a relatively low rate of fishing mortality on that species relative to the other alternatives. Section 6.2.1.1.2 describes the potential effects of fishing on the biological and ecological environment. Catch data are not available to calculate an MSY proxy and, therefore the OY value associated with this definition, for the remaining conch resources.

6.2.3.2.2.3 Caribbean reef fish

The estimates defined by OY Alternative 2 for food fish units in the Caribbean reef fish FMU are generally the lowest of all those OY estimates considered, with the exception of OY Alternative 3. The OY estimate defined by OY Alternative 2 for aquarium trade species in the Caribbean reef fish FMU (22,102 specimens; Table 9) is much higher relative to the estimate defined by Alternative 3 (0 specimens; Table 9), but more conservative relative to Alternatives 1 (OY would be undefined) and 4 (27,627 specimens; Table 9). Consequently, this alternative would be expected to support a relatively low rate of fishing mortality on Caribbean reef fish relative to the other alternatives. Section 6.2.1.1.2 describes the potential effects of fishing on the biological and ecological environment. The Council would not be required to define OY for aquarium trade species if the preferred alternative to move those species to a data collection category of the FMU (Section 4.1.2.2) is implemented.

6.2.3.2.2.4 Caribbean coral reef resource

The Council's preferred alternative is to continue prohibiting the take of the most vulnerable coral reef resources, which would effectively define OY as zero for those species (Section 6.2.3.3). Because the status quo for coral species is the prohibition of their harvest, catch data are not available to calculate an MSY or OY proxy for Caribbean coral reef resources. Furthermore, it would be problematic to estimate a biomass ratio due to the biological diversity of the numerous managed coral species and due to the influence of other environmental factors that influence coral biomass. Please refer to Section 6.2.1.3.2.4 for more discussion on this issue.

6.2.3.2.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.3.2.3 Direct and indirect effects on social and economic environment and their significance

The OY proposed by Alternative 2 is risk averse. In discussing the MSFCMA, Restrepo *et al.* (1998) note that the National Standard Guidelines, in paragraph (f)(5) call for the use of a precautionary approach in specifying OY: “[i]n general, Councils should adopt a precautionary approach to specification of OY." There could well be indirect social and economic implications associated with selection of this alternative if catches were managed to achieve OY. The extent and magnitude of such effects would strongly depend upon whether states would adopt the same management goal. To see why this is the case, recall that National Standard 3 states that “to the extent practicable, an individual stock of fish shall be managed as a unit throughout its range...." For species managed by the Council, the range relates to both (a) Puerto Rico and the USVI in total, and to (b) state and federal waters. While a large proportion of federally managed species captured in the USVI apparently are taken in federal waters, evidence, based on very limited information, suggests that catches of federally managed species in federal waters off Puerto Rico are limited; at least for many species.

One alternative for regulating fishing mortality would have NMFS and the states implement compatible regulations *via* a MOU (Sections 4.3.6, 6.3.6). If an MOU were successfully implemented (and enforcement in state waters is adequate), one can surmise that this alternative could result in catch reductions in state as well as federal waters. If the states elected not to adopt the same management goal, it could be impossible for fishery managers to achieve OY in federal waters. Furthermore, given the catch domination of certain species in Puerto Rico vis-a-vis the USVI, one can surmise that, in the absence of compatible goals and regulations in state waters of Puerto Rico, catch reductions in state waters of the USVI may be insufficient to achieve OY for the region (i.e., the U.S. Caribbean).

6.2.3.2.3.1 Caribbean spiny lobster

Under preferred Alternative 2, OY would be set at 410,000 lbs. Total catch of spiny lobster in the U.S. Caribbean has averaged 546,640 lbs annually in recent years (Table 7). Hence to achieve OY, catch, in the long term, would need to be reduced by 25%. This would translate into a reduction in revenues of about $719,410 annually, based on the 1998-2001 average price of $5.265/lb for Puerto Rican spiny lobster (Matos-Caraballo 2002). This number should be used cautiously for at least two reasons. First, a proportion of the reduction would be derived from recreational activities, yet the price used to determine the reduction in revenues pertains only to the commercial dockside price. Second, prices in the USVI tend to exceed those reported in Puerto Rico by a substantial amount (due to direct marketing). But the estimate is based only on the price reported by fishermen in Puerto Rico. Finally, this estimate of reduction in revenues assumes that landings in both state and federal waters are reduced by 25%.

For Puerto Rico, there is no information regarding how much, if any, spiny lobster is captured in federal waters. Given the depth of federal waters, one might expect that catches are relatively limited. Hence, social and economic effects associated with reducing catch in federal waters would likely be relatively limited. However, the social and economic effects associated with reducing catches in state waters would be significantly greater.

Total combined catch of spiny lobster in Puerto Rico averaged 426,187 lbs during 1997-2001. Thus, a long-term reduction of 25% equates to 106,547 lbs annually. Since about 40% of the reported commercial Puerto Rico spiny lobster catch is generally landed in communities along the southern coast, one would expect communities in this area to be particularly impacted, followed by communities along the western coast which account for about a third of all reported commercial landings. More specifically, primary landing sites (based on percentage of total reported commercial landings in 2002) include Esperanza, Morropo, Pastillo, and Puerto Real. These four municipalities reported commercial landings in excess of 20,000 lbs (unadjusted) in 2002, and accounted for one-third of the reported commercial spiny lobster catch (unadjusted) in 2002. Hence, communities in these areas might be particularly impacted by this OY alternative.

Total combined catch of spiny lobster in the USVI averaged 265,534 lbs annually during 1997-2001. A long-term reduction of 25% equates to 66,384 lbs annually. According to monthly catch records reported by St. Croix commercial fishermen, about 45% of the lobster catch is reported along the eastern side of the island, while another third is reported along the southern side of the island. Hence, one might anticipate that the greatest impact on communities associated with this alternative would be along the east and south coasts. In St. Thomas/St. John, about one-quarter of all spiny lobster landings are reported in the area Southwest of St. Thomas, while about 10% of the reported landings occur in each of the following areas: Southeast of St. John, Northeast of St. Thomas, and Northwest of St. Thomas. Hence, one might anticipate that communities in these areas may also be impacted by this alternative.

There is little or no information regarding recreational spiny lobster activities in either Puerto Rico or the USVI and, hence, they are not considered herein.

6.2.3.2.3.2 Caribbean conch resources

Under Alternative 2, OY for queen conch would be set at 339,000 lbs. Recent catch of queen conch in the U.S. Caribbean has averaged 438,948 lbs annually (Table 7). Hence to achieve OY, catch, in the long run, would need to be reduced by about 23%. Loss in revenues at dockside would approximate $230,689 annually, based on the 1998-2001 average price of $2.285/lb for Puerto Rican queen conch (Matos-Caraballo 2002). This number should be used cautiously for at least two reasons. First, a proportion of the reduction would be derived from recreational activities, yet the price used to determine the reduction in revenues pertains only to the commercial dockside price. Second, prices in the USVI tend to exceed those reported in Puerto Rico by a substantial amount (due to direct marketing). But the estimate is based only on the price reported by fishermen in Puerto Rico. Finally, this estimate of reduction in revenues assumes that landings in both state and federal waters are reduced by 23%. Additionally, the queen conch is overfished and, as such, current catch levels may be unsustainable.

As indicated by Rivera (1999), the commercial catch of queen conch in federal waters is apparently quite limited (Sections 5.3.4, 6.4.3.2.2). Hence, if both state and federal governments managed for this OY goal, the majority of the effects associated with a 23% reduction in Puerto Rico landings would be felt by those who fish in state waters. More than one-half of the reported commercial queen conch catch in Puerto Rico is landed along the west coast of the state with about an additional one-quarter of the total being landed in municipalities along the east coast. Landing sites of particular importance include Esperanza, Morropo, and El Combate. These three landing sites accounted for one-half of the total queen conch landings in Puerto Rico in 2002. Hence, communities in these areas might be particularly impacted under this alternative.

Based on monthly trip ticket reports for St. Croix, about one-third of the 2000-2001 (two-year period) commercial queen conch catch occurred along the northeastern section of the island, while about one-quarter of the total catch was taken along the eastern section of the island. Hence, communities in these areas may be particularly impacted by this alternative. By comparison, commercial catch along the western portion of the island was extremely limited. Hence, communities in this area would likely not be significantly impacted. Similarly, commercial queen conch landings in St. Thomas and St. John are extremely limited (less than 2,000 lbs per year). Hence, this alternative would be expected to have minimal effects on communities on these islands.

6.2.3.2.3.3 Caribbean reef fish resources

Under Alternative 2, each sub-unit of the Caribbean reef fish FMU would have its own OY definition. For FMU sub-units defined to be at risk (e.g., Snapper Unit 1, Grouper Unit 4, and Parrotfish), this definition would require, on average, a 52% reduction in current catch. For the remaining FMU sub-units, this definition would require a 25% reduction in catch. In total, OY would require a reduction in catch of about 1,200,000 lbs; based on current catch of 3,290,285,000 lbs (Table 7). At the average 1995-2001 landings price (for Puerto Rico) for all reef fish in the Reef Fish FMP (i.e., $1.99351/lb), this would translate into a reduction from current revenues of over $2,392,212 annually.

This number should be used very cautiously for at least three reasons. First, some FMU sub-units are defined to be overfished and, as such, current catch levels may be unsustainable. Second, the required reduction in poundage includes both commercial and recreational activities. The price used to determine the reduction in revenues, however, refers only to the dockside price for commercially harvested product. Finally, the dockside price used was that for Puerto Rico. The USVI price, as a result of direct marketing of the product, tends to exceed that reported for Puerto Rico by a significant amount.

With respect to Snapper Unit 1, silk snapper dominates commercial landings in Puerto Rico. About 60% of the reported commercial landings of silk snapper are along the west coast. Therefore, one might anticipate that communities in this area would be particularly impacted. By comparison, more than one-half of the reported landings of Snapper Unit 4 (yellowtail) are reported along the south coast. Hence, one might anticipate that communities in this area might be primarily impacted in association with Alternative 2. With respect to the USVI, catches of grouper and snapper appear to be relatively evenly distributed throughout much of St. Croix, as well as St. Thomas/St. John. Hence, one would not expect to find significant disproportionate effects on communities in the USVI associated with this alternative.

In general, however, great uncertainty underlies any type of inferences on effects on communities with respect to reef fish. Given the wide diversity of species, fishermen are likely to change behavior and pursue new target species in response to new catch restrictions and other regulations. Certainly, such effects would be expected in response to the catch reduction associated with the OY definition proposed in Alternative 2. However, almost all areas report significant landings of reef fish (of one type or another) and, therefore, effects in any single community would likely be quite limited.

6.2.3.2.3.4 Caribbean coral reef resource

The Council's preferred alternative is to continue prohibiting the take of the most vulnerable coral reef resources, which would effectively define OY as zero for those species (Section 6.2.3.3). Because the status quo for coral species is the prohibition of their harvest, catch data are not available to calculate an MSY or OY proxy for Caribbean coral reef resources. Furthermore, it would be problematic to estimate a biomass ratio due to the biological diversity of the numerous managed coral species and due to the influence of other environmental factors that influence coral biomass. Please refer to Section 6.2.1.3.2.4 for more discussion on this issue.

6.2.3.2.4 Direct and indirect effects on administrative environment and their significance

The relatively low OY estimates for the Caribbean spiny lobster, queen conch, and reef fish provided by Alternative 2 should benefit the administrative environment by encouraging the development and implementation of management measures that would sustain the stocks over the long term, as well as promote greater constancy and stability in the fisheries.

6.2.3.3 Alternative 3. Set OY = 0.

This alternative is preferred for all species in the Caribbean coral reef resource FMU, excluding those species retained for data collection purposes.

Alternative 3 would set OY equal to zero, indicating that maximum benefit to the Nation would be derived from prohibiting the take of the affected stock or unit (Table 9). This OY definition is the most conservative that could be adopted.

6.2.3.3.1 Direct and indirect effects on physical environment and their significance

As explained in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. The definition provided by OY Alternative 3 is far more conservative than that specified by OY Alternatives 1, 2, and 4. In effect, this definition would set a goal of reducing the take of affected stocks or units to zero. Consequently, this alternative would be expected to indirectly benefit the physical environment by eliminating fishing gear interactions with benthic habitat. The potential effects of gear used in the spiny lobster, queen conch, reef fish, and coral reef fisheries are described in Section 6.2.1.1.1.

6.2.3.3.2 Direct and indirect effects on biological and ecological environment and their significance

6.2.3.3.2.1 Caribbean spiny lobster

Alternative 3 would define OY as zero, indicating that the Caribbean spiny lobster fishery should be closed. As explained in Section 6.2.1.1.2, reducing (or in this case eliminating) fishing mortality would be expected to benefit the biological and ecological environment by helping the stock to return to a natural age, size, and sex structure, and promoting genetic integrity. However, because federal fisheries represent only a small portion of the total fishing mortality on Caribbean spiny lobster, the extent to which such effects were realized would be largely influenced by the amount of fishing mortality applied to the stock in state waters.

Additionally, although populations characterized by natural age structures, size structures, and sex ratios are more resilient to anthropogenic and environmental perturbations, the yield they produce becomes reduced as they reach their carrying capacities and density-dependent effects become more dominant. At high population sizes, older, larger fish occupy the available habitat and use the available food. The presence of these older fish limits the survival of young and inhibits recruitment. Recruitment and production of younger fish can be enhanced with the removal of some of these older, larger fish. Therefore, fishing and density-dependence can have the effect of creating a "surplus production" of fish in the population that is available for capture. The type and magnitude of density- dependent effects that populations will experience as they grow in size are difficult to predict, as they vary from species to species and are based on available resources in a particular system (Wilson and Bossert 1971).

6.2.3.3.2.2 Caribbean conch resource

The effects of defining OY as zero for stocks in the Caribbean conch resource FMU would be similar to those described for the Caribbean spiny lobster in Section 6.2.3.3.2.1.

6.2.3.3.2.3 Caribbean reef fish

The effects of defining OY as zero for stocks in the Caribbean reef fish FMU would be similar to those described for the Caribbean spiny lobster in Section 6.2.3.3.2.1.

6.2.3.3.2.4 Caribbean coral reef resource

Currently, the most vulnerable coral reef species are protected from fishing pressure based on the Council's determination that their ecological or non-consumptive value exceeds their commercial value (CFMC 1994). These resources provide habitat for reef-associated and reef-dependent organisms, buffer against coastal erosion, and have aesthetic values that support tourism and related activities. Given the limited distribution and slow regeneration rates of the majority of these species, as discussed in Section 5.2.1.4, they are considered to be non-renewable resources, for which an OY of zero is the only level which can reasonably be expected to ensure no net loss.

This alternative would support the Council's current prohibition on catch of vulnerable coral reef resources, as well as the Council's policy on coral resources, which recognizes the important ecological role of coral reefs in the marine environment. The Council has identified this OY definition as the preferred for all species in the Caribbean coral reef resource FMU, with the exception of aquarium trade species.

6.2.3.3.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.3.3.3 Direct and indirect effects on social and economic environment and their significance

Setting OY equal to zero may be appropriate in some unusual cases; for example, where fishing under any circumstances causes significant ecological disruption, or where the non-consumptive value associated with maintaining current stocks greatly exceeds consumptive values. However, in most situations, setting OY equal to zero would be considered economically inefficient. Having said this, the situation in the U.S. Caribbean is somewhat unique because such a large portion of the total landings occurs in state waters, particularly off Puerto Rico. Puerto Rico, historically, has not managed state fisheries in a manner that is consistent with federal regulations (the USVI has, to some extent, adopted compatible regulations in many instances). This has reduced the effectiveness of management measures implemented by the Council and has likely contributed to the overfished status of at least some Council-managed species. Setting OY equal to zero, which would effectively close federal waters to fishing, might be warranted if state management is compromising the Council's rebuilding or conservation efforts. From an economic perspective, however, one would need to address the question of whether the benefits of such an insurance policy exceed the costs. The answer to this would depend upon the amount of risk society is willing to accept and how much society is willing to pay to avoid the risk.

6.2.3.3.3.1 Caribbean spiny lobster

Because of a lack of information regarding commercial and recreational catches of Caribbean spiny lobster in federal waters off Puerto Rico, it is difficult to precisely determine the indirect effects associated with setting OY equal to zero. Overall, catches of spiny lobster in the U.S. Caribbean averaged 546,640 lbs annually during recent years (Table 7). Based on the 1998-2001 average Puerto Rico dockside price of $5.265 per lb, the loss in revenue if all fishing activity (state and federal) were curtailed would equal about $2,878,060 annually. This number should be used cautiously for at least two reasons. First, a proportion of the reduction would be derived from recreational activities, yet the price used to determine the reduction in revenues pertains only to the commercial dockside price. Second, prices in the USVI tend to exceed those reported in Puerto Rico by a substantial amount (due to direct marketing). But the estimate is based only on the price reported by fishermen in Puerto Rico.

If curtailment of fishing activity occurred only in federal waters, the reduction in revenues would be significantly less. Generally, the more fishing activity that occurs in federal waters, the greater will be the negative impact; at least in the short-run. The effects include the potential for exiting the fishery by some participants and, more likely, movement of spiny lobster fishing activities from federal waters to state waters. Increased fishing effort in state waters would result in a decline in CPUE among all participants and, likely, a reduction in inframarginal rents (if any) currently accruing from the use of the scarce resource.

Furthermore, increased fishing pressure in state waters implies increased pressure on the proportion of the stock that occurs in state waters. If significant, one can surmise that closing federal waters to fishing for the Caribbean spiny lobster may not lead to any increased long-term benefits generally associated with an increase in stock size because such an increase in stock size would depend on the importance of federal waters to the spiny lobster resource. However, closure of federal waters would provide some measure of protection by effectively creating an MPA for that species.

Spiny lobster landings in St. Croix that were reportedly derived from federal waters between January 2000 and December 2001 totaled about 46,000 lbs, or 45% of the total reported spiny lobster landings of 101,000 lbs. Commercial spiny lobster landings reported in St. Thomas between 2001 and 2002 (i.e., a two year period) were much smaller (16,000 lbs) than those reported for St. Croix. However, the reported percentage of those landings that was derived from federal waters (85%) was significantly higher. Given the prevalence of spiny lobster activities in federal waters off the USVI, one can surmise that USVI participants would be less likely to move their fishing operations to state waters in response to a closure of the EEZ, at least in the short run.

6.2.3.3.3.2 Caribbean conch resource

As is the case with Caribbean spiny lobster, setting OY equal to zero for queen conch would entail closing federal waters to queen conch activities. Section 6.4.3.2.2.3 describes the potential effects of such a closure.

6.2.3.3.3.3 Caribbean reef fish resource

Setting OY equal to zero would entail closing federal waters in the U.S. Caribbean to reef fish activities. Section 6.3.3 provides a detailed discussion of the effects to the human environment associated with such an action. The significance of such effects on Puerto Rican fishermen would, ultimately, depend on whether any significant amount of reef fish fishing activities occur in federal waters off that state. Given the depth of most EEZ waters off Puerto Rico, one might anticipate that activities are quite limited. However, to the extent that activities occur, one might anticipate the primary impact to be related to the movement of these activities to state waters. This movement, at least in the short term, would result in increased competition for the limited reef fish stocks in local waters. Hence, one might anticipate a reduction in CPUE among all commercial participants and a concomitant reduction in revenues for the individual participants in the fishery.

As a result of the declining per participant revenues (and inframarginal profits, if any), one could anticipate a proportion of the participants leaving the fishery in the short term. Assuming closure of federal waters results in long-term expansion of reef fish stocks, however, effort, in the absence of a rational effort management system, would expand. The extent to which the increased effort results in a long-term reduction in stock biomass (i.e., pre-EEZ closure level) would, ultimately, depend on numerous assumptions regarding MPAs. These assumptions are outlined in detail in Section 6.3.3.

While there may be little reef fish fishing activities in federal waters off Puerto Rico, available information suggests that commercial activity in federal waters off the USVI is relatively large. Based on monthly reports by commercial fishermen in St. Croix, for example, about 55% of the snapper catch, 44% of the grouper catch, 35% of the grunt catch, and 15% of the jack catch was reportedly caught in the EEZ during 2000-2001. For St. Thomas, about 45% of the commercial snapper catch, 85% of the grouper catch, 40% of the grunt catch, and 40% of the jack catch occurred in federal waters. Hence, the social and economic effects of closing federal waters, as outlined above and in Section 6.3.3, would be particularly acute in the USVI..

6.2.3.3.3.4 Caribbean coral reef resource

The Council has prohibited the take or possession of all coral resources, other than aquarium trade species, since 1995. Since participation in the fishery, other than the taking of aquarium trade species is prohibited, this alternative would not be expected to have any effects on the social or economic environment. It represents the preferred alternative for coral reef resources, other than aquarium trade species. The Council would not be required to specify OY for aquarium trade species if the preferred alternative for managing these resources is implemented (Section 4.1.2.2). That alternative would move these species to a data collection category of the FMU.

6.2.3.3.4 Direct and indirect effects on administrative environment and their significance

Defining OY as zero would be expected to directly benefit the administrative environment by eliminating the need to develop fishery management measures to constrain catches to a specified level. Closing all federal fisheries to fishing also would reduce the administrative burden associated with enforcing minimum size limits, area closures, and other species-specific management measures. However, prohibiting fishing for all species in the EEZ would be highly controversial. There would be little, if any, administrative effects associated with adopting this alternative for all Caribbean coral reef resources excepting aquarium trade species, because the take and possession of those species is already prohibited by the Council.

6.2.3.4 Alternative 4. Set OY equal to the average yield associated with fishing on a continuing basis at F_{OY}; where $F_{OY} = 0.75F_{MSY}$.

This alternative is preferred for Caribbean queen conch, spiny lobster, and all reef fish, excluding those species retained for data collection purposes.

The OY values that would be defined by this preferred alternative relative to the Council's Preferred FMU Alternative 2 (Section 4.1.1.2) are detailed in Table 9 under the column "OY Alt 4." These values were calculated using the Council's preferred MSY (Sections 4.2.1 and 6.2.1) and B and F ratio (Sections 4.2.2 and 6.2.2) definitions.

This OY definition is derived from technical guidance on implementing the MSFCMA's National Standard 1. The authors of that guidance indicate that fishing at this level adds precaution and maintains stocks at higher biomass levels, while sacrificing only a small amount of catch (Restrepo *et al*. 1998). The actual yield associated with this OY definition would be estimated as 93.75% of MSY. This yield is intermediate to that specified by OY Alternatives 1-3. Similar to OY Alternative 2, this alternative would reduce short-term social and economic benefits in favor of ensuring the long-term sustainability of the stocks and associated long-term biological, ecological, social, and economic benefits. But such reductions in short-term social and economic benefits would be lesser than those resulting from the adoption of the more conservative OY definition in Alternative 2.

6.2.3.4.1 Direct and indirect effects on physical environment and their significance

As explained in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. The estimates specified by OY Alternative 4 for the units in all four Caribbean FMUs are intermediate to those specified by OY Alternatives 1-3. Consequently, this alternative would be expected to support an intermediate rate of fishing mortality and habitat interactions relative to the other alternatives. The potential effects of gear used in the spiny lobster, queen conch, reef fish, and coral reef fisheries are described in Section 6.2.1.1.1.

6.2.3.4.2 Direct and indirect effects on biological and ecological environment and their significance

6.2.3.4.2.1 Caribbean spiny lobster

The estimate defined by OY Preferred Alternative 4 for the Caribbean spiny lobster (513,000 lbs; Table 9) is the highest of all those OY estimates considered, with the exception of OY Alternative 1 (i.e., status quo). Consequently, this alternative would be expected to support a relatively high rate of fishing mortality on that species relative to the other alternatives. Section 6.2.1.1.2 describes the potential effects of fishing on the biological and ecological environment.

6.2.3.4.2.2 Caribbean conch resource

The estimate defined by OY Preferred Alternative 4 for the Caribbean queen conch (424,000 lbs; Table 9) is the highest of all those OY estimates considered, with the exception of OY Alternative 1 (i.e., status quo). Consequently, this alternative would be expected to support a relatively high level of fishing effort on that species relative to the other alternatives.

6.2.3.4.2.3 Caribbean reef fish

The estimates defined by OY Preferred Alternative 4 for food fish units in the Caribbean reef fish FMU are generally the highest of all those OY estimates considered, with the exception of OY Alternative 1 (i.e., status quo). Consequently, this alternative would be expected to support a fairly high rate of fishing mortality on Caribbean reef fish relative to the other alternatives.

6.2.3.4.2.4 Caribbean coral reef resource

The Council's preferred alternative is to continue prohibiting the take of the most vulnerable coral reef resources, which would effectively define OY as zero for those species (Section 6.2.3.3). Because the status quo for coral species is the prohibition of their harvest, catch data are not available to calculate an MSY or OY proxy for Caribbean coral reef resources. Furthermore, it would be problematic to estimate a biomass ratio due to the biological diversity of the numerous managed coral species and due to the influence of other environmental factors that influence coral biomass. Please refer to Section 6.2.1.3.2.4 for more discussion on this issue.

The Council would not be required to define OY for aquarium trade species in the Caribbean coral reef resource FMU if the preferred alternative to move that sub-unit to a data collection category of the FMU (Section 4.1.3.2) is implemented.

6.2.3.4.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.3.4.3 Direct and indirect effects on social and economic environment and their significance

The indirect adverse effects on the human environment associated with this alternative are similar to, but likely significantly less than, those associated with Alternatives 2 and 3 because this preferred alternative would define OY to be a greater proportion (0.9375) of MSY relative to

Alternative 2 (0.75) and Alternative 3 (0). Given the likely paucity of all fishing activity in the EEZ off Puerto Rico, the indirect social and economic effects associated with applying this preferred alternative OY definition to any FMU would likely be minimal. While effects in the USVI would likely be somewhat greater, due to the higher proportion of fishable habitat, and possibly catch, in federal waters, effects would likely still be relatively minor.

6.2.3.4.4 Direct and indirect effects on administrative environment and their significance

The relatively high OY estimates for the Caribbean spiny lobster, queen conch, and reef fish provided by Preferred Alternative 4 could adversely affect the administrative environment if they are not sufficiently precautionary to sustain the fisheries over the long term, as the MSFCMA provisions related to ending overfishing and rebuilding overfished stocks are generally resource intensive. While these definitions are consistent with the technical guidance provided by Restrepo *et al.*, the great deal of uncertainty about the status of U.S. Caribbean stocks and fisheries could warrant a more conservative approach in some cases. However, the preferred alternative would be more conservative and risk aversive than fishing at MSY, it would be consistent with the Technical Guidelines, and would not result in potentially overly-restrictive catch limits as a result of the subsequent selection of a control rule alternative.

6.2.4 Minimum stock size threshold (MSST)

Defining MSST would not directly affect the physical, biological and ecological, or social/economic environments because this is an administrative action that simply provides fishery managers with a defined biomass threshold to use in assessing the sustainability of the biomass of a stock or unit. However, it could result in indirect environmental effects because the MSST defines the proportion of stock or unit biomass that should remain in the water. When biomass decreases below the MSST, fishery managers are required to take action to rebuild the stock or unit to B_{MSY}. This section describes the potential indirect effects of the various MSY alternatives.

6.2.4.1 Alternative 1. No action. Do not define MSST for managed species.

This alternative is preferred for all species in the Coral Reef FMP, excluding those species retained for data collection purposes.

NMFS is considering revisions to the National Standard 1 Guidelines, in particular to §600.310(d)(2). The proposed revisions would provide additional flexibility regarding the requirement for MSSTs for data-poor stocks. Depending on the publication of a Final Rule prior to final action by the Council, the Council may choose not to establish a MSST for some or all Caribbean stocks if it is determined that the available data are inadequate or insufficient for providing a defensible and meaningful estimate.

6.2.4.1.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. Generally, more conservative definitions of MSST call for reducing the overall rate of fishing mortality applied to a fishery relative to less conservative definitions because they require that a larger proportion of stock biomass be protected from fishing mortality. In this way, more conservative MSST definitions can reduce the degree of fishing gear interactions with the sea floor. However, the number, nature, and extent of such interactions are more greatly influenced by the type of management measures implemented to manage the extent and distribution of fishing effort.

MSST Alternative 1 would not provide fishery managers with MSST reference points for Council-managed species. Failing to define MSST for these species could adversely affect the physical environment if the absence of this "trigger" mechanism resulted in unlimited fishing pressure on the stocks, and therefore increased habitat interactions. However, this is unlikely to occur as the fishing mortality rates applied to the stocks will be constrained by the Council's adopted MSY definitions regardless of whether MSST values are specified.

6.2.4.1.2 Direct and indirect effects on biological and ecological environment and their significance

MSST Alternative 1 could result in indirect biological and ecological effects by failing to explicitly define the proportion of stock or unit biomass that should remain in the water. MSST defines the biomass level below which a stock or unit would be considered overfished. Generally, failing to define MSST for Council-managed species could have adverse environmental effects if the absence of this "trigger" mechanism resulted in stocks or units being fished to a level that threatened their long-term viability. This is unlikely to occur if the fishing mortality rates applied to the stocks are suitably constrained at or below those rates that would produce MSY. However, data deficiencies make the MSY estimates considered for these stocks or units somewhat uncertain.

6.2.4.1.2.1 Caribbean spiny lobster

Alternative 1 would not provide fishery managers with an MSST warning signal that would let them know when the sustainability of the Caribbean spiny lobster stock was in jeopardy. As a result, this alternative could potentially result in adverse effects to the stock and surrounding ecosystem. Such effects are described in Section 6.2.1.1.2.

6.2.4.1.2.2 Caribbean conch resource

Alternative 1 would not provide fishery managers with an MSST warning signal that would let them know when the sustainability of the Caribbean conch resources was in jeopardy. As a result, this alternative could potentially result in adverse effects to the queen conch stock and surrounding ecosystem. Such effects are described in Section 6.2.1.1.2.

6.2.4.1.2.3 Caribbean reef fish

Alternative 1 would not provide fishery managers with an MSST warning signal that would let them know when the sustainability of Caribbean reef fish was in jeopardy. As a result, this alternative could potentially result in adverse effects to reef fish and the surrounding ecosystem. Such effects are described in Section 6.2.1.1.2.

6.2.4.1.2.4 Caribbean coral reef resource

Because the status quo for coral species is the continued complete prohibition of harvest (i.e., F equal to zero), and because it would be problematic to estimate a biomass ratio due to the biological diversity of the numerous managed coral species and due to the influence of other environmental factors that influence coral biomass, it is not possible to accurately define an MSST for species in the Coral FMP. Regardless, because the status quo for coral species is the complete prohibition of harvest, and because the MSY and OY preferred alternative for species in the coral FMP would be equal to zero, any harvest above that level (i.e., any harvest aside from permitted collection activities for research, etc.) would introduce an overfished condition.

6.2.4.1.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.4.1.3 Direct and indirect effects on social and economic environment and their significance

6.2.4.1.3.1 Caribbean spiny lobster

In the absence of an MSST definition, one would be lacking a trigger mechanism needed to determine when more restrictive management measures are warranted. This could lead to significant overfished conditions that would translate, in the long term, to a significant reduction in revenues being generated from the fishery, as well as a substantial loss in employment opportunities in both the fishing and related sectors. In the extreme, the fishery may require a prohibition of fishing activities in total as a means of protecting the stock. Such an action would obviously have significant social and economic ramifications.

6.2.4.1.3.2 Caribbean conch resource

The potential indirect social and economic effects associated with this alternative are described in Section 6.2.4.1.3.1.

6.2.4.1.3.3 Caribbean reef fish resource

The potential indirect social and economic effects associated with this alternative are described in Section 6.2.4.1.3.1.

6.2.4.1.3.4 Caribbean coral reef resources

The potential indirect social and economic effects associated with this alternative are described in Section 6.2.4.1.3.1. Given the fact that take of the most vulnerable coral reef resources in federal waters has been prohibited since 1995, one would expect no indirect effects on the human environment associated with this alternative.

6.2.4.1.4 Direct and indirect effects on administrative environment and their significance

This alternative could have a direct adverse effect on the environment because the MSFCMA requires that an objective and measurable criteria for identifying when a fishery is overfished.

6.2.4.2 Alternative 2. Set MSST = B_{MSY}(1-c); where c = the natural mortality rate (M) or 0.50, whichever is smaller.

This alternative is preferred for Caribbean spiny lobster, queen conch, and all species in the reef fish and coral reef resource FMUs, excluding those species retained for data collection purposes.

The MSST definition proposed in Alternative 2 is derived from technical guidance provided by Restrepo *et al.*(1998). It incorporates two important biological parameters: (1) the MSY, and (2) the natural mortality rate (M). MSY is important because the biomass associated with MSY (B_{MSY}) is the target of rebuilding. The natural mortality rate (M) is intended to serve as a surrogate for the productivity of a species and, thus, its rebuilding potential. Species with a high M typically will be able to sustain a higher rate of fishing mortality and rebuild more quickly in response to reduced fishing mortality rates. Therefore, this definition would trigger an overfished determination earlier for those species with a low M and, thus, a lesser potential for rebuilding, compared to species with a higher M and, thus, a greater potential for rebuilding.

This MSST definition also caps the lower boundary at which MSST can be set at a minimum value of $1/2B_{MSY}$ to reduce the risk that stock biomass could decrease to a level from which it would be difficult to rebuild the stock to B_{MSY} within ten years when fishing at the maximum fishing mortality threshold. This is based on guidance provided at 50 CFR §600.310(d)(2)(ii), which specifies that "to the extent possible, the stock size threshold should equal whichever of the following is greater: One-half the MSY stock size, or the minimum stock size at which rebuilding to the MSY level would be expected to occur within ten years if the stock or stock complex were exploited at the maximum fishing mortality threshold...."

The MSST values that would be defined by this alternative relative to the Council's Preferred FMU Alternative 2 (Section 4.1.1.2) are detailed in Table 10 under the column "MSST Alt 2." These values were calculated using the Council's preferred MSY (Sections 4.2.1, 6.2.1) and B and F ratio (Sections 4.2.2, 6.2.2) definitions. Information on the natural mortality rate of each stock and unit is provided in Section 5.2 and in Table 8, respectively.

6.2.4.2.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. The proportion of stock or unit biomass that should be protected from fishing mortality if MSST Alternative 2 is adopted is generally more than that which would be protected under MSST Alternative 3 and less than that which would be protected under MSST Alternative 4. As a result, any indirect effects of this MSST definition to the physical environment would be expected to be beneficial relative to those associated with Alternative 3, and adverse relative to those associated with Alternative 4.

6.2.4.2.2 Direct and indirect effects on biological and ecological environment and their significance

6.2.4.2.2.1 Caribbean spiny lobster

The estimate defined by MSST Alternative 2 for the Caribbean spiny lobster (1,463,000 lbs; Table 10) is intermediate to those MSST estimates defined by Alternatives 3 and 4. Consequently, the proportion of stock biomass this MSST definition would propose to protect from fishing mortality is intermediate to that associated with the other alternatives. The potential adverse effects of fishing on the biological and ecological environment are described in Section 6.2.1.1.2.

6.2.4.2.2.2 Caribbean conch resource

The estimate defined by MSST Alternative 2 for the Caribbean queen conch (1,185,000 - 1,309,000 lbs; Table 10) is intermediate to those MSST estimates defined by Alternatives 3 and 4. Consequently, the proportion of stock biomass this MSST definition would propose to protect from fishing mortality is intermediate to that associated with the other alternatives. The potential adverse effects of fishing on the biological and ecological environment are described in Section 6.2.1.1.2.

6.2.4.2.2.3 Caribbean reef fish

The estimates defined by MSST Alternative 2 for food fish units in the Caribbean reef fish FMU are generally intermediate to those MSST estimates defined by Alternatives 3 and 4. Consequently, the proportion of stock biomass this MSST definition would propose to protect from fishing mortality is intermediate to that associated with the other alternatives. The potential adverse effects of fishing on the biological and ecological environment are described in Section 6.2.1.1.2.

6.2.4.2.2.4 Caribbean coral reef resource

No B_{MSY} estimate is available to calculate the MSST value associated with this definition for species in the coral reef FMU.

6.2.4.2.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.4.2.3 Direct and indirect effects on social and economic environment and their significance

6.2.4.2.3.1 Caribbean spiny lobster

Under Alternative 2, MSST for Caribbean spiny lobster would equal 1,463,000 lbs (Table 10) and the stock would not be considered overfished at this time (e.g., B_{CURR}/MSST = 1.52; Table 8). Because the resource would not be considered overfished, there would be no short-term indirect effects to fishery participants associated with the selection of this preferred alternative. The current status of the Caribbean spiny lobster stock appears to suggest a low likelihood that severely restrictive management measures would need to be imposed in the near future. The Council identified this alternative MSST definition as the preferred for the Caribbean spiny lobster.

6.2.4.2.3.2 Caribbean conch resources

Under Alternative 2, MSST for queen conch would equal 1,185,000 - 1,309,000 lbs (Table 10), and the stock would be considered to be overfished (e.g., B_{CURR}/MSST < 1.00; Table 8). The specification of an overfished status for queen conch has no direct effects on fishing participants. However, rebuilding measures could result in indirect effects on these participants. The effects that would be forthcoming would be expected to be negative in the short term, with benefits accruing over time as the stock is rebuilt. However, in the absence of a comprehensive effort management system, these benefits will be eroded over time as a result of entry into the fishery and/or expanded effort among existing participants.

In general, the type and degree of indirect short-term effects associated with the queen conch rebuilding plan depend on a large number of factors. The first, and perhaps the most relevant, relates to the extent to which fishing activities related to this species occur in federal waters. Rivera (1999) provides evidence that fishing for queen conch in federal waters is relatively limited (Section 6.4.3.2.2). To the extent that Rivera's findings remain valid, if rebuilding measures are applied only to federal waters, both short-term and long-term effects should be negligible. Second, the length of the rebuilding schedule will influence the extent of short-term effects. In general, lengthening the rebuilding schedule will lessen the short-term effects. However, lengthening the rebuilding schedule will also increase the time frame before benefits begin to accrue in any meaningful manner.

Third, the specific management measures selected to rebuild the stock will directly influence short-term effects because alternative management measures impose different levels of costs on participants. Finally, though tied implicitly to management measures, in the absence of an effective rational effort management system, the long-term benefits associated with rebuilding the stock are likely to be considerably less than if some rational effort management system is established. The Council identified this alternative MSST definition as the preferred for the queen conch.

6.2.4.2.3.3 Caribbean reef fish resource

The following sub-units in the Caribbean reef fish FMU would be considered overfished according to the MSST definition provided by Alternative 2: Grouper Unit 1 (MSST between 18,000 and 171,000 lbs (Table 10); B_{CURR}/MSST << 0.90 (Table 8), Grouper Unit 2 (MSST between 38,000 and 114,000 lbs (Table 10); B_{CURR}/MSST << 0.95 (Table 8)), and Grouper Unit 4 (MSST equal to 528,000 lbs (Table 10); B_{CURR}/MSST = 0.91 (Table 8)). An overfished determination necessitates management action to rebuild the stocks or FMU sub-units to B_{MSY}, and such action could have indirect effects on fishery participants. The effects that would be forthcoming would be expected to be negative in the short term, with benefits accruing over time as the stocks are rebuilt.

In general, the type and degree of indirect short-term effects associated with reef fish rebuilding plans depend on a large number of factors. The first, and perhaps the most relevant, relates to the extent to which fishing activities related to these species occur in federal waters. If rebuilding measures are applied only to federal waters and fishing activities on these stocks in federal waters are negligible or nonexistent, both short-term and long-term effects also will be negligible. Second, the length of the rebuilding schedule will influence the extent of short-term effects. In general, lengthening the rebuilding schedule will lessen the short-term effects. However, lengthening the rebuilding schedule will also increase the time frame before benefits begin to accrue in any meaningful manner. Third, the specific management measures selected to rebuild the stock will directly influence short-term effects because alternative management measures impose different levels of costs on participants. Finally, though tied implicitly to management measures, in the absence of an effective rational effort management system, the long-term benefits associated with rebuilding the stock are likely to be considerably less than if some rational effort management system is established.

The remaining food fish sub-units in the reef fish FMU would not be considered overfished and, hence, no management action would be required. These FMU sub-units include the Snapper Units 1-3, Grouper Unit 3, Grunt Unit, Goatfish Unit, Porgy Unit, Squirrelfish Unit, Tilefish Unit, Jack Unit, Parrotfish Unit, Surgeonfish Unit, Triggerfish and Filefish Unit, Boxfish Unit, Wrasse Unit, and Angelfish Unit. Because no further management actions would be required for these stocks or units, there would be no indirect effects to fishery participants associated with the selection of this alternative in the short term. Should increased fishing pressure reduce these stocks to an overfished condition, indirect effects would become relevant. The Council identified this alternative MSST definition as the preferred for food fish species in the Caribbean reef fish FMU.

6.2.4.2.3.4 Caribbean coral reef resources

No B_{MSY} estimate is available to calculate the MSST value associated with this definition for species in the coral reef FMU.

6.2.4.2.4 Direct and indirect effects on administrative environment and their significance

Specifying MSST would directly benefit the administrative environment, as the MSFCMA requires that this parameter be defined for managed species. If stock biomass falls below the threshold level defined by this parameter, fishery managers would be required to develop and implement a plan to rebuild the stock. Such plans are generally resource intensive, but benefit management overall by recovering the biomass of overfished stocks to sustainable levels. The smaller the buffer between MSST and B_{MSY}, the more often the rebuilding plan requirement will be triggered but the sooner the stock will be rebuilt. This alternative appears to provide a compromise relative to the other alternatives in that it sets realistic goals for stock rebuilding without frequently (or unnecessarily) burdening the administrative environment.

6.2.4.3 Alternative 3. Set MSST = B_{MSY}(0.50).

Alternative 3 would define MSST as one-half of B_{MSY} regardless of the productivity of the stock. The MSST values that would be defined by this alternative relative to the Council's Preferred FMU Alternative 2 (Section 4.1.1.2) are detailed in Table 10 under the column “MSST Alt 3.” These values were calculated using the Council's preferred MSY (Sections 4.2.1, 6.2.1) and B and F ratio (Sections 4.2.2, 6.2.2) definitions.

6.2.4.3.1 Direct and indirect effects on physical environment and their significance

As explained in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. The proportion of stock or unit biomass that should be protected from fishing mortality if MSST Alternative 3 is adopted is generally less than that which would be protected under MSST

Alternatives 2 and 4. As a result, any indirect effects of this MSST definition to the physical environment would be expected to be adverse relative to those associated with Alternatives 2 and 4.

6.2.4.3.2 Direct and indirect effects on biological and ecological environment and their significance

6.2.4.3.2.1 Caribbean spiny lobster

The estimate defined by MSST Alternative 3 for the Caribbean spiny lobster (1,109,000 lbs; Table 10) is the lowest of all those MSST estimates considered, with the exception of MSST Alternative 1, which would not define MSST for this species. The lower the MSST, the greater the risk to the long-term sustainability of the fishery and its surrounding ecosystem (Section 6.2.1.1.2). As a result, any indirect effects of this MSST definition to the biological and ecological environments would be expected to be adverse relative to those associated with Alternatives 2 and 4.

6.2.4.3.2.2 Caribbean conch resource

The estimate defined by MSST Alternative 3 for the Caribbean queen conch (847,000 - 935,000 lbs; Table 10) is the lowest of all those MSST estimates considered, with the exception of MSST Alternative 1, which would not define MSST for this species. The lower the MSST, the greater the risk to the long-term sustainability of the fishery and its surrounding ecosystem (Section 6.2.1.1.2). As a result, any indirect effects of this MSST definition to the biological and ecological environments would be expected to be adverse relative to those associated with Alternatives 2 and 4.

6.2.4.3.2.3 Caribbean reef fish

The estimates defined by MSST Alternative 3 for food fish units in the Caribbean reef fish FMU are generally the lowest of all those MSST estimates considered, with the exception of MSST Alternative 1, which would not define MSST for this species. The lower the MSST, the greater the risk to the long-term sustainability of the fishery and its surrounding ecosystem (Section 6.2.1.1.2). As a result, any indirect effects of this MSST definition to the biological and ecological environments would be expected to be adverse relative to those associated with Alternatives 2 and 4.

6.2.4.3.2.4 Caribbean coral reef resource

No B_{MSY} estimate is available to calculate the MSST value associated with this definition for species in the coral reef FMU.

6.2.4.3.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.4.3.3 Direct and indirect effects on social and economic environment and their significance

6.2.4.3.3.1 Caribbean spiny lobster

Under this alternative, MSST for Caribbean spiny lobster would equal 1,109,000 lbs, which is significantly less than B_{CURR}, which is estimated to equal 2,217,334 lbs. Because MSST is significantly less than the estimated B_{CURR}, the stock would not be considered overfished according to this definition. Because the resource would not be considered overfished, there would be no indirect effects to fishery participants associated with the selection of this alternative unless an increase in fishing pressure caused stock biomass to decline below the MSST. The current status of the Caribbean spiny lobster stock appears to suggest a low likelihood that severely restrictive management measures would need to be imposed in the near future.

6.2.4.3.3.2 Caribbean conch resources

Since the threshold for defining overfishing under Alternative 3 is less restrictive than that associated with Alternative 2, the effects on the human environment associated with this alternative may not be as large as those associated with Alternative 2. However, the general types of effects would be the same as previously outlined in Section 6.2.4.2.3.2.

6.2.4.3.3.3 Caribbean reef fish resource

Since the threshold for defining overfishing under Alternative 3 is less restrictive than that associated with Alternative 2, a number of the FMU sub-units that would be considered to be overfished under Alternative 2 would not be considered overfished under Alternative 3 (e.g., Grouper Unit 4). Grouper Units 1 (Nassau grouper) and 2 (Goliath grouper) are the only Caribbean reef fish FMU sub-units that would be considered overfished under this alternative definition of MSST. Because possession of both Nassau grouper and Goliath grouper has been prohibited in federal waters since 1990 and 1993, respectively, one would anticipate that the indirect effects on the human environment associated with this alternative would be negligible.

6.2.4.3.3.4 Caribbean coral reef resources

No B_{MSY} estimate is available to calculate the MSST value associated with this definition for species in the coral reef FMU.

6.2.4.3.4 Direct and indirect effects on administrative environment and their significance

Specifying MSST would directly benefit the administrative environment, as the MSFCMA requires that this parameter be defined for managed species. If stock biomass falls below the threshold level defined by this parameter, fishery managers would be required to develop and implement a plan to rebuild the stock. Such plans are generally resource intensive, but should benefit management overall by recovering the biomass of overfished stocks to sustainable levels. The extent to such benefits were realized would depend on the amount of fishing activity occurring in state waters. The smaller the buffer between MSST and B_{MSY}, the more often the rebuilding plan requirement will be triggered but the sooner the stock will be rebuilt. The MSST definition provided by Alternative 3 could make it more difficult to rebuild a stock from MSST to B_{MSY} within ten years while fishing at MFMT, particularly if the stock was not very productive.

6.2.4.4 Alternative 4. Set MSST = B_{MSY}.

The MSST values that would be defined by this alternative relative to the Council's Preferred FMU Alternative 2 (Section 4.1.1.2) are detailed in Table 10 under the column "MSST Alt 4." These values were calculated using the Council's preferred MSY (Sections 4.2.1, 6.2.1) and B and F ratio (Sections 4.2.2, 6.2.2) definitions. If all other factors remained constant, Alternative 4 would build additional conservatism into the definition of MSST by eliminating the buffer between MSST and B_{MSY} so that a stock would never be permitted to fall below B_{MSY} without triggering an "overfished" determination and the need to develop a rebuilding plan within one year of that determination.

6.2.4.4.1 Direct and indirect effects on physical environment and their significance

As explained in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. The proportion of stock or unit biomass that should be protected from fishing mortality if MSST Alternative 4 is adopted is higher than that which would be protected under MSST Alternatives 2 and 3. As a result, any indirect effects of this MSST definition to the physical environment would be expected to be beneficial relative to those associated with Alternatives 2 and 3.

6.2.4.4.2 Direct and indirect effects on biological and ecological environment and their significance

6.2.4.4.2.1 Caribbean spiny lobster

The estimate defined by MSST Alternative 4 for the Caribbean spiny lobster (2,217,000 lbs; Table 10) is the highest of all those MSST estimates considered. The potential biological and ecological benefits of maintaining a higher stock biomass are discussed in Section 6.2.1.1.2.

6.2.4.4.2.2 Caribbean conch resource

The estimate defined by MSST Alternative 4 for the Caribbean queen conch (1,693,000 - 1,871,000 lbs; Table 10) is the highest of all those MSST estimates considered. The potential biological and ecological benefits of maintaining a higher stock biomass are discussed in Section 6.2.1.1.2.

6.2.4.4.2.3 Caribbean reef fish

The estimates defined by MSST Alternative 4 for food fish units in the Caribbean reef fish FMU are the highest of all those MSST estimates considered. The potential biological and ecological benefits of maintaining higher stock biomass levels are discussed in Section 6.2.1.1.2.

6.2.4.4.2.4 Caribbean coral reef resource

No B_{MSY} estimate is available to calculate the MSST value associated with this definition for species in the coral reef FMU.

6.2.4.4.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.4.4.3 Direct and indirect effects on social and economic environment and their significance

6.2.4.4.3.1 Caribbean spiny lobster

Alternative 4 would define the MSST of the Caribbean spiny lobster as 2,217,000 lbs (Table 10), and the stock would not be considered overfished (e.g., B_{CURR}/MSST = 1.00). Because the fishery would not be considered overfished, no management actions would be required. However, given that current biomass would be equal to the MSST, some management action might be considered to ensure that the stock does not become overfished in the future. While such action would likely entail indirect effects on the social and economic environment, the degree or extent of these effects cannot be determined in the absence of information on what measures would be taken. Long-term benefits would be in the provision of additional assurance that the stock would not be placed in an overfished status.

6.2.4.4.3.2 Caribbean conch resources

MSST for Caribbean queen conch under Alternative 4 would be set at 1,693,000 - 1,871,000 lbs (Table 10), and the stock would be considered overfished. The specification of an overfished status for queen conch would trigger the need for management action to rebuild the stock, and such action could affect fishery participants. The effects that would be forthcoming would be expected to be negative in the short term, with benefits accruing over time as the stock is rebuilt.

In general, the type and degree of indirect short-term effects associated with the queen conch rebuilding plan depend on a large number of factors. The first, and perhaps the most relevant, relates to the extent to which fishing activities related to this species occur in federal waters. Rivera (1999) provides evidence that fishing for queen conch in federal waters is relatively limited (Section 6.4.3.2.2). To the extent that Rivera's findings remain valid, if rebuilding measures are applied only to federal waters, both short-term and long-term effects should be negligible. Second, the length of the rebuilding schedule will influence the extent of short-term effects. In general, lengthening the rebuilding schedule will lessen the short-term effects. However, lengthening the rebuilding schedule will also increase the time frame before benefits begin to accrue in any meaningful manner.

Third, the specific management measures selected to rebuild the stock will directly influence short-term effects because alternative management measures impose different levels of costs on participants. Finally, though tied implicitly to management measures, in the absence of an effective rational effort management system, the long-term benefits associated with rebuilding the stock are likely to be considerably less than if some rational effort management system is established. The Council identified this alternative MSST definition as the preferred for the queen conch.

6.2.4.4.3.3 Caribbean reef fish resources

Because the threshold for defining an overfished condition under Alternative 4 is more restrictive than that associated with Alternatives 2 and, the parrotfish sub-unit that would not be considered to be overfished under Alternatives 2 and/or 3 would be considered overfished under Alternative 4. The remaining food fish sub-units in the Caribbean reef fish FMU would not be considered overfished. The social and economic effects associated with both "overfished" and "not overfished" determinations are described in Section 6.2.4.2.3.3.

6.2.4.4.3.4 Caribbean coral reef resources

No B_{MSY} estimate is available to calculate the MSST value associated with this definition for species in the coral reef FMU.

6.2.4.4.4 Direct and indirect effects on administrative environment and their significance

Specifying MSST would directly benefit the administrative environment, as the MSFCMA requires that this parameter be defined for managed species. If stock biomass falls below the threshold level defined by this parameter, fishery managers would be required to develop and implement a plan to rebuild the stock. Such plans are generally resource intensive, but benefit management overall by recovering the biomass of overfished stocks to sustainable levels. The smaller the buffer between MSST and B_{MSY}, the more often the rebuilding plan requirement will be triggered but the sooner the stock will be rebuilt.

MSST Alternative 4 would provide the greatest assurance of all the MSST alternatives that an overfished stock could be rebuilt to B_{MSY} within ten years. The tradeoff associated with this assurance is that natural variation in recruitment could cause the stock to more frequently alternate between an overfished and rebuilt condition, even if the fishing mortality rate applied to the stock was within the limits specified by the MFMT. As a result, this MSST definition could excessively burden the administrative environment by frequently triggering overfishing definitions and unnecessarily restricting fishing effort. However, the likelihood of this occurring would be reduced if the stocks were managed to achieve OY.

6.2.5 Maximum fishing mortality threshold (MFMT), and limit and target control rules.

Defining limit (MFMT/ABC) and target (OY) control rules could directly affect the physical, biological and ecological, and social/economic environments because such rules specify the amount of fish that can (limit rule) and should (target rule) be taken annually in the fishery under various conditions to achieve a long-term average catch approximating MSY and OY, respectively. This section describes the potential indirect effects of the various MSY alternatives.

6.2.5.1 Alternative 1. No action. Do not define MFMT or control rules for FMU sub-units.

6.2.5.1.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. The MFMT (ABC) calculated by limit control rules defines the threshold that would trigger an overfishing determination and related legal requirements. Consequently, failing to define a limit control rule could adversely affect the physical environment if the lack of this trigger mechanism resulted in an unsustainable level of fishing activity (and associated habitat interactions) that continued unabated. Additionally, failing to define a target control rule could adversely affect the physical environment if it compromised the ability of fishery managers to achieve OY over the long term. The potential effects of gear used in the spiny lobster, queen conch, reef fish, and coral reef fisheries are described in Section 6.2.1.1.1.

6.2.5.1.2 Direct and indirect effects on biological and ecological environment and their significance

6.2.5.1.2.1 Caribbean spiny lobster

Alternative 1 would not provide fishery managers with control rules for the Caribbean spiny lobster. As a result, no MFMT would be defined for that species and there would be no pre-agreed upon strategy for managing catches of that species to avoid overfishing and to achieve OY over the long term. This alternative could adversely affect the biological and ecological environment if it resulted in overfishing that was left unchecked for too long. As explained in Section 6.2.1.1.2, overfishing could ultimately affect the size and age structure, size and age at maturity, and sex ratio of the spiny lobster stock. Additionally, it could lead to growth overfishing and recruitment failure, compromise the genetic integrity of the population, and alter the community structure and ecological functions of the supporting reef ecosystem.

6.2.5.1.2.2 Caribbean conch resource

Alternative 1 would not provide fishery managers with control rules for species in the Caribbean conch resource FMU. As a result, no MFMT would be defined for those species and there would be no pre-agreed upon strategy for managing catches to avoid overfishing and to achieve OY over the long term. This alternative could adversely affect the biological and ecological environment if it resulted in overfishing that was left unchecked for too long. As explained in Section 6.2.1.1.2, overfishing could ultimately affect the size and age structure, size and age at maturity, and sex ratio of stocks. Additionally, it could lead to growth overfishing and recruitment failure, compromise the genetic integrity of affected populations, and alter the community structure and ecological functions of the supporting reef ecosystem.

6.2.5.1.2.3 Caribbean reef fish

Alternative 1 would not provide fishery managers with control rules for species in the Caribbean reef fish FMU. As a result, no MFMT would be defined for those species and there would be no pre-agreed upon strategy for managing catches to avoid overfishing and to achieve OY over the long term. This alternative could adversely affect the biological and ecological environment if it resulted in overfishing that was left unchecked for too long. As explained in Section 6.2.1.1.2, overfishing could ultimately affect the size and age structure, size and age at maturity, and sex ratio of stocks. Additionally, it could alter the size and age at transition of hermaphroditic species, lead to growth overfishing and recruitment failure, compromise the genetic integrity of affected populations, and alter the community structure and ecological functions of the supporting reef ecosystem.

6.2.5.1.2.4 Caribbean coral reef resource

Alternative 1 would not provide fishery managers with control rules for species in the Caribbean coral reef resource FMU. As a result, no MFMT would be defined for those species and there would be no pre-agreed upon strategy for managing catches to avoid overfishing and to achieve OY over the long term. This alternative could adversely affect the biological and ecological environment if it resulted in overfishing that was left unchecked for too long. However, this is unlikely to occur because the Council has prohibited fishing for the most vulnerable coral reef resources since 1995, despite the lack of management reference points for those species.

6.2.5.1.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.5.1.3 Direct and indirect effects on social and economic environment and their significance

The MFMT provides a benchmark for determining when overfishing is occurring. Exceeding MFMT for a period of one or more years would constitute overfishing and would trigger management action to reverse the overfishing status. Such management action could affect fishery participants. Without control rules, fishery scientists and managers would lack a trigger mechanism to indicate when additional management measures are warranted. This could lead to significant overfished conditions that would translate, in the long term, to a significant reduction in revenues being generated from the affected fisheries, as well as a substantial loss in employment opportunities in both the harvesting and related sectors. In the extreme, overfished fisheries may require a prohibition of fishing activities in total as a means of protecting the stocks. Such an action would have significant social and economic ramifications.

6.2.5.1.3.1 Caribbean spiny lobster

To the extent that MFMT is correctly specified, taking no action when overfishing is occurring could result in depletion of the stock and, could, potentially, result in an overfished status. Depletion of the Caribbean spiny lobster stock would, in the long run, likely translate into lower yields and, as such, lower revenues being generated from the fishery. To the extent that inframarginal rents are being generated in the fishery, the reduction in stock biomass would likely result in a reduction in these rents. Finally, if the overfishing causes stock biomass to fall below the overfished threshold, more significant management actions would be required. These more severe restrictions could, potentially, have social and economic impacts significantly greater than if action had been taken in the presence of overfishing. If MFMT were underestimated„ management action may be taken that is not warranted. In this situation, costs would be imposed on fishing participants with no long-term benefits forthcoming.

6.2.5.1.3.2 Caribbean conch resources

Assuming the preferred alternative in Section 6.2.4 (MSST) is adopted, queen conch will be defined as overfished and management action will be required to rebuild the stock. Given that rebuilding of the stock will be required, taking no action with respect to defining MFMT for queen conch will likely have no impact on fishery participants as the stock is being rebuilt. However, specification of MFMT could, in practice, provide an additional benchmark to assist in determining whether the fishing mortality rate applied to the stock is sustainable. Failure to define MFMT could result in overfishing once the stock is rebuilt. Such activity could result in a reversal of gains made in recovering stock biomass to B_{MSY}. Any benefits associated with an interim rebuilding program will be dissipated over time if a more rational management system is not adopted.

6.2.5.1.3.3 Caribbean reef fish

Assuming the preferred alternative in Section 6.2.4 (MSST) is adopted, some reef fish FMU sub-units will be considered as overfished, while others will not (see Section 6.2.4.2.3.3). For those not declared as overfished, the effects of not defining MFMT would be similar to those discussed for the Caribbean spiny lobster (Section 6.2.5.1.3.1). For those declared as overfished, the effects would be similar to those defined for the queen conch resource (Section 6.2.5.1.3.2). Any benefits associated with an interim rebuilding program will be dissipated over time if a more rational management system is not adopted.

6.2.5.1.3.4 Caribbean coral reef resources

Alternative 1 would not provide fishery managers with control rules for species in the Caribbean coral reef resource FMU. As a result, no MFMT would be defined for those species and there would be no pre-agreed upon strategy for managing catches to avoid overfishing and to achieve OY over the long term. This alternative could adversely affect the social and economic environments if it resulted in overfishing that was left unchecked for too long. However, this is unlikely to occur because the Council has prohibited fishing for the most vulnerable coral reef resources since 1995, despite the lack of management reference points for those species.

6.2.5.1.4 Direct and indirect effects on administrative environment and their significance

Control Rule Alternative 1 would leave undefined explicit yield-based strategies for managing catches to avoid overfishing and to achieve OY. Adjustments to current management measures desired to accomplish these management goals and objectives could be achieved with or without the use of a control rule. However, NMFS' *Technical Guidance on the Use of Precautionary Approaches to Implementing National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act* recommends that fishery managers establish such a rule to assist in planning how fishing effort will be managed to achieve established goals (Restrepo et al. 1999). Additionally, the MFMT parameter defined by limit control rules, is required by the MSFCMA. Consequently, this alternative would be expected to have adverse effects on the administrative environment if it were applied to managed species.

6.2.5.2 Alternative 2.

A) Specify an MSY control rule to define MFMT and ABC as follows: 1) If $B_{CURR}/B_{MSY} < B_{MIN}$, then ABC = 0; 2) If B_{CURR}/B_{MSY} 1, then ABC = MSY; and 3) If B_{CURR}/B_{MSY} is between B_{MIN} and 1, then ABC = $(MSY/(1-B_{MIN}))((B_{CURR}/B_{MSY})-B_{MIN})$; where $B_{MIN} = 0.25$; and

B) Specify an OY control rule to define target catch levels such that : 1) If $B_{CURR}/B_{MSY} < B_{MIN}$, then target catch levels = 0; 2) If B_{CURR}/B_{MSY} 1, then target catch levels = OY; and 3) If B_{CURR}/B_{MSY} is between B_{MIN} and 1, then target catch levels = $(OY/(1-B_{MIN}))(B_{CURR}/B_{MSY}-B_{MIN})$; where $B_{MIN} = 0.25$.

Control Rule Alternative 2 is based on a constant catch strategy. When stock biomass is at or above B_{MSY}, the limit control rule described by this alternative would define the level of catch that would trigger an overfishing determination to be equal to MSY. This rule would not allow the limit catch level to increase in response to an increase in stock biomass above the MSY level. If stock biomass decreased below B_{MSY}, this rule would decrease the limit catch level proportionately. In other words, the further stock biomass declined below B_{MSY}, the further the limit catch level would be reduced from MSY. The target control rule described by this alternative would prescribe a harvest level equal to OY when stock biomass was at B_{MSY} or higher, and would reduce target catch levels proportionately when stock biomass decreased below B_{MSY}. If stock biomass decreased below the identified threshold level defined as B_{MIN}, both the limit and target control rules would require that catches be reduced to zero. The B_{MIN} component of the rule is defined to equal 25% of the unfished abundance level, or about 10-15% of B_{MSY}.

Components of the rule that would scale back catch levels if stock biomass drops below B_{MSY} , and prohibit fishing if stock biomass declines below B_{MIN}, are meant to promote resiliency in the face of management error. Sladek Nowlis and Bollermann (2002) showed that the use of B_{MIN} nearly guaranteed that a species would not collapse, even in the face of very large directed errors in the management system. The constant catch policy employed by the rule also is designed to promote greater resiliency, as well as constancy of catches, and stock abundance (Sladek Nowlis, in press). The tradeoff for such benefits is foregone yield, as well as associated social and economic benefits.

Table 10 details the specific limit and target catch levels defined by this alternative relative to the Council's Preferred FMU Alternative 2 (Section 4.1.1.2). These values were calculated using the Council's preferred biological reference point and status determination criteria alternatives, which are summarized in Table 8. Table 11 describes the reductions in catch that would be prescribed by each rule relative to average catches from 1997-2001. The MSY and OY rules described by this alternative are illustrated in Figure 2.

6.2.5.2.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. It is impossible to determine with certainty how Control Rule Alternative 2 would affect such interactions. However, we can theorize about the magnitude of effects associated with this alternative by considering the rate of fishing mortality it would support under various stock conditions. Overall, this control rule alternative would be expected to support an intermediate rate of fishing mortality (and habitat interactions) relative to the other control rule alternatives. The potential effects of gear used in the spiny lobster, queen conch, reef fish, and coral reef fisheries are described in Section 6.2.1.1.1.

6.2.5.2.2 Direct and indirect effects on biological and ecological environment and their significance

6.2.5.2.2.1 Caribbean spiny lobster

The limit and target catch levels defined by Control Rule Alternative 2 for the Caribbean spiny lobster (547,000 lbs and 410,000 lbs, respectively; Table 10) are among the highest considered. However, the constant catch and B_{MIN} components of this rule would add precautionary aspects to the management of this species that are not shared by all the control rule alternatives. Consequently, the biological and ecological benefits of this alternative would be expected to be intermediate to those provided by Control Rule Alternatives 3-7. The types of benefits provided would be related to preventing overfishing and maintaining a more natural stock structure (see Section 6.2.1.1.2 for more information).

6.2.5.2.2.2 Caribbean conch resource

Because no discrete B and F ratios have been selected for queen conch, in large part due to its overfished status, it is not currently practical to define limit and target catch levels for this species. Discussion on the Council's preferred alternative to prohibit the harvest and possession of queen conch in the EEZ is presented in Section 6.4.2.2.2.

6.2.5.2.2.3 Caribbean reef fish

The limit and target catch levels defined by Control Rule Alternative 2 for the sub-units of the Caribbean reef fish FMU are among the highest considered. However, the constant catch and B_{MIN} components of this rule would add precautionary aspects to the management of these species that are not shared by all the control rule alternatives. Consequently, the biological and ecological benefits of this alternative would be expected to be intermediate to those provided by Control Rule Alternatives 3-7. The types of benefits provided would be related to preventing overfishing and maintaining a more natural stock structure (see Section 6.2.1.1.2 for more information).

Because no discrete B and F ratios have been selected for Goliath and Nassau grouper, in large part due to their overfished status, it is not currently practical to define limit and target catch levels for these species. Further, the harvest of both species is currently prohibited in federal waters, as well as state waters, with the exception of Nassau grouper in the USVI.

6.2.5.2.2.4 Caribbean coral reef resource

Catch data are not available to calculate an MSY proxy, and therefore limit and target catch levels, for Caribbean coral reef resources. This is not likely to adversely affect the biological or ecological environments because the Council has prohibited the take of the most vulnerable coral reef resources since 1995, despite the absence of management reference points.

6.2.5.2.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.5.2.3 Direct and indirect effects on social and economic environment and their significance

6.2.5.2.3.1 Caribbean spiny lobster

Under this alternative, the Caribbean spiny lobster would not be considered to be undergoing overfishing and, hence, no management measures would be required if status quo fishing conditions were to continue. Therefore, one would anticipate no indirect effects on the human environment associated with this alternative. The constant catch and B_{MIN} components of this rule would promote resiliency if MFMT is underestimated or overestimated.

6.2.5.2.3.2 Caribbean conch resources

Under this alternative, the queen conch would be considered to be undergoing overfishing. There could be indirect effects since an overfishing determination would require additional management measures to rehabilitate the stock. In the short term, ending overfishing could lead to a significant reduction in revenues being generated from the fishery, as well as a substantial loss of employment opportunities in both the fishing and related sectors. In the extreme, all fishing activities could be prohibited as a means of protecting the stock. Such an action would have significant social and economic ramifications. However, these adverse effects should be weighed against the long term benefits associated with maintaining a healthy stock. Any rents generated by the fishery will be dissipated unless a more rational management strategy is adopted.

6.2.5.2.3.3 Caribbean reef fish

Under this alternative Grouper Unit 4 and Parrotfish FMU sub-units would be considered to be undergoing overfishing. Consequently, there could be indirect effects associated with management measures required to end overfishing. In the short term, ending overfishing could lead to a significant reduction in revenues being generated from the fishery, as well as a substantial loss of employment opportunities in both the fishing and related sectors. In the extreme, all fishing activities could be prohibited as a means of protecting the stocks. Such an action would have significant social and economic ramifications. However, these adverse impacts should be weighed against the long term benefits associated with maintaining a healthy stock. Any rents generated by the fishery will be dissipated unless a more rational management strategy is adopted.

The remaining food fish FMU sub-units would not be considered to be undergoing overfishing and, hence, no management measures would be required if status quo fishing conditions were to continue. Therefore, this alternative would not be expected to result in indirect effects on the human environment related to the management of those FMU sub-units. The constant catch and B_{MIN} components of this rule would promote resiliency if MFMT is underestimated or overestimated.

6.2.5.2.3.4 Caribbean coral reef resources

Catch data are not available to calculate an MSY proxy, and therefore limit and target catch levels, for Caribbean coral reef resources. This is not likely to adversely affect the biological or ecological environments because the Council has prohibited the take of the most vulnerable coral reef resources since 1995, despite the absence of management reference points.

6.2.5.2.4 Direct and indirect effects on administrative environment and their significance

This alternative would benefit the administrative environment by providing fishery managers pre-agreed upon strategies for managing catches to avoid overfishing and achieve OY over the long term. Monitoring and adjusting catches to effectively implement the control rule would present somewhat of an administrative burden. However, such activities are considered a routine part of the fishery management process.

6.2.5.3 Alternative 3.

A) Specify an MSY control rule to define MFMT and ABC as 0; and
B) Specify an OY control rule to define target catch levels as 0.

This alternative is preferred for all species in the Coral FMP, excluding those species retained for data collection purposes.

Control Rule Alternative 3 would set limit and target catch levels equal to zero, requiring that fisheries managed under this rule be closed. This control rule is the most conservative that could be adopted.

6.2.5.3.1 Direct and indirect effects on physical environment and their significance

As explained in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. Control Rule Alternative 3 would be expected to indirectly benefit the physical environment by eliminating fishing gear interactions with benthic habitat. The potential effects of gear used in the spiny lobster, queen conch, reef fish, and coral reef fisheries are described in Section 6.2.1.1.1.

6.2.5.3.2 Direct and indirect effects on biological and ecological environment and their significance

6.2.5.3.2.1 Caribbean spiny lobster

Alternative 3 would require that the Caribbean spiny lobster fishery be closed. As explained in Section 6.2.1.1.2, reducing (or in this case eliminating) fishing mortality would be expected to benefit the biological and ecological environment by helping the stock to return to a natural age, size, and sex structure, and promoting genetic integrity. However, because federal fisheries represent only a small portion of the total fishing mortality on Caribbean spiny lobster, the extent to which such effects were realized would be largely influenced by the amount of fishing mortality applied to the stock in state waters.

Additionally, although populations characterized by natural age structures, size structures, and sex ratios are more resilient to anthropogenic and environmental perturbations, the yield they produce becomes reduced as they reach their carrying capacities and density-dependent effects become more dominant. At high population sizes, older, larger fish occupy the available habitat and use the available food. The presence of these older fish limits the survival of young and inhibits recruitment. Recruitment and production of younger fish can be enhanced with the removal of some of these older, larger fish. Therefore, fishing and density-dependence can have the effect of creating a "surplus production" of fish in the population that is available for capture. The type and magnitude of density- dependent effects that populations will experience as they grow in size are difficult to predict, as they vary from species to species and are based on available resources in a particular system (Wilson and Bossert 1971).

6.2.5.3.2.2 Caribbean conch resource

The effects of closing fisheries for stocks in the Caribbean conch resource FMU would be similar to those described for the Caribbean spiny lobster in Section 6.2.4.1.2.1.

6.2.5.3.2.3 Caribbean reef fish

The effects of closing fisheries for stocks in the Caribbean reef fish FMU would be similar to those described for the Caribbean spiny lobster in Section 6.2.4.1.2.1.

6.2.5.3.2.4 Caribbean coral reef resource

Currently, the most vulnerable coral reef species are protected from fishing pressure based on the Council's determination that their ecological or non-consumptive value exceeds their commercial value (CFMC 1994). These resources provide habitat for reef-associated and reef-dependent organisms, buffer against coastal erosion, and have aesthetic values that support tourism and related activities. Given the limited distribution and slow regeneration rates of the majority of these species, as discussed in Section 5.2.1.4, they are considered to be non-renewable resources.

This alternative would support the Council's current prohibition on catch of vulnerable coral reef resources, as well as the Council's policy on coral resources, which recognizes the important ecological role of coral reefs in the marine environment. The Council has identified this control rule alternative as the preferred for all species in the Caribbean coral reef resource FMU, with the exception of aquarium trade species. The Council's preferred alternative to move aquarium trade species to a data collection category of the FMU (Section 4.1.2.2) would eliminate the need to adopt a control rule for that FMU sub-unit.

6.2.5.3.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.5.3.3 Direct and indirect effects on social and economic environment and their significance

6.2.5.3.3.1 Caribbean spiny lobster

Under this alternative, the spiny lobster catch would be zero. The short-term adverse effects on the socioeconomic environment associated with this alternative would be significantly greater than those associated with the other control rule alternatives. Such effects would include a significant reduction in revenues being generated from the fishery, as well as a substantial loss of employment opportunities in both the fishing and related sectors. Clearly, these adverse effects should be weighed against the long-term benefits associated with maintaining a healthy stock. Any rents generated by the fishery will be dissipated unless more rational management strategy is adopted.

6.2.5.3.3.2 Caribbean conch resources

Under this alternative, the queen conch catch would be zero. The short-term adverse effects on the socioeconomic environment associated with this alternative would be significantly greater than those associated with the other control rule alternatives. Such effects would include a significant reduction in revenues being generated from the fishery, as well as a substantial loss of employment opportunities in both the fishing and related sectors. Clearly, these adverse effects should be weighed against the long-term benefits associated with maintaining a healthy stock. Any rents generated by the fishery will be dissipated unless more rational management strategy is adopted.

6.2.5.3.3.3 Caribbean reef fish

Under this alternative, the catch of all species in the Caribbean reef fish FMU would be zero. The short-term adverse effects on the socioeconomic environment associated with this alternative would be significantly greater than those associated with the other control rule alternatives. Such effects would include a significant reduction in revenues being generated from the fishery, as well as a substantial loss of employment opportunities in both the fishing and related sectors. Clearly, these adverse effects should be weighed against the long-term benefits associated with maintaining a healthy stock. Any rents generated by the fishery will be dissipated unless more rational management strategy is adopted.

6.2.5.3.3.4 Caribbean coral reef resources

Since participation in the fishery, other than the taking of aquarium trade species is prohibited, this alternative would not be expected to have any effects on the social or economic environment. It represents the preferred alternative for coral reef resources, other than aquarium trade species. The Council would not be required to specify OY for aquarium trade species if the preferred alternative for managing those species is implemented (Section 4.1.2.2). That alternative would move the aquarium trade species FMU sub-unit to a data collection category of the FMU.

6.2.5.3.4 Direct and indirect effects on administrative environment and their significance

Control Rule Alternative 3 would be expected to directly benefit the administrative environment by eliminating the need to develop fishery management measures to constrain catches to pre-specified levels. Closing EEZ waters to fishing also would reduce the administrative burden associated with enforcing minimum size limits, area closures, and other species-specific management measures. However, prohibiting fishing in federal waters would be highly controversial. There would be little, if any, administrative effects associated with adopting this alternative for all Caribbean coral reef resources excepting aquarium trade species, because the take and possession of those species is already prohibited by the Council.

6.2.5.4 Alternative 4.

A) Specify an MSY control rule to define MFMT and ABC as follows: 1) If $B_{CURR}/B_{MSY} < B_{MIN}$, then ABC = 0; 2) If B_{CURR}/B_{MSY} 1, then ABC = $F_{MSY}(B)$; and 3) If B_{CURR}/B_{MSY} is between B_{MIN} and 1, then ABC = $(F_{MSY}(B)/(1-B_{MIN}))((B_{CURR}/B_{MSY})-B_{MIN})$; where $B_{MIN} = 0.25$. If F_{MSY} cannot be estimated directly, use M as a proxy; and

B) Specify an OY control rule to define target catch levels such that: 1) If B_{CURR}/B_{MSY} is less than B_{MIN}, then target catch levels = 0; 2) If B_{CURR}/B_{MSY} is equal to or greater than 1, then target catch levels = $F_{OY}(B)$; and 3) If B_{CURR}/B_{MSY} is between B_{MIN} and 1, then target catch levels = $(F_{OY}(B)/(1-B_{MIN}))((B_{CURR}/B_{MSY})-B_{MIN})$; where $B_{MIN} = 0.25$. If F_{OY} cannot be estimated directly, use 0.5(M) as a proxy.

Control Rule Alternative 4 is similar to Alternative 2, but is based on a constant fishing mortality rate (F) strategy rather than on a constant catch strategy. When stock biomass is at or above B_{MSY}, the limit control rule described by this alternative would define the level of catch that would trigger an overfishing determination to be equal to the yield associated with fishing at F_{MSY}. As a result, this alternative would allow the limit catch level to increase in response to an increase in stock biomass above the MSY level. The target control rule described by this alternative would prescribe a catch level equal to the yield associated with fishing at F_{OY} when stock biomass was at B_{MSY} or higher.

The amount by which this limit and target control rule would decrease catches if stock biomass decreased below B_{MSY} is greater than the amount by which catches would be reduced using the rules proposed in Control Rule Alternative 2. Similar to the rules proposed by Alternative 2, if stock biomass decreased below the identified threshold level defined as B_{MIN}, these limit and target control rules would require that catches be reduced to zero. B_{MIN} is defined to equal 25% of the unfished abundance level, or about 10-15% of B_{MSY}. This component of the rules is meant to promote resiliency in the face of management error. Sladek Nowlis and Bollermann (2002) showed that the use of B_{MIN} nearly guaranteed that a species would not collapse, even in the face of very large directed errors in the management system.

Table 10 details the specific ABC and target catch levels defined by this alternative, based on the stock status determinations of the SFA workgroup. Table 11 describes the reductions in catch that would be prescribed by each rule relative to average catches from 1997-2001. The MSY and OY rules described by this alternative are illustrated in Figure 3.

6.2.5.4.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. It is impossible to determine with certainty how Control Rule Alternative 4 would affect such interactions. However, we can theorize about the magnitude of effects associated with this alternative by considering the rate of fishing mortality it would support under various stock conditions. Overall, this control rule alternative would be expected to support an intermediate rate of fishing mortality (and habitat interactions) relative to the other control rule alternatives. The potential effects of gear used in the spiny lobster, queen conch, reef fish, and coral reef fisheries are described in Section 6.2.1.1.1.

6.2.5.4.2 Direct and indirect effects on biological and ecological environment and their significance

6.2.5.4.2.1 Caribbean spiny lobster

The limit catch level defined by Control Rule Alternative 4 for the Caribbean spiny lobster (547,000 lbs; Table 10) is among the highest considered. The target catch level this rule would define for this species (295,000 lbs; Table 10) is intermediate to the other values considered. The B_{MIN} component of this rule would add a precautionary aspect to the management of this species that is not shared by all the control rule alternatives. However, the constant F strategy employed by these rules is less precautionary from a biological and ecological perspective relative to a constant catch strategy. Consequently, the biological and ecological benefits of this alternative would be expected to be intermediate to those provided by the other control rules. The types of benefits provided would be related to preventing overfishing and maintaining a more natural stock structure (see Section 6.2.1.1.2 for more information).

6.2.5.4.2.2 Caribbean conch resource

Because no discrete B and F ratios have been selected for queen conch, in large part due to its overfished status, it is not currently practical to define limit and target catch levels for this species. Discussion on the Council's preferred alternative to prohibit the harvest and possession of queen conch in the EEZ is presented in Section 6.4.2.2.2.

6.2.5.4.2.3 Caribbean reef fish

The limit catch levels defined by Control Rule Alternative 4 for reef fish FMU sub-units that are at B_{MSY} are among the highest considered. The limit catch levels defined by this rule for reef fish FMU sub-units that are below B_{MSY} are intermediate to those specified by other alternatives. The target catch levels this rule would define for these species also are intermediate to the other values considered. The B_{MIN} component of this rule would add a precautionary aspect to the management of this species that is not shared by all the control rule alternatives. However, the constant F strategy employed by these rules is less precautionary from a biological and ecological perspective relative to a constant catch strategy. Consequently, the biological and ecological benefits of this alternative would be expected to be intermediate to those provided by the other control rules. The types of benefits provided would be related to preventing overfishing and maintaining a more natural stock structure (see Section 6.2.1.1.2 for more information).

Because no discrete B and F ratios have been selected for Goliath and Nassau grouper, in large part due to their overfished status, it is not currently practical to define limit and target catch levels for these species. Further, the harvest of both species is currently prohibited in federal waters, as well as state waters, with the exception of Nassau grouper in the USVI.

6.2.5.4.2.4 Caribbean coral reef resource

Catch data are not available to calculate an MSY proxy, and therefore limit and target catch levels, for Caribbean coral reef resources. This is not likely to adversely affect the biological or ecological environments because the Council has prohibited the take of the most vulnerable coral reef resources since 1995, despite the absence of management reference points.

6.2.5.4.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.5.4.3 Direct and indirect effects on social and economic environment and their significance

6.2.5.4.3.1 Caribbean spiny lobster

Under this alternative, the MFMT for spiny lobster would be set at 547,000 pounds and the OY target would be set at 295,000 pounds. This alternative could affect the social and economic environments if it leads the Council to impose management measures to reduce current catches to the target level. Such measures would have significant social and economic ramifications, in terms of forgone revenues and employment alternatives. Clearly, these adverse effects should be weighed against the long-term benefits associated with maintaining a healthy stock. As mentioned earlier, any rents generated by the fishery will be dissipated unless more rational management strategy is adopted.

6.2.5.4.3.2 Caribbean conch resources

Under this alternative, the queen conch would be considered to be undergoing overfishing. There could be indirect effects since an overfishing determination would require additional management measures to rehabilitate the stock. In the short term, ending overfishing could lead to a significant reduction in revenues being generated from the fishery, as well as a substantial loss of employment opportunities in both the fishing and related sectors. In the extreme, all fishing activities could be prohibited as a means of protecting the stock. Such an action would have significant social and economic ramifications. However, these adverse effects should be weighed against the long term benefits associated with maintaining a healthy stock. Any rents generated by the fishery will be dissipated unless a more rational management strategy is adopted.

6.2.5.4.3.3 Caribbean reef fish

Under this alternative, Snapper Unit 1, Grouper Unit 4, and parrotfish would be considered to be undergoing overfishing. The catch reductions required to end overfishing on these FMU sub-units would range from 35 to 54%. There could be indirect effects associated with management measures required to end overfishing and/or to achieve OY. In the short term, such measures could lead to a significant reduction in revenues being generated from the fishery, as well as a substantial loss of employment opportunities in both the fishing and related sectors. However, these adverse impacts should be weighed against the long term benefits associated with maintaining a healthy stock. Any rents generated by the fishery will be dissipated unless a more rational management strategy is adopted.

The remaining food fish FMU sub-units would not be considered to be undergoing overfishing and, hence, no management measures would be required if status quo fishing conditions were to continue. Therefore, this alternative would not be expected to result in indirect effects on the human environment related to the management of those FMU sub-units. The B_{MIN} component of this rule would promote resiliency if MFMT is underestimated or overestimated.

6.2.5.4.3.4 Caribbean coral reef resources

Catch data are not available to calculate an MSY proxy, and therefore limit and target catch levels, for Caribbean coral reef resources. This is not likely to adversely affect the biological or ecological environments because the Council has prohibited the take of the most vulnerable coral reef resources since 1995, despite the absence of management reference points.

6.2.5.4.4 Direct and indirect effects on administrative environment and their significance

This alternative would benefit the administrative environment by providing fishery managers pre-agreed upon strategies for managing catches to avoid overfishing and achieve OY over the long term. Monitoring and adjusting catches to effectively implement the control rule would present somewhat of an administrative burden. However, such activities are considered a routine part of the fishery management process.

6.2.5.5 Alternative 5.

A) Specify an MSY control rule to define MFMT and ABC as follows: 1) If B_{CURR}/B_{MSY} < MSST/B_{MSY}, ABC = 0.33MSY; 2) If B_{CURR}/B_{MSY} 1, ABC = MSY; and 3) If B_{CURR}/B_{MSY} is between MSST/B_{MSY} and 1, ABC = 0.67MSY; and

B) Specify an OY control rule to define target catch levels such that: 1) If B_{CURR}/B_{MSY} < MSST/B_{MSY}, target catch levels = 0.25MSY; 2) If B_{CURR}/B_{MSY} 1, target catch levels = 0.75MSY; and 3) If B_{CURR}/B_{MSY} is between MSST/B_{MSY} and 1, target catch levels = 0.5MSY.

Control Rule Alternative 5 would define the limit and target catch levels as MSY and 75% of MSY, respectively, when stock biomass is at or above B_{MSY}. This rule would not allow catches to increase in response to an increase in stock biomass above the MSY level. If stock biomass decreased below B_{MSY}, but remained above the overfished threshold (i.e., MSST), this rule would decrease the limit and target catch levels to 67% of MSY and to 50% of MSY, respectively. The limit and target catch levels would be further reduced to 33% of MSY and to 25% of MSY, respectively, if stock biomass decreased below the overfished threshold. This rule offers some precaution and resiliency. However, it does so in a non-strategic manner. And the tradeoff for such benefits is foregone yield, as well as associated social and economic benefits. Additionally, this rule lacks a precautionary B_{MIN} component that would reduce the risk of stock collapse.

Table 10 details the specific ABC and target catch levels defined by this alternative, based on the stock status determinations of the SFA workgroup. Table 11 describes the reductions in catch that would be prescribed by each rule relative to average catches from 1997-2001. The MSY and OY rules described by this alternative are illustrated in Figure 4.

6.2.5.5.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. It is impossible to determine with certainty how Control Rule Alternative 5 would affect such interactions. However, we can theorize about the magnitude of effects associated with this alternative by considering the rate of fishing mortality it would support under various stock conditions. Overall, this control rule alternative would be expected to support an intermediate rate of fishing mortality (and habitat interactions) relative to the other control rule alternatives. The potential effects of gear used in the spiny lobster, queen conch, reef fish, and coral reef fisheries are described in Section 6.2.1.1.1.

6.2.5.5.2 Direct and indirect effects on biological and ecological environment and their significance

6.2.5.5.2.1 Caribbean spiny lobster

The limit and target catch levels defined by Control Rule Alternative 5 for the Caribbean spiny lobster (547,000 lbs and 410,000 lbs, respectively; Table 10) are among the highest considered. The MSST component of this rule, which would increase the amount by which catches would need to be reduced if stock biomass decreased below the overfished threshold, is a precautionary mechanism that has not been incorporated in the other control rule alternatives. The constant catch strategy employed by this rule also adds a level of precaution. However, this rule does not contain the B_{MIN} component that has been incorporated into Control Rule Alternatives 2-4 as a means to guard against stock collapse. Consequently, the biological and ecological benefits of this alternative would be expected to be intermediate to those provided by the other control rules. The types of benefits provided would be related to preventing overfishing and maintaining a more natural stock structure (see Section 6.2.1.1.2 for more information).

6.2.5.5.2.2 Caribbean conch resource

Because no discrete B and F ratios have been selected for queen conch, in large part due to its overfished status, it is not currently practical to define limit and target catch levels for this species. Discussion on the Council's preferred alternative to prohibit the harvest and possession of queen conch in the EEZ is presented in Section 6.4.2.2.2.

6.2.5.5.2.3 Caribbean reef fish

The limit and target catch levels defined by Control Rule Alternative 5 for reef fish FMU sub-units that are at B_{MSY} are among the highest considered. Similar to the other control rule alternatives, this alternative would reduce catches if stock biomass decreased below B_{MSY}. However, it is unique in that it would further reduce catches if stock biomass decreased below the MSST. Consequently, this rule would generally require greater catch reductions for overfished stocks relative to the other alternatives. The exception to this would be if stock biomass decreased to a very low level (e.g., less than 10-15% B_{MSY}), in which case Control Rule Alternatives 2-4 would require that the affected fishery be closed. Consequently, the biological and ecological benefits of this alternative would be expected to be intermediate to those provided by the other control rules. The types of benefits provided would be related to preventing overfishing and maintaining a more natural stock structure (see Section 6.2.1.1.2 for more information).

Because no discrete B and F ratios have been selected for Goliath and Nassau grouper, in large part due to their overfished status, it is not currently practical to define limit and target catch levels for these species. Further, the harvest of both species is currently prohibited in federal waters, as well as state waters, with the exception of Nassau grouper in the USVI.

6.2.5.5.2.4 Caribbean coral reef resource

Catch data are not available to calculate an MSY proxy, and therefore limit and target catch levels, for Caribbean coral reef resources. This is not likely to adversely affect the biological or ecological environments because the Council has prohibited the take of the most vulnerable coral reef resources since 1995, despite the absence of management reference points.

6.2.5.5.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.5.5.3 Direct and indirect effects on social and economic environment and their significance

6.2.5.5.3.1 Caribbean spiny lobster

Under this alternative, MFMT for the Caribbean spiny lobster would be set at 547,000 lbs, and the target catch rate would equal 295,000 pounds. This alternative would have short-term adverse effects on the human environment in terms of forgone economic benefits and employment opportunities if the Council imposed management measures to reduce catches to the OY level. Clearly, these adverse effects should be weighed against the long-term benefits associated with maintaining a healthy stock. Any rents generated by the fishery will be dissipated unless a more rational management strategy is adopted.

6.2.5.5.3.2 Caribbean conch resources

Under this alternative, the queen conch would be considered to be undergoing overfishing. There could be indirect effects since an overfishing determination would require additional management measures to rehabilitate the stock. In the short term, ending overfishing could lead to a significant reduction in revenues being generated from the fishery, as well as a substantial loss of employment opportunities in both the fishing and related sectors. In the extreme, all fishing activities could be prohibited as a means of protecting the stock. Such an action would have significant social and economic ramifications. However, these adverse effects should be weighed against the long term benefits associated with maintaining a healthy stock. Any rents generated by the fishery will be dissipated unless a more rational management strategy is adopted.

6.2.5.5.3.3 Caribbean reef fish resources

Under this alternative, Snapper Unit 1, Grouper Unit 4, and parrotfish would be considered to be undergoing overfishing. The catch reductions required to end overfishing on these FMU sub-units would range from 31 to 69%. There could be indirect effects associated with management measures required to end overfishing and/or to achieve OY. In the short term, such measures could lead to a significant reduction in revenues being generated from the fishery, as well as a substantial loss of employment opportunities in both the fishing and related sectors. However, these adverse impacts should be weighed against the long term benefits associated with maintaining a healthy stock. Any rents generated by the fishery will be dissipated unless a more rational management strategy is adopted.

The remaining food fish FMU sub-units would not be considered to be undergoing overfishing and, hence, no management measures would be required if status quo fishing conditions were to continue. Therefore, this alternative would not be expected to result in indirect effects on the human environment related to the management of those FMU sub-units.

6.2.5.5.3.4 Caribbean coral reef resources

Catch data are not available to calculate an MSY proxy, and therefore limit and target catch levels, for Caribbean coral reef resources. This is not likely to adversely affect the biological or ecological environments because the Council has prohibited the take of the most vulnerable coral reef resources since 1995, despite the absence of management reference points.

6.2.5.5.4 Direct and indirect effects on administrative environment and their significance

This alternative would meet the legal requirements of the MSFCMA. It would avoid overfishing by limiting catches below MSY through an ABC control rule. It would also achieve OY on a continuing basis through a target, or OY, control rule. An indirect effect of the alternative would be that it would require a greater level of management action in order to achieve the benchmarks set forth by the control rules. However, such administrative activity is unavoidable in meeting the requirements of the MSFCMA.

6.2.5.5.5 Direct and indirect effects on administrative environment and their significance

This alternative would benefit the administrative environment by providing fishery managers pre-agreed upon strategies for managing catches to avoid overfishing and achieve OY over the long term. Monitoring and adjusting catches to effectively implement the control rule would present somewhat of an administrative burden. However, such activities are considered a routine part of the fishery management process.

6.2.5.6 Alternative 6.

A) Specify an MSY control rule to define ABC = F_{MSY}(B). When the data needed to determine F_{MSY} are not available, use natural mortality (M) as a proxy for F_{MSY}; and

B) Specify an OY control rule to define target catch limits such that they equal F_{OY}(B).

This alternative is preferred for Caribbean queen conch, spiny lobster, and reef fish, excluding those species retained for data collection purposes.

Alternative 6 would define the limit and target catch levels as the yield associated with fishing at F_{MSY} and F_{OY}, respectively, regardless of where stock biomass is in relation to B_{MSY} and to MSST. This rule would use M and (0.5)(M) as proxies for F_{MSY} and F_{OY} when those parameters are undefined. The constant F strategy employed by this rule would allow catches to increase in response to an increase in stock biomass, but would require that catches be reduced as stock biomass decreased. Table 10 details the specific ABC and target catch levels defined by this alternative, based on the stock status determinations of the SFA workgroup. Table 11 describes the reductions in catch that would be prescribed by each rule relative to average catches from 1997-2001. The MSY and OY rules described by this alternative are illustrated in Figure 5.

6.2.5.6.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. It is impossible to determine with certainty how Control Rule Alternative 6 would affect such interactions. However, we can theorize about the magnitude of effects associated with this alternative by considering the rate of fishing mortality it would support under various stock conditions. Overall, the limit control rule specified by this alternative would be expected to support a high rate of fishing mortality (and habitat interactions) relative to the other control rule alternatives. The target control rule specified by this alternative would be expected to support an intermediate rate of fishing mortality (and habitat interactions) relative to the other control rule alternatives. The potential effects of gear used in the spiny lobster, queen conch, reef fish, and coral reef fisheries are described in Section 6.2.1.1.1.

6.2.5.6.2 Direct and indirect effects on biological and ecological environment and their significance

6.2.5.6.2.1 Caribbean spiny lobster

The limit catch level defined by Control Rule Alternative 6 for the Caribbean spiny lobster (547,000 lbs; Table 10) is among the highest considered. The target catch level this rule would define for this species (295,000 lbs; Table 10) is intermediate to the other values considered. Similar to the control rules proposed in other alternatives, this rule would reduce catches as stock biomass decreased below B_{MSY}. However, this rule lacks the precautionary mechanisms that are incorporated in many of the other alternatives in the form of a maximum cap on catch and/or a B_{MIN} component. Consequently, this rule is generally less precautionary from a biological and ecological perspective relative to the other alternatives and, as a result, could provide less biological and ecological benefits. The types of benefits provided would be related to preventing overfishing and maintaining a more natural stock structure (see Section 6.2.1.1.2 for more information).

6.2.5.6.2.2 Caribbean conch resource

Because no discrete B and F ratios have been selected for queen conch, in large part due to its overfished status, it is not currently practical to define limit and target catch levels for this species. Discussion on the Council's preferred alternative to prohibit the harvest and possession of queen conch in the EEZ is presented in Section 6.4.2.2.2.

6.2.5.6.2.3 Caribbean reef fish

The limit catch levels defined by Control Rule Alternative 6 for reef fish FMU sub-units that are at B_{MSY} are among the highest considered. The limit catch levels defined by this rule for reef fish FMU sub-units that are below B_{MSY} are the highest of those considered. The target catch levels defined by this rule are generally intermediate to those defined by the other alternatives. Similar to the control rules proposed in other alternatives, this rule would reduce catches as stock biomass decreased below B_{MSY}. However, this rule lacks the precautionary mechanisms that are incorporated in many of the other alternatives in the form of a maximum cap on catch and/or a B_{MIN} component. Consequently, this rule is generally less precautionary from a biological and ecological perspective relative to the other alternatives and, as a result, could provide less biological and ecological benefits. The types of benefits provided would be related to preventing overfishing and maintaining a more natural stock structure (see Section 6.2.1.1.2 for more information).

Because no discrete B and F ratios have been selected for Goliath and Nassau grouper, in large part due to their overfished status, it is not currently practical to define limit and target catch levels for these species. Further, the harvest of both species is currently prohibited in federal waters, as well as state waters, with the exception of Nassau grouper in the USVI.

6.2.5.6.2.4 Caribbean coral reef resource

Catch data are not available to calculate an MSY proxy, and therefore limit and target catch levels, for Caribbean coral reef resources. This is not likely to adversely affect the biological or ecological environments because the Council has prohibited the take of the most vulnerable coral reef resources since 1995, despite the absence of management reference points.

6.2.5.6.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.5.6.3 Direct and indirect effects on social and economic environment and their significance

6.2.5.6.3.1 Caribbean spiny lobster

Under this alternative, no reduction in status quo catch would be required to achieve the MFMT/ABC, but a 46% reduction would be required to achieve the target catch level. This alternative could affect the social and economic environments if it leads the Council to impose management measures to reduce current catches to the target level. Such measures would have significant social and economic ramifications, in terms of forgone revenues and employment alternatives. Clearly, these adverse effects should be weighed against the long-term benefits associated with maintaining a healthy stock. As mentioned earlier, any rents generated by the fishery will be dissipated unless more rational management strategy is adopted.

6.2.5.6.3.2 Caribbean conch resources

Under this alternative, the queen conch would be considered to be undergoing overfishing. There could be indirect effects since an overfishing determination would require additional management measures to rehabilitate the stock. In the short term, ending overfishing could lead to a significant reduction in revenues being generated from the fishery, as well as a substantial loss of employment opportunities in both the fishing and related sectors. In the extreme, all fishing activities could be prohibited as a means of protecting the stock. Such an action would have significant social and economic ramifications. However, these adverse effects should be weighed against the long term benefits associated with maintaining a healthy stock. Any rents generated by the fishery will be dissipated unless a more rational management strategy is adopted.

6.2.5.6.3.3 Caribbean reef fish resources

Under this alternative, Grouper Unit 4 would be considered overfished, and Snapper Unit 1 and parrotfish would be undergoing overfishing. The catch reductions required to end overfishing on these FMU sub-units would range from 23 to 30%. There could be indirect effects associated with management measures required to end overfishing and/or to achieve OY. In the short term, such measures could lead to a significant reduction in revenues being generated from the fishery, as well as a substantial loss of employment opportunities in both the fishing and related sectors. However, these adverse impacts should be weighed against the long term benefits associated with maintaining a healthy stock. Any rents generated by the fishery will be dissipated unless a more rational management strategy is adopted.

The remaining food fish FMU sub-units would not be considered to be undergoing overfishing and, hence, no management measures would be required if status quo fishing conditions were to continue. Therefore, this alternative would not be expected to result in indirect effects on the human environment related to the management of those FMU sub-units.

6.2.5.6.3.4 Caribbean coral reef resources

Catch data are not available to calculate an MSY proxy, and therefore limit and target catch levels, for Caribbean coral reef resources. This is not likely to adversely affect the biological or ecological environments because the Council has prohibited the take of the most vulnerable coral reef resources since 1995, despite the absence of management reference points.

6.2.5.6.4 Direct and indirect effects on administrative environment and their significance

This alternative would benefit the administrative environment by providing fishery managers pre-agreed upon strategies for managing catches to avoid overfishing and achieve OY over the long term. Monitoring and adjusting catches to effectively implement the control rule would present somewhat of an administrative burden. However, such activities are considered a routine part of the fishery management process.

6.2.5.7 Alternative 7.

A) Specify an MSY control rule to define ABC = F_{MSY}(B). When the data needed to determine F_{MSY} are not available, use a proxy for F_{MSY} calculated as a fraction of the natural mortality rate (M) as follows: 1) Use 1.00(M) as a proxy for F_{MSY} for species that are not believed to be at risk based on the best available information; 2) Use 0.75(M) as a proxy for F_{MSY} for species for which no positive or negative determination can be made on the status of their condition; and 3) Use 0.50(M) as a proxy for F_{MSY} for species that are believed to be at risk based on the best available information; and

B) Specify an OY control rule to define target catch levels equal to F_{MSY}(B)(OY/MSY). When the data needed to determine F_{MSY} are not available, use a proxy for F_{MSY} calculated as a fraction of the natural mortality rate (M) as follows: 1) Use 0.75(M) as a proxy for F_{MSY} for species that are not believed to be at risk based on the best available information; 2) Use 0.50(M) as a proxy for F_{MSY} for species for which no positive or negative determination can be made on the status of their condition; and 3) Use 0.25(M) as a proxy for F_{MSY} for species that are believed to be at risk based on the best available information.

This alternative differs from Alternative 6 only in how it would define F_{MSY} and F_{OY} when those parameters have not been estimated. It would manage the fishery more conservatively in such situations. It states that for FMU sub-units determined to be not at risk, the MFMT should be set equal to M, such that ABC = M(B), and the target catch level should be set equal to 3/4 of M multiplied by B. For FMU sub-units for which no determination can be made, MFMT should be set equal to 2/3 of M, resulting in an ABC = 2/3M(B), while the target catch level should be set equal to ½ of M multiplied by B. Finally for FMU sub-units believed to be at risk, MFMT should be set equal to ½ of M, resulting in an ABC = 1/2M(B), while the target catch level should be set equal to 1/4 of M multiplied by B. Table 10 details the specific ABC and target catch levels defined by this alternative, based on the stock status determinations of the SFA workgroup. Table 11 describes the reductions in catch that would be prescribed by each rule relative to average catches from 1997-2001. The MSY and OY rules described by this alternative are illustrated in Figure 6.

6.2.5.7.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, fishery management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat. It is impossible to determine with certainty how Control Rule Alternative 6 would affect such interactions. However, we can theorize about the magnitude of effects associated with this alternative by considering the rate of fishing mortality it would support under various stock conditions. Overall, this control rule would be expected to support a low rate of fishing mortality (and habitat interactions) relative to the other control rule alternatives. The potential effects of gear used in the spiny lobster, queen conch, reef fish, and coral reef fisheries are described in Section 6.2.1.1.1.

6.2.5.7.2 Direct and indirect effects on biological and ecological environment and their significance

6.2.5.7.2.1 Caribbean spiny lobster

The limit catch level defined by Control Rule Alternative 7 for the Caribbean spiny lobster (426,000 lbs; Table 10) is the lowest considered, with the exception of that defined by Control Rule Alternative 3, which would require that the fishery be closed. The target catch level this rule would define for this species (295,000 lbs; Table 10) is intermediate to the other values considered. Similar to the control rules proposed in other alternatives, this rule would reduce catches as stock biomass decreased below B_{MSY}. However, this rule lacks the precautionary mechanisms that are incorporated in many of the other alternatives in the form of a maximum cap on catch and/or a B_{MIN} component. Additionally, this rule relies on M as a proxy for F_{MSY}. Numerous studies have demonstrated that F_{MSY} should be less than M in virtually all cases, with specific studies suggesting that F_{MSY} should equal 40-80% of M. Consequently, this rule could be considered less precautionary from a biological and ecological perspective relative to the other alternatives (with the possible exception of Alternative 6) and, as a result, could provide less biological and ecological benefits. The types of benefits provided would be related to preventing overfishing and maintaining a more natural stock structure (see Section 6.2.1.1.2 for more information).

6.2.5.7.2.2 Caribbean conch resource

Because no discrete B and F ratios have been selected for queen conch, in large part due to its overfished status, it is not currently practical to define limit and target catch levels for this species. Discussion on the Council's preferred alternative to prohibit the harvest and possession of queen conch in the EEZ is presented in Section 6.4.2.2.2.

6.2.5.7.2.3 Caribbean reef fish

The limit and target catch levels defined by Control Rule Alternative 7 for reef fish FMU sub-units that are at or below B_{MSY} are generally the lowest considered, with the exception of those defined by Control Rule Alternative 3, which would require that these fisheries be closed. Similar to the control rules proposed in other alternatives, this rule would reduce catches as stock biomass decreased below B_{MSY}. However, this rule lacks the precautionary mechanisms that are incorporated in many of the other alternatives in the form of a maximum cap on catch and/or a B_{MIN} component. Consequently, this rule could be considered less precautionary from a biological and ecological perspective relative to the other alternatives and, as a result, could provide less biological and ecological benefits. The types of benefits provided would be related to preventing overfishing and maintaining a more natural stock structure (see Section 6.2.1.1.2 for more information).

Because no discrete B and F ratios have been selected for Goliath and Nassau grouper, in large part due to their overfished status, it is not currently practical to define limit and target catch levels for these species. Further, the harvest of both species is currently prohibited in federal waters, as well as state waters, with the exception of Nassau grouper in the USVI.

6.2.5.7.2.4 Caribbean coral reef resource

Catch data are not available to calculate an MSY proxy, and therefore limit and target catch levels, for Caribbean coral reef resources. This is not likely to adversely affect the biological or ecological environments because the Council has prohibited the take of the most vulnerable coral reef resources since 1995, despite the absence of management reference points.

6.2.5.7.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.2.5.7.3 Direct and indirect effects on social and economic environment and their significance

6.2.5.7.3.1 Caribbean spiny lobster

Under this alternative, a 22% reduction in the status quo level of harvest would be required to achieve the MFMT/ABC, while a 46% reduction in harvest would be required to achieve the target catch level. Overall, the adverse socioeconomic effects associated with this alternative would likely exceed those of any of the other alternatives in this section, with the exception of Alternative 3, which would require that the fishery be closed. Such effects are described in Section 6.2.5.6.3.1.

6.2.5.7.3.2 Caribbean conch resources

Under this alternative, the queen conch would be considered to be undergoing overfishing. There could be indirect effects since an overfishing determination would require additional management measures to rehabilitate the stock. In the short term, ending overfishing could lead to a significant reduction in revenues being generated from the fishery, as well as a substantial loss of employment opportunities in both the fishing and related sectors. In the extreme, all fishing activities could be prohibited as a means of protecting the stock. Such an action would have significant social and economic ramifications. However, these adverse effects should be weighed against the long term benefits associated with maintaining a healthy stock. Any rents generated by the fishery will be dissipated unless a more rational management strategy is adopted.

6.2.5.7.3.3 Caribbean reef fish resources

Under this alternative, all food fish FMU sub-units would be considered to be undergoing overfishing. The catch reductions required to end overfishing would range from 19 to 64%. The adverse short-term socioeconomic effects associated with this alternative would exceed those associated with any other alternative in this section, with the exception of Alternative 3, which would require that the fishery be closed. Such effects are described in Section 6.2.5.6.3.3.

6.2.5.7.3.4 Caribbean coral reef resources

Catch data are not available to calculate an MSY proxy, and therefore limit and target catch levels, for Caribbean coral reef resources. This is not likely to adversely affect the biological or ecological environments because the Council has prohibited the take of the most vulnerable coral reef resources since 1995, despite the absence of management reference points.

6.2.5.7.4 Direct and indirect effects on administrative environment and their significance

This alternative would benefit the administrative environment by providing fishery managers pre-agreed upon strategies for managing catches to avoid overfishing and achieve OY over the long term. Monitoring and adjusting catches to effectively implement the control rule would present somewhat of an administrative burden. However, such activities are considered a routine part of the fishery management process.

6.3 Regulating fishing mortality

Due to the required reductions in fishing mortality to end overfishing for managed species that will ultimately be a result of the preferred control rule alternatives, it is necessary to evaluate companion management actions that would lead to the desired goals of the aforementioned control rules.

The requirements of the MSFCMA mandate that any FMP shall contain the conservation and management measures which are necessary to protect, restore, and promote the long-term health and stability of the fishery. Based on the preferred control rule alternatives, a maximum reduction in mortality of 30% would be needed under the limit control rule to end overfishing for Grouper Unit 4, Snapper Unit 1, and parrotfishes (Table 11). While this reduction in mortality would be needed for both state and federal waters, the Council only has jurisdiction in the EEZ.

Due to the nature of the Caribbean fisheries, in that the majority of harvest occurs in state waters due to the predominance of fishable habitat occurring in state waters (Figure 1), and that the stock status parameters and control rules are based on landings data that does not differentiate between federal and state landings, it is highly likely that any benefits gained as a result of reducing fishing mortality in federal waters would be masked by increased fishing activity in state waters. For example, if large areas of the EEZ were closed to fishing, it is likely that effort would be displaced to other areas. Furthermore, it is speculated that even if the entire EEZ were closed to fishing that the desired reductions in mortality would not be realized due to displacement of effort to state waters, resulting in no tangible change in landings. However, the MSFCMA requirements do not allow inaction due to scenarios such as what currently exists in the U.S. Caribbean. Regardless, it should be pointed out that without regulations to reduce fishing mortality being implemented in state waters, the possibility of establishing sustainable fisheries in the U.S. Caribbean is extremely remote. The following proposed alternatives are offered to reduce the required fishing mortality within the Council's jurisdiction.

6.3.1 Alternative 1. No action. Do not adopt additional management measures.

6.3.1.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with bottom habitat, either through gear impacts to bottom habitat or through the direct harvest of bottom habitat. This alternative would not result in any further direct impacts on the physical environment. However, while most fishing gear utilized in the U.S. Caribbean results is moderate to no impact on EFH (CFMC 2004), continued fishing activities that impact EFH, particularly coral, theoretically could potentially degrade habitat to the point that it could indirectly impact spawning aggregations and jeopardize sustainable fisheries.

6.3.1.2 Direct and indirect effects on biological and ecological environment and their significance

6.3.1.2.1 Caribbean spiny lobster

While spiny lobster is not considered to be overfished and is not undergoing overfishing based on the preferred suite of stock status parameters, in order to achieve OY a 6% reduction in mortality would be required under the preferred target control rule. Therefore, the no action alternative would not be sufficient to achieve the desired goal of managing spiny lobster at OY, and result in a direct effect to the biological environment. This could indirectly lead to more restrictive management measures in the future, should inaction and environmental conditions (e.g., poor recruitment) result in the fishery's stability being jeopardized.

6.3.1.2.2 Caribbean conch resources

Queen conch is considered to be overfished and is most likely undergoing overfishing, and reductions in mortality would potentially be required to maintain MSY. Further, a 3% reduction in mortality would be required under the preferred target control rule. Therefore, the no action alternative would not be sufficient to achieve management under MSY (and be in violation of the MSFCMA) or under the potentially more desirable goal of managing queen conch at OY, and result in a direct effect to the biological environment. This could indirectly lead to more restrictive management measures in the future, should inaction and environmental conditions (e.g., poor recruitment) result in the fishery's stability being jeopardized.

However, as the preferred alternative for rebuilding queen conch under Section 6.4.3.2 is to prohibit the harvest and possession of queen conch in the EEZ, the direct and indirect effects of the no action alternative discussed above, as it applies to the EEZ, would largely be negated.

6.3.1.2.3 Caribbean reef fish resources

Maintaining the status quo would allow current fishing activity to continue unabated, even in the presence of evidence that illustrated in some cases species are overfished (i.e., Goliath grouper, Nassau grouper, and Grouper Unit 4), and others are undergoing overfishing (e.g., Grouper Unit 4 and parrotfishes). Therefore, the no action alternative would not be sufficient to achieve management under MSY for several species (and be in violation of the MSFCMA) or under the potentially more desirable goal of managing multiple species at OY, and result in a direct effect to the biological environment. This could allow the status of some species in FMU sub-units that are undergoing overfishing to potentially be exacerbated, complicating future management actions that could be implemented to improve their status. Further, this alternative would not be sufficient to achieve the potentially desirable goal of managing species at OY for all species except the aquarium trade species in the Reef Fish FMP. This could indirectly lead to more restrictive management measures in the future, should inaction and environmental conditions (e.g., poor recruitment) result in the fishery's stability being jeopardized.

However, as the harvest and possession of Goliath and Nassau grouper is currently prohibited in the EEZ, this alternative may not result in any additional direct or indirect effects to those two overfished species.

6.3.1.2.4 Caribbean coral reef resources

The direct and indirect effects on coral reef resources in taking no action would likely be the same as those described in Section 6.3.1.1. As the harvest and possession of coral reef resources is currently prohibited in the EEZ (with the exception of several invertebrate species utilized in the aquarium trade), this alternative may not result in any direct effects to those prohibited corals. Further, it should be noted that the preferred alternative in Section 6.7.2 would further minimize fishery-related impacts on coral reef resources.

6.3.1.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. This alternative would maintain the present level of fishery interactions with protected resources. Available information on the biology and status of protected species and the extent of their interaction with commercial and recreational fisheries in the U.S. Caribbean is summarized in Section 5.2.

6.3.1.3 Direct and indirect effects on social and economic environment and their significance

The no action alternative would not result in any direct effects to the socioeconomic environment, however, inaction could potentially lead to indirect negative impacts. For example, declining catch from decreased abundance or restricted catch due to the future implementation of management measures may result in forgone socioeconomic benefits. While Goliath and Nassau grouper are considered overfished, the harvest and possession of these two species is currently prohibited in the EEZ. Additionally, their harvest and possession is also prohibited in Puerto Rican waters, while only the harvest and possession of Goliath grouper is prohibited in USVI waters. As such, the no action alternative will likely result in no additional direct or indirect impacts on socioeconomic environment in relation to these two species. Likewise, as the directed harvest and possession of corals are prohibited in the EEZ, the no action alternative would not result in any direct or indirect effects on the socioeconomic environment. The socioeconomic impacts associated with inaction, in regard to the incidental harvest of corals and fishery-related impacts on coral habitat are described in the Section 2.5.1 of the EFH EIS (CFMC 2004).

6.3.1.4 Direct and indirect effects on administrative environment and their significance

Current management measures could not effectively end overfishing or maintain fishing mortality within target levels adopted through this amendment for the Spiny Lobster, Queen Conch, and Reef Fish FMPs. Therefore, this alternative would not comply with the MSFCMA requirements required for those FMPs. The harvest and possession of corals in the Coral FMP are prohibited, and the no action would not have any direct or indirect impacts on the administrative environment as it applies to this specific FMP.

6.3.2 Alternative 2. Establish seasonal closures.

With respect to Alternatives 2f and 2g, reducing the fishing year by 25% or 50% would not necessarily equate to a 25% or 50% reduction in federal landings, as effort would likely increase during the open season. Further, since landings are not differentiated between state and federal waters, it may be hard to detect any significant reduction in landings, especially if effort is shifted to the open seasons or to state waters. Regardless, a portion of both seasonal closures would coincide with the spawning season of a number of FMU sub-units.

Appeldoorn *et al.* (1992) stated in their 1992 assessment that the most obvious management recommendation to increase the productivity of the reef fish fishery was to reduce fishing effort, particularly on small fishes. However, reductions in fishing effort would probably not be sufficient to obtain significant increases in yield, especially for species that are undergoing recruitment overfishing. Therefore, they recommended the establishment of no harvest zones and protection of known spawning aggregations as a means to improve the spawning stock size. The Council has implemented a permanent closed area on Hind Bank, to protect spawning aggregations of red hind, as well as protect and conserve the localized coral reef ecosystem. Yet, it is highly unlikely that this one closed area would be sufficient to achieve the required reduction in fishing mortality to end overfishing (30%) for the entire U.S. Caribbean.

Sub-alternatives considered in this section include:

Alternative 2a (Preferred). Close the U.S. EEZ to the possession of all species except misty grouper in Grouper Unit 4 (i.e., red, black, tiger, yellowfin, and yellowedge grouper) from February 1 through April 30.

Grouper Unit 4 includes red, misty, black, tiger, yellowfin, and yellowedge grouper, and would be considered overfished based on the preferred suite of stock status parameters. Grouper Unit 4 would require a 30% reduction in fishing mortality to end overfishing (Table 11). This alternative is expected to achieve a 24% reduction in fishing mortality for all species in Grouper Unit 4 (except misty grouper) in and of itself (Table 13).

Alternative 2b (Preferred). Close the U.S. EEZ off the west coast of Puerto Rico to the possession of red hind from December 1 through February 28.

For the purposes of this alternative, the delineation of the west coast of Puerto Rico would be those waters in the U.S. Caribbean EEZ west of 67° 10' W longitude. Red hind is included in Grouper Unit 3, and is not currently undergoing overfishing, however, a 6% in fishing mortality would be required to achieve OY for this FMU sub-unit (Table 11). This alternative is expected to achieve a 33% reduction in fishing mortality for red hind in and of itself (Table 13).

Alternative 2c (Preferred). Close the U.S. EEZ to the possession of all species in Snapper Unit 1 (including the black, blackfin, vermilion, and silk snapper) from October 1 through December 31.

Snapper Unit 1 includes black, blackfin, silk, and vermillion snapper. Snapper Unit 1 would require a 23% reduction in fishing mortality to end overfishing (Table 11). This alternative is expected to achieve a 23% reduction in fishing mortality for all species in Snapper Unit 1 in and of itself (Table 13).

Alternative 2d. Close the U.S. EEZ to the possession of Snapper Unit 4 from April 1 through June 30.

Snapper Unit 4 consists of yellowtail snapper, and it would not be considered overfished based on the preferred suite of stock status parameters; however, a 6% in fishing mortality would be required to achieve OY for this FMU sub-unit (Table 11). This alternative is expected to achieve a 26% reduction in fishing mortality for yellowtail snapper in and of itself (Table 13).

Alternative 2e (Preferred). Close the U.S. EEZ to the possession of mutton snapper and lane snapper from April 1 through June 30.

Mutton and lane snapper are included in Snapper Unit 3, and they are not currently undergoing overfishing, however, a 6% in fishing mortality would be required to achieve OY for this FMU sub-unit (Table 11). This alternative is expected to achieve a 29% reduction in fishing mortality for mutton and lane snapper in and of itself (Table 13).

Alternative 2f. Close the U.S. EEZ to the possession of all Caribbean Council-managed species each year from January 1 to March 31 (3-month closure).

Alternative 2g. Close the U.S. EEZ to the possession of all Caribbean Council-managed species each year from January 1 to March 31 and from July 1 to September 30 (6-month closure).

Alternative 2h. Close the U.S. EEZ to the possession of all Caribbean Council-managed species all year round (total closure).

6.3.2.1 Direct and indirect effects on physical environment and their significance

Implementing a closed season could result in a reduction in fishing effort if the season were applicable to all species (e.g., Alternatives 2f - 2h), in effect creating a closed area of limited duration. A reduction in fishing effort could directly benefit the physical environment, in particular coral habitat, as it would reduce fishing-related impacts during that time period. During the closed season gear impacts and anchoring of fishing vessels would be expected to be absent, allowing benthic communities to recover. Yet, any benefits incurred from the closed season could potentially be negated by increased fishing activity just prior to the closed season, as well as just after. Further, since the EEZ only includes approximately 14% of fishable habitat, which would include areas identified as EFH, all of the proposed closed season alternatives would have a limited benefit to the physical environment in the U.S. Caribbean. Obviously, the longer the duration of the closure (e.g., Alternative 2h versus Alternative 2f) the greater the direct beneficial impact to the physical environment.

Any beneficial impacts of a closed area may not result if the season were only applicable to particular species (e.g., Alternatives 2a - 2e). Species-specific closed seasons would still allow fishing activities to continue on other species that co-habitat with the closed-season species. Therefore, fishery-related impacts (Barnette 2001) could still occur to the physical environment, and as the prohibited species in any alternative (i.e., Alternatives 2a - 2e) co-habitat with other allowable species, it is unlikely that these alternatives would result in any measurable impact to the physical environment that is not occurring under the status quo.

6.3.2.2 Direct and indirect effects on biological and ecological environment and their significance

6.3.2.2.1 Caribbean spiny lobster

Alternatives 2a - 2e would have no direct or indirect impact on the biological environment for spiny lobster not already occurring under the status quo. Alternatives 2f - 2h would result in direct, but limited, benefits to spiny lobster, in that reduced harvest could allow the species to become more abundant throughout the U.S. Caribbean. However, fishing pressure before and after the closures in Alternatives 2f and 2g might negate some of the benefits accrued during the closed season. Additionally, increased fishing pressure in state waters may also negate any conservation benefits derived by a closure in the EEZ. A complete closure of federal waters would protect the portion of the stock that resides in the EEZ. Yet, only 14% of fishable habitat occurs in the EEZ, and the 100-fathom (200 m) contour is also considered the limits of spiny lobster habitat, with a greater proportion likely occurring within 100 m (Section 5.2.1.1.1). Due to the differences in state boundaries (i.e., 9 nm for Puerto Rico and 3 nm for the USVI), and the fact that there is a greater amount of fishable habitat in the EEZ that occurs off the USVI, it is likely that Alternatives 2f - 2h would have a greater direct impact off the USVI than that which would occur off Puerto Rico.

While spiny lobster may benefit from a seasonal closure (i.e., Alternatives 2f - 2h), it is likely that the U.S. Caribbean spiny lobster resource depends on larval input from outside jurisdictional boundaries. Since spiny lobster planktonic larvae spend up to 11 months at sea before settling (Section 5.2.1.1.1), the source for a large proportion of U.S. Caribbean spiny lobster is likely "upcurrent" of Puerto Rico and the USVI. Likewise, only a small proportion of spiny lobster larvae is likely retained within the U.S. Carribean; it is most likely that larvae spawned in the U.S. Caribbean could, for example, settle at Bermuda (Munro 1974a). Therefore, the biological benefit of a closure for spiny lobster in the U.S. Caribbean will be limited.

6.3.2.2.2 Caribbean conch resources

Alternatives 2a - 2e would have no direct or indirect impact on the biological environment for queen conch not already occurring under the status quo. Alternatives 2f - 2h would result in direct benefits to Caribbean conch by reducing harvest pressure on the resource. Yet, the same issues discussed for spiny lobster in Section 6.3.2.2.1 also apply to queen conch. For example, the documented range of queen conch extends to about 100 m in depth (Section 5.2.1.2.1.1). However, while there may be some export of conch larvae, their duration in the water column is much shorter, and some studies have concluded that the majority of queen conch larvae are retained locally. Alternative 2f would not likely result in any significant benefit to the resource, however, since Alternative 2g includes the latter portion of the queen conch spawning period in the U.S. Caribbean, it could result in significant direct and indirect benefits. Discussion of the impacts to the biological environment resulting from a prohibition of catch year-round (Alternative 2h) is provided in Section 6.4.3.2.4; this is the Council's preferred alternative to rebuild the queen conch resource.

6.3.2.2.3 Caribbean reef fish resources

Preferred Alternative 2a would create a three-month closure for Grouper Unit 4 (excluding misty grouper), Preferred Alternative 2c would create a three month closure for Snapper Unit 1, while Alternative 2d would result in a three month closure for Snapper Unit 4. Grouper Unit 4 is classified as overfished through this amendment. Alternatives 2a - 2e are set up around known spawning periods (Table 13) for the respective species, and thus could result in direct benefits to the respective species due to spawning aggregation protection and increased reproductive success. However, if the species stocks are impacted severely enough just before and just after the closed season, it could possibly reduce the potential benefits of the closure.

Because of the nature of the reef fish fishery, in that fishermen can harvest numerous reef fish species from the same location, it is possible that the benefit of a seasonal closure may be impacted from bycatch mortality. Fishermen would not be prohibited from fishing in particular areas, and thus may still incidentally catch species such as grouper or snapper that are encompassed by a closed season. Should the fish be harvested from deep water, the greater the chance the fish will not survive its release due to barotrauma and/or predation risk. As Alternatives 2a - 2e only apply to federal waters, and the various affected species in each alternative are predominantly found in state waters due to the prevalence of habitat (Figure 1; more applicable to Puerto Rico than the USVI), intensified fishing pressure in state waters could negate any biological benefit from a seasonal closure in federal waters. Therefore, it is unclear if Alternatives 2a - 2e would be successful in ending overfishing for those species undergoing overfishing or are overfished, and it is unlikely that any of these alternatives would result in sufficient declines in fishing mortalities so that landings are approximating that of OY. However, Alternative 2b would be consistent with a currently-existing seasonal closure in Puerto Rican waters, and Puerto Rico and the USVI stated at the 117th Council meeting in San Juan that they would work to implement consistent (to the preferred alternatives) seasonal closure periods in state waters.

Alternatives 2f and 2g would result in a three-month and six-month seasonal closure for all Council-managed species, respectively. Alternative 2f would occur during the spawning period of many grouper species, such as those classified as overfished in Grouper Unit 4 (see Section 5.2.1.3.33). Furthermore, Alternative 2g would occur not only during spawning periods of many groupers in the Spring (Section 5.2.1.3.33), but also during the spawning periods of some snappers (e.g., yellowtail and silk snapper) in the summer months (Section 5.2.1.3.19). However, it is not possible to determine if either of these closures would ensure that the established targets are achieved, due to the fact that the majority of the catch originates from state waters, the potential mitigation of mortality reduction stemming from increased fishery activity just prior to and just after the closed season, as well as the likelihood that what effort that does occur in the EEZ would be displaced to state waters during the closures. Regardless, Alternative 2g would provide a greater buffer from this focus of fishing effort than Alternative 2f, due to the greater length of the closed season. However, the conservation benefits of any of these alternatives are likely to be eroded if effort is shifted to state waters during closed seasons. For this reason, the selection of any of these alternatives should be coupled with one of the administrative options provided in Alternative 6.

Reducing catches by shortening (or eliminating) the fishing year would benefit both managed stocks and the surrounding ecosystem. Alternatives 2f - 2h would likely provide progressively greater conservation benefits than the species-specific alternatives (2a - 2e). However, due to the logistical problems and financial costs of removing one's supply of fish traps, it is possible that trap fishermen will allow their traps to soak throughout the three-month periods proposed in Alternatives 2f and 2g, resulting in some extent of ghost fishing mortality.

6.3.2.2.4 Caribbean coral reef resources

Alternatives 2a - 2e would have no direct or indirect impact on the biological environment for coral reef resources not already occurring under the status quo. Alternatives 2f - 2h would result in direct benefits to the coral reef resources. Reducing fishing pressure and interactions of fishing gear with habitat will undoubtedly protect coral habitat, which has been identified as EFH. Further applicable discussion on the biological impacts that could be associated with Alternatives 2f - 2h can be found in Section 4.5.7.1 of the EFH EIS (CFMC 2004).

6.3.2.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Since the closures in Alternatives 2a - 2e are species-specific rather than area or gear based, total fishing effort will not likely be reduced, and, therefore, they will likely have no effect on protected species' interactions. Most cetaceans in the area are sighted during winter and early spring, with the increase in sightings beginning in December, peaking in February, and gradually decreasing in March and April. Therefore, a January 1 through March 31 closure (Alternatives 2f - 2h) may reduce the possibility of fishery interactions with whale species. For sea turtles it would strictly depend on how much of the total fishing effort would be reduced.

6.3.2.3 Direct and indirect effects on social and economic environment and their significance

To examine the impact of implementing closed seasons, it is useful to first analyze, from an economic perspective, the dynamics that transpire in an open-access fishery[7], such as the situation in Puerto Rico.[8] In theory, equilibrium will be achieved (i.e., entry will just equal exit) when the average revenues per unit of effort (e.g., trip) equal marginal costs and average costs per unit effort (assuming a homogenous fleet). At this point, total revenues minus total costs (including normal returns to capital and labor) are equal to zero and profits are equal to zero. If average revenues exceed the minimum of average variable costs, entry will be attracted into the fishery. Conversely, if the minimum of average variable costs exceed average revenues, profits will be negative, hence, encouraging exit from the fishery.

The change in the stock size of a given species over time period t is often defined as:

$$dP/dt = F(P) - H(t)$$

[7] The term "open access" as used in this setting is meant to refer to a situation where there is no, or limited, institutional (or other) constraints to the movement of capital and labor in and out of the fishery.

[8] The USVI has enacted a moratorium on the issuance of fishing licenses. Thus, while the commercial fishery in the USVI would currently not be considered open access (assuming it is being enforced), one would assume that there is considerable ability for expanding effort among individual fishing units. Furthermore, the EEZ, the primary focus of this analysis, would still be considered open access in the absence of any permit or other requirements.

Where dP/dt represents the change in stock size during time period t, F(P) is equal to the natural growth rate of the stock, and H(t) is equal to the harvest rate. The change in stock size over a given time period is, therefore, the natural growth rate of the stock minus the harvest rate. If F(P) exceeds H(t), the change in population is positive. Conversely, if H(t) exceeds F(P), the change in population will be negative.

Implementing a closed season in the EEZ for any given species will result in H(t) equal to zero, assuming full compliance and no bycatch. The assumption of no bycatch is unrealistic when considering a single species in a multi-species fishery, such as the reef fish fishery of the U.S. Caribbean. Of course, as the number of species included in the seasonal closure is expanded, the amount of bycatch would be expected to decline accordingly. For any level of $F(P) > 0$, therefore, dP/dt will also be greater than zero, ensuring an increase in stock size in EEZ waters.

Effort, defined as the total number of trips, is, of course, a function of expected profits, where profits per trip are equal to total revenues minus total costs. Furthermore, total revenues per trip are equal to the catch per trip multiplied by the price received for the landed product. Finally, catch per trip is expected to be positively related to population.

Based on the growth equation presented above, increasing the length of the closed season is expected to increase the population size (density) of the species being considered in EEZ waters. The increased population, however, is expected to result in increased profits to fishermen during that portion of the year when the fishery is open in EEZ waters, resulting in a potential increase in effort in EEZ waters. Specifically, average revenues will exceed average costs, encouraging additional effort in the EEZ fishery.

The increased effort will, over time, result in a reduction in EEZ population and, hence, average revenues per trip in EEZ waters. As population and average revenues per trip decline, effort will leave the EEZ waters. Eventually, an equilibrium level of effort will be achieved. This equilibrium level of effort will be at that point where the average revenues per trip equal the average costs per trip.

6.3.2.3.1 Caribbean spiny lobster

Alternatives 2a - 2e would have no direct or indirect impact on the biological environment for spiny lobster not already occurring under the status quo. Because of a lack of information regarding harvest (commercial or recreational) of Caribbean spiny lobster in federal waters off Puerto Rico, determining direct or indirect impacts associated with Alternative 2h. However, due to the species' range and habitat requirements (i.e., maximum depth of 100 fathoms), it is a safe assumption that the predominance of Puerto Rico spiny lobster landings and fishing activity occurs in state waters. Regardless, the potential impacts of Alternative 2h include the potential for exiting the fishery by some participants and, more likely, movement of spiny lobster harvesting activities from federal waters to state waters. Increased fishing effort in state waters will result in a decline in catch per unit of effort among all participants and, likely, a reduction in inframarginal rents (if any) currently accruing from the use of the resource. Furthermore, increased fishing pressure in state waters implies increased pressure on proportion of the stock in state waters. As discussed above, this is not expected to be significant for the Puerto Rican fishery. However, one can surmise the closure of the EEZ may not, under certain conditions, lead to any increased long-term benefits generally associated with an increase in stock size because the stock size may not necessarily increase due to the suspected lack of importance of the EEZ waters to the spiny lobster resource for Puerto Rico. However, as noted, closure of the federal waters would provide some measure of protection.

In St. Croix, where commercial harvest by distance from shore is provided, spiny lobster landings from federal waters (3+ nm from shore) for January 2000 to December 2001 totaled about 46,000 pounds for the two-year period, or 45% of the total reported spiny lobster landings of 101,000 pounds from St. Croix. While the St. Thomas reported commercial spiny lobster landings for 2001-2002 were much smaller (16,000 pounds) than those reported for St. Croix, the reported percentage being derived from federal waters (85%) was significantly higher. Given the prevalence of spiny lobster activities in federal waters off the USVI, one can surmise that movement to state waters in response to closure of the EEZ might be relatively limited, at least in the short run, and that the socioeconomic impact would be much more severe as compared to that which would occur to Puerto Rican lobster fishermen.

6.3.2.3.2 Caribbean conch resources

Alternatives 2a - 2e would have no direct or indirect impact on the biological environment for queen conch not already occurring under the status quo. The socioeconomic consequences of Alternative 2h is included in Section 6.4.3.2.2.3.

6.3.2.3.3 Caribbean reef fish resources

Preferred Alternative 2a, one of the least restrictive of the eight alternatives listed in this section, would, if implemented, close the EEZ to the possession of all species in Grouper Unit 4 excluding misty grouper (i.e., red, black, tiger, yellowfin, and yellowedge grouper) from February 1 through April 30. Selected statistics related to the commercial harvest of red, misty, black, tiger, yellowfin, and yellowedge grouper in Puerto Rico are presented in Table 6.3.2a.[9] In total, 79,686 pounds of Grouper Unit 4 species (i.e., red, misty, black, tiger yellowfin, and yellowedge grouper) were landed in Puerto Rico on a total of 1,654 trips during 1995-2002.[10] Trips by month, expressed on a percentage basis, ranged from less than six (November) to 9.5 or more (February, March, May, and August). Average pounds per trip were relatively low, ranging from less than 40 in several months to more than 90 (February). The relatively low catch per trip

[9] Landings data for USVI snapper and grouper are not at a sufficient level of detail to be utilized for the socioeconomic analysis of Alternatives 2a - 2e. Various snapper and grouper species are lumped into one respective landings category, and are not species-specific.

[10] This should be interpreted as a minimum estimate of number of trips, as well as catch and revenues, since reporting was not mandatory during the period in question (see Matos-Caraballo 2002, for additional detail).

likely reflects the fact that species included in Grouper Unit 4, while several, still constitute only a portion of species harvested on any given trip.

In total, 28% of all trips (466 of the total 1,654 trips) were reported during the February through April period. Only a portion of these trips, possibly relatively small, occurred in the EEZ. However, it is expected that a larger proportion of reef fish trips occur in the EEZ off the USVI than in the EEZ off Puerto Rico due to USVI's greater dependance on EEZ waters. That is, due to the disparity in state boundaries – 9 nm for Puerto Rico versus 3 nm for the USVI – there is more overall fishable habitat and in the EEZ off the USVI than off Puerto Rico, and a larger ratio (federal:state) of fishable habitat occurs off the USVI. This issue is applicable for Alternatives 6.2.1.3a - 6.2.1.3e. Regardless, to the extent that the number of EEZ trips is significant, however, implementation of a February through April closure would, in the absence of bycatch mortality, allow increased reproductive success and for some growth in stock size. This growth in stock size, however, could potentially be quickly dissipated upon re-opening of EEZ waters to the species included in the Grouper Unit 4 category. Specifically, one would anticipate an increasing number of trips during that portion of the year when the EEZ waters are not closed to Grouper Unit 4 category harvest; particularly in the months directly following the closure. As such, no long-term economic benefits would likely accrue as a result of the three-month seasonal closure.

Finally, some additional comments regarding Preferred Alternative 2a are in order. First, as indicated in Table 6.3.2a, pounds per trip of species included in the Grouper Unit 4 category is relatively small, reflecting, in all probability, the multi-species nature of reef fish fishing activities in the U.S. Caribbean. Given this situation, one might question whether the total amount of effort in the EEZ would be significantly reduced during the February through April period upon the implementation of Preferred Alternative 2a. If effort is not significantly reduced, one might expect that harvest of the species in the Grouper Unit 4 category would not be significantly lessened, though all harvest would be returned to the water assuming full compliance. If release mortality among these fish are high, the costs of implementing Preferred Alternative 2a could well exceed any benefits. Specifically, landed product could provide benefits in terms of both consumer and producer surplus (assuming that some inframarginal rents to the fishery exist). If release mortality is exceedingly high, there would be little growth in stock size, even in the absence of expansion of effort. In this situation, the alternative would impose costs (i.e., the reduction in consumer and producer surplus) with no concurrent or future benefits being derived. In this situation, net benefits associated with Preferred Alternative 2a would likely be negative. This outcome would, of course, depend upon the species' release mortality during the closed season, estimates for which are unknown.

Furthermore, implementation of Preferred Alternative 2a may result in a redirection or shifting of effort. Most likely, effort will move to state waters. In this situation, a three-month closure in EEZ waters will have minimal, if any, positive impact on stock size (assuming that the density of these species in state waters is not significantly lower than in EEZ waters), even in the absence of any expansion of effort in EEZ waters during those months when the EEZ is not closed to the harvest of species in the Grouper Unit 4 category. Another possibility is that effort may be directed to other species. This redirection of effort would certainly exacerbate any existing problems associated with species in Grouper Unit 4 (i.e., overfished and experiencing overfishing). Finally, some fishermen may cease fishing activities and enter an alternative occupation. One can surmise that since they had selected fishing over another occupation prior to regulation, the welfare of these individuals will be affected.

Table 6.3.2a. Selected Monthly Statistics Related to the Reported Commercial Harvest of Grouper 4 (i.e., red, misty, black, tiger yellowfin, and yellowedge grouper) in Puerto Rico, 1995-2002 Totals[a].

Month	Trips	Pounds	Revenues	%Trips	Pounds/Trip
January	146	6,078	$12,388	8.8	41.6
February	157	8,983	$18,354	9.5	57.2
March	158	6,939	$14,743	9.6	43.9
April	151	14,765	$30,480	9.1	97.8
May	160	7,670	$16,916	9.7	47.9
June	135	5,825	$12,801	8.2	43.1
July	144	5,344	$10,986	8.7	37.1
August	158	6,656	$13,554	9.5	42.1
September	111	3,945	$ 8,744	6.7	35.5
October	135	5,033	$10,253	8.2	37.3
November	97	4,568	$10,020	5.9	47.1
December	102	3,880	$ 7,872	6.2	38.0
TOTAL	1,654	79,686	$167,661	100	48.2

[a] Estimates derived from Puerto Rico trip ticket data for the 1995-2002 period. To the extent that some fishermen did not complete trip tickets, these figures should be considered lower-bound estimates (see Matos-Caraballo 2002 for one possible conversion methodology).

Preferred Alternative 2b, if implemented, would close the EEZ to the possession of red hind off the west coast of Puerto Rico from December 1 through February 28. Selected statistics related to the commercial harvest of red hind in Puerto Rico are presented in Table 6.3.2b. As indicated, the number of reported trips during the 1995-2002 period totaled about 11,000 or an average of 1,360 per year. The average catch of red hind per trip, when evaluated on a monthly basis, ranged from about 37 pounds (April and May) to 70 pounds (January). Reported monthly trips in relation to the total fell within the relatively narrow range of about 7% to 10%. Over one-quarter of all reported trips occurred during this three-month period and these trips accounted for about one-third of the total reported commercial landings of red hind in Puerto Rico (Table 6.3.2b).

Similar to the situation with the discussion of Preferred Alternative 2a, harvest of red hind, on average, likely contributes only a small proportion of total revenues associated with any given trip. This reflects the multi-species nature of the U.S. Caribbean reef fish fishery. Specifically, reported commercial harvest of red hind, based only on those trips where red hind was reportedly landed (i.e., 10,882 trips during 1995-2002) averaged 45 pounds per trip. The number of trips reporting the harvest of red hind accounted for only 17% of the trips where federally-managed reef fish species were harvested (see Table 6.3.2f), while total red hind harvest per trip equaled 23% of the total pounds of federally-managed reportedly landed per trip, on average, during 1995-2002 (see Table 6.3.2f). Therefore, the same conclusions reached with respect to Preferred Alternative 2a are germane for Preferred Alternative 2b.

Table 6.3.2b. Selected Monthly Statistics Related to the Reported Commercial Harvest of Red Hind in Puerto Rico, 1995-2002 Totals[a].

Month	Trips	Pounds	Revenues	%Trips	Pounds/Trip
January	1,123	78,940	$152,728	10.3	70.3
February	995	48,750	$ 99,868	9.1	49.0
March	952	36,441	$ 75,400	8.7	38.3
April	897	33,209	$ 69,139	8.2	37.0
May	936	34,618	$ 71,993	8.6	37.0
June	873	34,715	$ 71,297	8.0	39.8
July	884	38,378	$ 78,918	8.1	43.4
August	969	43,938	$ 90,998	8.9	45.3
September	867	37,521	$ 77,506	8.0	43.3
October	918	37,103	$ 77,379	8.4	40.4
November	751	30,692	$ 64,087	6.9	40.9
December	717	32,931	$ 67,353	6.6	45.9
TOTAL	10,882	487,236	$996,667	100	44.8

[a] Estimates derived from Puerto Rico trip ticket data for the 1995-2002 period. To the extent that some fishermen did not complete trip tickets, these figures should be considered lower-bound estimates (see Matos-Caraballo 2002 for one possible conversion methodology).

Adoption of Preferred Alternative 2c would result in the closure in the EEZ to the possession of species in Snapper Unit 1 (i.e, black, blackfin, vermilion, and silk snapper) from October 1 through December 31. Selected statistics related to the reported commercial harvest of these species in Puerto Rico are presented in Table 6.3.2c. As indicated, the number of reported trips wherein species from Snapper Unit 1 harvest were harvested during the 1995-2002 period equaled 17,198 and, when examined on a monthly basis, ranged from approximately 1,000 (December) to almost 1,700 (May). Average catch per trip equaled 131 pounds with associated revenues of $358.

Given the relatively high catch per trip of Snapper Unit 1 species (either in terms of pounds or value) in conjunction with the three-month duration of the proposed seasonal closure, one might anticipate some redirection of reef fish effort, primarily trapping activities, in the EEZ. While some fishermen, in response to adoption of Preferred Alternative 2c, may cease fishing activities, one might also anticipate a significant movement of effort to state waters during the October through December period. This movement of effort would certainly exacerbate crowding externalities along the area-limited insular platforms and would, at least in the short run, result in a reduction in catch per unit effort among all reef fishermen targeting reef fish in state waters. Furthermore, the 17,198 trips associated with Snapper Unit 1 species during 1995-2002 represent only about one-quarter of the 65,733 trips wherein federally-managed reef fish species were reportedly harvested during 1995-2002 (see Table 6.3.2f). Hence, one might anticipate that the ability to target non-Snapper Unit 1 species might increase if Preferred Alternative 2c is adopted which would, likely, result in a decline in catch per unit effort for participants targeting non-Snapper Unit 1 species. This could result in a reduction in inframarginal rents among participants and, in the long run, negatively impact stock sizes of the non-Snapper Unit 1 species.

Furthermore, assuming that adoption of Preferred Alternative 2c does result in a significant increase in the stock sizes of those species included in Snapper Unit 1 in EEZ waters, effort in EEZ waters could expand during that portion of the year (i.e., January through September) when harvest of species in the Snapper Unit 1 category is permitted. As such, any economic benefits, as well as biological benefits, will likely be dissipated over time.

Table 6.3.2c. Selected Monthly Statistics Related to the Reported Commercial Harvest of Snapper Unit 1 (i.e., black, blackfin, vermilion, and silk snapper) in Puerto Rico, 1995-2002 Totals[a].

Month	Trips	Pounds	Revenues	%Trips	Pounds/Trip
January	1,463	192,302	$526,192	8.5	131.4
February	1,398	211,557	$584,832	8.1	151.3
March	1,607	226,438	$620,543	9.3	140.9
April	1,607	207,495	$570,677	9.3	129.1
May	1,697	209,572	$568,071	9.9	123.5
June	1,428	180,634	$482,066	8.3	126.5
July	1,372	153,035	$416,004	8.0	111.5
August	1,510	184,761	$510,479	8.8	122.4
September	1,418	172,230	$475,495	8.2	121.5
October	1,453	217,550	$586,069	8.4	149.7
November	1,214	153,232	$422,196	7.1	126.2
December	1,023	145,520	$394,554	5.9	142.2
TOTAL	17,198	2,254,326	$6,157,180	100	131.1

[a] Estimates derived from Puerto Rico trip ticket data for the 1995-2002 period. To the extent that some fishermen did not complete trip tickets, these figures should be considered lower-bound estimates (see Matos-Caraballo 2002 for one possible conversion methodology).

Adoption of Amendment 2d would close the EEZ to the possession of yellowtail snapper from April 1 through June 30. Summary statistics related to the reported commercial harvest of yellowtail snapper in Puerto Rico are presented in Table 6.3.2d. In total, about 2.3 million pounds of yellowtail snapper was landed in Puerto Rico on a total of approximately 28,500 trips during 1995-2002.[11]

In total, 27% of all trips were reported during the April through June period. Only a portion of these trips, possibly relatively small, occurred in the EEZ.[12] To the extent that the number of EEZ trips is significant, however, implementation of an April through June closure would, in the absence of bycatch mortality, allow for some growth in stock size. This growth in stock size, however, would, in theory, be quickly dissipated upon re-opening of EEZ waters to yellowtail snapper harvesting activities. Specifically, one would anticipate an increasing number of trips during that portion of the year when the EEZ waters are not closed to yellowtail snapper harvest; particularly in the months directly following the closure. As such, no long-term economic benefits would likely accrue as a result of the three-month seasonal closure.

Table 6.3.2d. Selected Monthly Statistics Related to the Reported Commercial Harvest of Yellowtail Snapper in Puerto Rico, 1995-2002 Totals[a].

Month	Trips	Pounds	Revenues	%Trips	Pounds/Trip
January	2,468	188,671	$381,147	8.7	76.4
February	2,439	194,123	$397,527	8.6	79.6
March	2,751	268,912	$539,140	9.7	97.7
April	2,641	230,835	$467,189	9.3	87.4
May	2,596	203,548	$411,021	9.1	78.4
June	2,413	185,180	$371,918	8.5	76.7
July	2,443	184,395	$368,199	8.6	75.5
August	2,514	214,647	$428,480	8.8	85.4
September	2,222	184,393	$369,859	7.8	83.0
October	2,329	196,143	$388,305	8.2	84.2
November	1,951	162,888	$316,750	6.9	83.5
December	1,703	124,296	$242,707	6.0	73.0
TOTAL	28,470	2,339,461	$4,682,242	100	82.2

[a] Estimates derived from Puerto Rico trip ticket data for the 1995-2002 period. To the extent that some fishermen do not complete trip tickets, these figures should be considered lower-bound estimates (see Matos-Caraballo 2002 for one possible conversion methodology).

Preferred Alternative 2e would close the EEZ to the possession of mutton snapper and lane snapper from April 1 through June 30. Summary statistics related to the reported commercial harvest of mutton and lane snapper in Puerto Rico are presented in Table 6.3.2e. In total, about

[11] This should be interpreted as a minimum estimate of number of trips, as well as catch and revenues, since reporting was not mandatory during the period in question (see Matos-Caraballo 2002, for additional detail).

[12] As discussed earlier in this analysis, the significance of reef fish activities in the EEZ are likely to be more pronounced off of the USVI than to those occurring off Puerto Rico.

2.4 million pounds of mutton and lane snapper were landed in Puerto Rico on a total of 34,830 trips during 1995-2002. Monthly trips, as a percentage of annual total, show relatively little fluctuation, ranging from 6% (December) to 9.7% (March). Average per trip catch of mutton and lane snapper during the 1995-2002 period equaled 70 pounds for the 34,830 trips wherein mutton and lane snapper were reported, which reflects the multi-species nature of reef fish harvesting activities in the U.S. Caribbean. Given these considerations, the discussion provided for the other proposed seasonal closures would likely also be relevant for an April through June closure of mutton and lane fishing in the EEZ.

Table 6.3.2e. Selected Monthly Statistics Related to the Reported Commercial Harvest of Mutton and Lane Snapper in Puerto Rico, 1995-2002 Totals[a].

Month	Trips	Pounds	Revenues	%Trips	Pounds/Trip
January	3,111	215,872	$421,953	8.9	69.4
February	3,099	212,857	$412,601	8.9	68.7
March	3,369	268,714	$518,458	9.7	79.8
April	3,352	289,961	571,148	9.6	86.5
May	3,277	225,473	$439,536	9.4	68.8
June	2,902	196,375	$386,249	8.3	67.7
July	2,976	199,996	$378,967	8.5	67.2
August	2,977	200,613	$400,276	8.5	67.4
September	2,625	153,934	$301,514	7.5	58.6
October	2,667	166,353	$328,648	7.7	62.4
November	2,354	164,141	$309,115	6.8	69.7
December	2,121	145,528	$282,071	6.1	68.6
TOTAL	34,830	2,439,817	$4,750,539	100	70.0

[a] Estimates derived from Puerto Rico trip ticket data for the 1995-2002 period. To the extent that some fishermen do not complete trip tickets, these figures should be considered lower-bound estimates (see Matos-Caraballo 2002 for one possible conversion methodology).

Alternative 2f would close the EEZ to the possession of all Caribbean Council-managed species from January 1 through March 31 (i.e., a three-month closure) while Alternative 2g would close the EEZ from January 1 to March 31 and from July 1 to September 30 (in total, a six-month closure). Finally, Alternative 2h would result in a year-round closure of the EEZ to all Council-managed species.

Selected statistics related to reported commercial harvesting activities for federally-managed reef fish in Puerto Rico for 1995-2002 are presented in Table 6.3.2f. As indicated, during the January 1 through March 31 period, a total of 17,607 trips occurred wherein reef fish landings were reported. During the six month proposed closure, a total of 34,088 trips were reported.

Alternatives 2f - 2h would close federal waters to all federally-managed reef fish activities during different times of the year with a year-round closure proposed in Alternative 2h. While information is incomplete to determine all impacts on the human environment associated with these three alternatives, some generalizations can be made. First, one would anticipate the severity of the adverse socioeconomic impacts to increase as the length of the seasonal closure increases. Hence, the adverse affects of the year-round closure (Alternative 2h) are likely greater than those associated with, say, Alternative 2f. Second, since these three alternatives would result in closure of the federal waters to all reef fish activities, one would anticipate that adverse impacts would be more severe than those associated with closure of the federal waters to only certain types of reef fish fishing activities (e.g., specific FMU sub-units). Third, one might anticipate that the adverse impacts may be worse in the USVI than in Puerto Rico because, likely, a greater proportion of reef fish activities occur in federal waters of the USVI than in Puerto Rico. For example, 55% of the reported commercial snapper activities in St. Croix during 2000-2001 occurred in federal waters, according to the monthly trip ticket reports. Similarly, almost 50% of the reported commercial harvest of snapper was, according to the monthly reporting forms, taken in federal waters around St. Thomas during the 2000-2001 period. While harvest in federal waters off Puerto Rico is unknown, because of the depth of federal waters off Puerto Rico, it is likely to be significantly less than that reported for either St. Croix or St. Thomas. Finally, the adverse socioeconomic impacts would, almost certainly, be worse given a complete closure of federal waters to reef fish fishing activities than a closure to the harvest and possession of single FMU sub-units (i.e., Alternatives 2a - 2e). Whether any of the closures would contribute significantly to rebuilding of the stocks is, for reasons already discussed, debatable. However, one could look at a year-round closure (i.e., Alternative 2h) as an insurance policy for protection of the reef fish species. Whether the benefits of this insurance exceeds the costs ultimately depends upon the amount of risk society is willing to take and willingness to pay to avoid this risk.

Table 6.3.2f. Selected Monthly Statistics Related to the Reported Commercial Harvest of federally-managed Reef Fish in Puerto Rico, 1995-2002 Totals[a].

Month	Trips	Pounds	Revenues	%Trips	Pounds/Trip
January	5,812	1,148,708	$2,288,003	8.8	197.6
February	5,726	1,127,693	$2,267,971	8.7	196.9
March	6,069	1,335,828	$2,639,183	9.2	220.1
April	5,978	1,245,656	$2,486,582	9.1	189.5
May	6,019	1,128,563	$2,272,629	9.2	187.5
June	5,602	1,026,114	$2,035,220	8.5	183.2
July	5,554	1,029,272	$2,014,403	8.4	185,3
August	5,767	1,147,942	$2,273,798	8.8	199.1
September	5,160	948,007	$1,907,801	7.8	183.7
October	5,211	1,040,506	$2,124,915	7.9	199.7
November	4,639	897,893	$1,787,185	7.1	193.6
December	4,196	802,091	$1,575,273	6.4	191.2
TOTAL	65,733	12,878,273	$25,672,963	100	195.9

[a] Estimates derived from Puerto Rico trip ticket data for 1995-2002. To the extent that some fishermen do not complete trip tickets, these figures should be considered lower-bound estimates (see Matos-Caraballo 2002 for one possible conversion methodology).

6.3.2.3.4 Caribbean coral reef resources

Alternatives 2a - 2e would have no direct or indirect impact on the biological environment for coral reef resources not already occurring under the status quo. As the Council has prohibited the harvest and possession of corals, Alternatives 2f- 2h are not expected to have any direct effect to the socioeconomic environment in regard to this FMP. However, these alternatives may result in beneficial indirect impacts due to the protection of coral habitat and EFH.

6.3.2.4 Direct and indirect effects on administrative environment and their significance

Seasonal closures could introduce several significant direct effects on the administrative environment. The species-specific seasonal closures (Alternatives 2a - 2e) would need to address public outreach issues, such as species identification due to differences in local vernacular of the same species. Enforcement would be complicated due to the absence of consistent regulations in state waters. Therefore, the species-specific alternatives would require enforcement action to occur in federal waters, as once fishermen reached state waters it would not be possible to enforce the possession prohibition. A comprehensive seasonal closure would be easier to enforce than a species-specific seasonal closure, as any vessel in federal waters that possess a managed species during that time period would be in violation. Additionally, a longer time period (i.e., Alternative 2h versus 2f or 2g) would minimize confusion, though it could lead to significant economic impacts, as discussed in Section 6.3.2.3. Alternative 2f would present a considerable closed season and would avoid the potential confusion of season openings and closings that could occur from Alternative 2g.

Regardless, because the majority of the catch is taken from state waters, none of the seasonal closures described in Alternatives 2a - 2h would likely be capable of achieving the required reductions, especially for spiny lobster and queen conch. The Council must balance the need to implement measures that are reasonably capable of achieving the necessary reductions in federal waters with the realism that the actual potential for achieving defined targets will be critically dependent on the willingness of the states to implement consistent measures (i.e., for species-specific alternatives (Alternatives 2a - 2e) in state waters. If there were compatible regulations in state waters, a seasonal closure would be easier to enforce than area closures (Section 6.3.3), as agents could simply inspect the catch at the docks, versus conducting operations offshore.

6.3.3 Alternative 3. Establish area closures.

The Puerto Rican shelf, or fishable habitat 100 fathoms or less, encompasses an approximate 1,837 nm^2 area. Of that area, only 6.3% (116 nm^2) occurs in the EEZ, and the vast majority of that area is found off the west coast of Puerto Rico. Conversely, the USVI shelf only encompasses an approximate 630 nm^2 area. Of that area, 38% (240 nm^2) occurs in the EEZ. The bulk of the shelf occurs off St. Thomas and St. Johns, with a 291 nm^2 total area in state waters and a 218 nm^2 total area in federal waters. St. Croix has 98 nm^2 of fishable habitat in state waters, and only a 21 nm^2 area off its east coast that resides in the EEZ. This disparity between Puerto Rico and the USVI, that is the amount of fishable habitat that occurs in federal waters off each state, is a result of the difference in state jurisdictions. Puerto Rico waters extend offshore 9 nm, while USVI waters only extend out 3 nm. Therefore, the USVI fisheries depend on the EEZ to a much greater extent than those prosecuted off Puerto Rico. Further, St. Thomas and St. Johns have a greater reliance on the EEZ, with approximately 43% of the total shelf occurring in the EEZ, as compared to that of St. Croix, which only has approximately 18% of its waters in the EEZ.

The following alternatives are based on the assumption that a specific reduction in available fishable habitat (i.e., 100 fathoms or shallower) in EEZ waters resulting from an area closure corresponds with a matching reduction in fishing mortality. That is, a 10% closure of waters 100 fathoms or less results in a 10% reduction in fishing mortality.

Alternative 3a. Establish one or more closed areas off Puerto Rico and the USVI as identified in Figures 7 - 9, and 12 - 15.

The following area closures would attempt to achieve any needed reductions in fishing mortality by prohibiting fishing for all Council-managed species year round in select areas of the EEZ. Each closed area is described with respect to its potential to reduce total annual fishing mortality on affected species in federal waters, based on the assumption that catches in the EEZ are distributed equally over fishable habitat in the EEZ (e.g., a closed area that encompasses 10% of fishable habitat in the EEZ would be presumed to result in a 10% reduction in fishing mortality for all Council-managed stocks). In reality, this assumption is not likely to hold true, as the distribution of fishing effort is affected by multiple factors, including the availability of fish and the redistribution of effort to other areas in the EEZ. However, state trip ticket programs do not collect data that would allow us to more precisely describe the spatial distribution of fishing effort. Assuming that total landings are divided equally throughout the EEZ allows us to evaluate the potential impact of the alternatives relative to one another and to the goals and objectives established by the preferred limit (ABC) and target control rules. Calculations defining the total percentage of fishable habitat (i.e., waters 100 fathoms or shallower) in the EEZ that would be protected by each area closure alternative recognize recent protections to fishable habitat provided by the designation of the Hind Bank MCD, located south of St. Thomas, USVI. Implemented in December 1999, the Hind Bank MCD encompasses an area about 13 nm^2, which includes approximately 11 nm^2 (approximately 3%) of fishable habitat in EEZ waters off the USVI.

The proposed areas are identified in Figures 7 - 9, and 12 - 15. Coordinates for the proposed areas are as follows:

Alternative 3a(1). West of Puerto Rico (PRW)
A) 18° 13.50N, 67° 27.00W
B) 18° 13.50N, 67° 23.00W
C) 18° 00.00N, 67° 23.00W
D) 18° 00.00N, 67° 27.00W

PRW (Figure 7) would create a closed area of approximately 51.46 nm^2, with 31.98 nm^2 consisting of waters 100 fathoms or shallower. This area encompasses an existing red hind seasonal spawning closure off the west coast of Puerto Rico. It covers about 28% of the fishable habitat in EEZ waters off Puerto Rico, and about 9% of the total fishable habitat in the EEZ.

Alternative 3a(2). Northeast of Puerto Rico (PRN)
A) 18° 33.50N, 65° 17.00W
B) 18° 33.50N, 65° 10.00W
C) 18° 30.00N, 65° 10.00W
D) 18° 30.00N, 65° 17.00W

PRN (Figures 8 and 9) would create a closed area of approximately 23.14 nm^2, with 20.36 nm^2 consisting of waters 100 fathoms or shallower. This area covers about 12% of the fishable habitat in EEZ waters off Puerto Rico, and about 3% of the total fishable habitat in the EEZ.

Alternative 3a(3). East of St. Croix on Lang Bank (CRX)
A) 17° 50.50N, 64° 28.50W
B) 17° 50.50N, 64° 25.00W
C) 17° 47.00N, 64° 25.00W
D) 17° 47.00N, 64° 28.50W

CRX (Figure 8) would create a closed area of approximately 11.63 nm^2, with 7.47 nm^2 consisting of waters 100 fathoms or shallower. This area encompasses most of the area protected by the existing red hind seasonal spawning closure on Lang Bank. It covers about 3% of the fishable habitat in EEZ waters off the USVI, and about 2% of the total fishable habitat in the EEZ.

Alternative 3a(4). South of St. John (JOS)
A) 18° 14.50N, 64° 47.50W
B) 18° 14.50N, 64° 44.00W
C) 18° 10.00N, 64° 44.00W
D) 18° 10.00N, 64° 47.50W

JOS (Figure 8) would create a closed area of approximately 14.94 nm^2, with 13.01 nm^2 consisting of waters 100 fathoms or shallower. This area covers about 5% of the fishable habitat in EEZ waters off the USVI, and about 4% of the total fishable habitat in the EEZ.

Alternative 3a(5). North of St. Thomas (THN)
A) 18° 14.50N, 64° 47.50W
B) 18° 14.50N, 64° 44.00W
C) 18° 10.00N, 64° 44.00W
D) 18° 10.00N, 64° 47.50W

THN (Figures 8 and 9) would create a closed area of approximately 66.12 nm^2, with 55.21 nm^2 consisting of waters 100 fathoms or shallower. This area covers about 23% of the fishable habitat in EEZ waters off the USVI, and about 16% of the total fishable habitat in the EEZ.

Alternative 3a(6). West of Puerto Rico (PRW2)
A) 18° 12.12N, 67° 27.30W
B) 18° 12.12N, 67° 25.00W
C) 18° 05.00N, 67° 25.00W
D) 18° 05.00N, 67° 27.30W

PRW2 (Figure 13) would create a closed area of approximately 15.64 nm^2, with 10.60 nm^2 consisting of waters 100 fathoms or shallower. This area encompasses a portion of the area protected by the existing red hind seasonal spawning closure off the west coast of Puerto Rico. It covers about 9% of the fishable habitat in EEZ waters off Puerto Rico, and about 3% of the total fishable habitat in the EEZ.

Preferred Alternative 3a(7). West of Puerto Rico (PRW3)
A) 18° 12.00N, 67° 27.00W
B) 18° 12.00N, 67° 23.00W
C) 18° 03.50N, 67° 23.00W
D) 18° 03.50N, 67° 27.00W

PRW3 (Figures 12 and 13) would create a closed area of approximately 32.93 nm^2, with 28.40 nm^2 consisting of waters 100 fathoms or shallower. This area encompasses an existing red hind seasonal spawning closure off the west coast of Puerto Rico. It covers about 24% of the fishable habitat in EEZ waters off Puerto Rico, and about 8% of the total fishable habitat in the EEZ.

Preferred Alternative 3a(8). North of St. Thomas and Culebra (CARIB)
A) 18° 33.50N, 65° 17.00W
B) 18° 33.50N, 65° 05.00W
C) 18° 30.00N, 65° 05.00W
D) 18° 30.00N, 65° 17.50W

CARIB (Figures 14 and 15) would create a closed area of approximately 39.74 nm^2, of which 38.24 nm^2 consists of waters 100 fathoms or shallower (~13.73 nm^2 in Puerto Rico and ~24.44 nm^2 in USVI). This area covers about 12% and 10% of the fishable habitat in EEZ waters off Puerto Rico and the USVI, respectively, and about 11% of the total fishable habitat in the EEZ.

Alternative 3b. Close the EEZ off Puerto Rico, and establish a closed area off the USVI (e.g., Alternative 3a(5), THN, or Alternative 3a(8), CARIB), as indicated in Figure 8 or 15.

The delineation for the closed area off Puerto Rico would be seaward of the state boundary, and westward of 65° 15'W longitude. This 116 nm^2 area encompasses 100% of the fishable habitat in federal waters off Puerto Rico, and comprises about 33% of the fishable habitat in the EEZ. Additionally, this alternative would close one of two areas off the USVI: Alternative 3a(5), THN, or Alternative 3a(8), CARIB. The total percentage of fishable habitat in the EEZ covered by this alternative is 49% if the THN alternative is selected, and 44% if the CARIB alternative is selected.

Alternative 3c. Within any preferred closed area alternative, prohibit all fishing for and possession of all species with the exception of HMS species.

This alternative would supplement any preferred area closure (i.e., Alternatives 3a(7) and 3a(8)), and allow the harvest of HMS species such as tunas and sharks, but prohibit all other fishing activities. As with Alternatives 3a and 3b, there would be no transit provision for fishing vessels with this alternative.

Alternative 3d. Within any preferred closed area alternative, prohibit all fishing for and possession of all species, but allow the transit of fishing vessels with properly stowed gear and catch.

This alternative would supplement any preferred area closure (i.e., Alternatives 3a(7) and 3a(8)), but allow the transit of fishing vessels that have their gear and catch stowed.

6.3.3.1 Direct and indirect effects on physical environment and their significance

Implementing a closed area would result in a reduction of fishing effort in a localized area. That reduction in fishing effort could directly benefit the physical environment, in particular coral habitat, as it would eliminate fishing-related impacts within that area (Barnette 2001). Within the closed area gear impacts and anchoring of fishing vessels would be expected to be absent, allowing benthic communities to recover. Yet, any benefits incurred from the closed area could potentially be indirectly reduced by increased fishing activity around the perimeter of the boundaries, as well as increased pressure to benthic communities elsewhere in the U.S. Caribbean.

6.3.3.2 Direct and indirect effects on biological and ecological environment and their significance

6.3.3.2.1 Caribbean spiny lobster

A closure in federal waters would protect the portion of the stock that resides in that portion of the EEZ. Yet, only 14% of fishable habitat occurs in the EEZ, and the 100-fathom (200 m) contour is also considered the limits of spiny lobster habitat, with a greater proportion likely occurring within 100 m (Section 5.2.1.1.1). While spiny lobster may benefit from an area closure, it is likely that the U.S. Caribbean spiny lobster resource depends on larval input from outside jurisdictional boundaries. Since spiny lobster planktonic larvae spend up to 11 months at sea before settling (Section 5.2.1.1.1), the source for a large proportion of U.S. Caribbean spiny lobster is likely “upcurrent” of Puerto Rico and the USVI. Likewise, only a small proportion of spiny lobster larvae is likely retained within the U.S. Carribean; it is most likely that larvae spawned in the U.S. Caribbean could, for example, settle at Bermuda (Munro 1974a). Therefore, the biological benefit of a closure for spiny lobster in the U.S. Caribbean will be limited.

6.3.3.2.2 Caribbean conch resources

Alternatives 3a and 3b would result in direct benefits to Caribbean conch by reducing harvest pressure on the resource. However, the direct and indirect effects to the biological environment resulting from any of the closed areas in Alternative 3, as it applies to the Caribbean conch resource, would be overshadowed by the impacts to the biological environment resulting from a prohibition of catch year-round in the EEZ, which is the Council’s preferred alternative to rebuild the queen conch resource; a discussion on the biological impacts of that action is provided in Section 6.4.3.2.2.2.

The same issues discussed for spiny lobster in Section 6.3.3.2.1 also apply to queen conch. For example, the documented range of queen conch extends to about 100 m in depth (Section 5.2.1.2.1.1). While there may be some export of conch larvae, their duration in the water column is much shorter, and some studies have concluded that the majority of queen conch larvae are retained locally. Thus, the protection of any portion of the queen conch stock in the EEZ may directly benefit the biological environment in the U.S. Caribbean, as it applies to the Queen Conch FMP.

6.3.3.2.3 Caribbean reef fish

Protecting areas of reef fish habitat from fishing mortality may enhance reproductive success and recruitment. Where established, no-take reserves have reportedly been successful in directly increasing both the size and abundance of reef fish within their borders (Bryant *et al.* 1998). Furthermore, properly sited closed areas could be effective in regulating fishing mortality, as well as in reducing bycatch and protecting important habitat. They would also provide a controlled area for assessing fishing impacts. Other ancillary benefits are discussed in Section 6.3.3.3.

All three alternatives would provide enhanced protection to spawning aggregations of numerous species of reef fish. The three proposed closed areas off the west coast of Puerto Rico included in Alternative 3a (i.e., 3a(1), 3a(6), and 3a(7)) either partially (Alternative 3a(6)) or fully encompasses (Alternatives 3a(1) and 3a(7)) one existing seasonal spawning closure for red hind (i.e., Abrir La Sierra Bank). Furthermore, the red hind seasonal spawning closure on Lang Bank off St. Croix would also be fully encompassed year-round under Alternatives 3a(3) and 3b.

The sedentary nature and high catchability of many snapper species make them particularly at risk (Weber 1998). While many reef fishermen do not have the basic electronic equipment typically used to locate aggregations, the strong site fidelity of some snapper species, both to non-spawning habitat and to spawning sites, as well as the temporal predictability of their spawning aggregations, makes them easy to locate (AFS 2001; Rielinger 1999). Furthermore, fishers have historically targeted unprotected spawning aggregations, including those of mutton snapper, gray snapper and yellowtail snapper (Rielinger 1999).

Luckhurst (1998) demonstrated that spawning site fidelity in red hind is an acquired trait. Additionally, the loss of spawning aggregations in several grouper species due to overfishing, despite their proximity to more healthy spawning stocks, would strongly suggest that spawning fidelity is a learned behavior in many reef fish species. When heavy fishing on aggregations removes the experienced fish, new recruits cannot find the aggregations, which can then collapse as functional spawning units (Coleman *et al.* 2000). For example, of the nearly 50 Caribbean aggregations known for Nassau grouper, at least 10 have been annihilated by fishing. Those aggregations that were fished out have yet to rebuild (Coleman *et al.* 2000).

Aside from protection of spawning aggregations of managed species, implementing closed areas would offer additional benefits, such as protection to juveniles and aquarium trade species from bycatch mortality in fish traps. However, closed areas could also present a few negative impacts. Without comprehensive regional management, especially in regard to state waters, fish populations and benthic habitats outside of the closed areas could be subjected to increased fishing pressure. Displacement of effort could have a significant localized effect, especially on undocumented spawning aggregation sites.

The reductions in fishing mortality resulting from the proposed area closures are documented in Table 13. Depending on the which closed areas are selected, closed area(s) could successfully result in a sufficient reduction in fishing mortality that would end overfishing for the queen conch, Snapper Unit 1, Snapper Unit 4, Grouper Unit 4, parrotfish, triggerfish and filefish, and boxfish FMU sub-units. Further, the reductions in fishing mortality will undoubtedly aid the rebuilding of some overfished species such as those included in Snapper Unit 4 and Grouper Unit 4.

6.3.3.2.4 Caribbean coral resources

Reducing fishing pressure and interactions of fishing gear with habitat will undoubtedly protect coral habitat within the boundaries of any given area closure. Further applicable discussion on the biological impacts that could be associated with Alternatives 3a and 3b, in regards to EFH, can be found in Section 4.5.7.1 of the EFH EIS (CFMC 2004). However, closed areas could also present a few negative impacts. Without comprehensive regional management, benthic habitats outside of the closed areas could be subjected to increased fishing pressure. Displacement of effort could have a significant localized effect, especially on coral habitat sites that have not been mapped or whose importance has yet to be recognized (e.g., spawning aggregation sites).

6.3.3.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Aside from protection of spawning aggregations of managed species, implementing closed areas would offer additional benefits, such as reduction of potential fishery-related impacts with sea turtles and other endangered species. Closed areas adjacent to areas designated as critical habitat for sea turtles (i.e., areas where there may be higher concentrations of sea turtles) may reduce the number of incidental takes. Any total effort reductions as a result of area closures may be beneficial to protected resources.

Alternative 3c would permit fishing activities for HMS species. Theoretically, trolling for HMS may incidentally catch other managed species, but it is expected these events would be fairly rare. However, it is very possible that bycatch of wahoo and dolphin could occur on a regular basis, and Alternative 3c would require that these species be discarded within the closed area.

6.3.3.3 Direct and indirect effects on social and economic environment and their significance

Table 13 documents the potential economic impacts resulting from, as well as the size and area encompassed by each of the closed area alternatives. There are some artifacts produced that should be considered when trying to determine potential impacts from closed area alternatives. Due to the lack of discrete effort data, it is not possible to precisely determine economic impacts resulting from discrete closed areas. That is, catch reporting areas are much larger than the area encompassed by each of the proposed closed areas. What portion of the landings originate from within the closed area boundaries is impossible to determine given the constraints of the current reporting regime.

Ex-vessel values for Puerto Rico were used for the entire U.S. Caribbean to determine the economic impact of the various closed area alternatives (Table 13). While prices for USVI fish and shellfish and typically higher than those in Puerto Rico, the nature of how the product is marketed is different between the two states. Fishermen in the USVI generally market their product directly to the consumer or to restaurants (i.e., wholesale or quasi-retail), so it does not reflect a true ex-vessel value. Therefore, a direct comparison between the economic impacts between Puerto Rico and the USVI would have artifacts associated with it, and would potentially be misleading. Regardless, considering public comment and input from members of the Council, the proposed closed areas would introduce significant economic burdens to fishermen, and would likely put many fishermen out of business.

Recreational data in the U.S. Caribbean is not sufficient to conduct a thorough analysis of the economic impact of that sector for the purposes of Table 13. MRFSS data is available only for Puerto Rico, and it does not differentiate if fish are landed in state or federal waters. However, anecdotal information suggests that most recreational fishing activity, in particular activity conducted on charter vessels, is focused on HMS and other pelagic species, with little effort expended on reef fish or other Council-managed species.[13] Therefore, Alternative 3c would not be expected to result in significant economic effects, with the exception of discarded dolphin, wahoo, or other species that are not managed by the Council, but the harvest and possession of which would be prohibited within the closed areas.

Obviously, due to the location of the various closed area alternatives, it is possible for an alternative to have a greater impact on users in one area than in others. For example, the implementation of the CARIB closed area alternative would impact fishers operating from the north coast of St. Thomas and the northeast coast of Puerto Rico, while most likely having a negligible effect on fishers in St Croix. This is largely a function of where the available habitat areas are in the Caribbean EEZ that could be utilized to reduce fishing mortality through a closed area alternative; there are very specific areas where closed areas could be sited. Further, due to the disparity between the amount of area in the EEZ off Puerto Rico and the USVI, respectively,

[13] Information on this issue was offered by several charter boat captains at a CFMC advisory panel meeting in San Juan, on March 11, 2004.

and the fact that the USVI has a greater percentage of fishable habitat in the EEZ as compared to Puerto Rico, any closed area alternative may potentially have a greater impact on USVI fishermen than Puerto Rican fishermen.

The proposed closure on Lang Bank off St. Croix (i.e., STX), while less than 12 nm^2 in size, might have a significant local effect on St. Croix fishers. Due to the recently implemented closed areas at Buck Island Reef National Monument and St. Croix East End Marine Park, which closed 28.33 nm^2 (approximately 9.32 nm^2 of which is shallower than 100 fathoms) and approximately 5 nm^2 in state waters, respectively, as well as the very narrow shelf area around most of the island of St. Croix, the additive effects of closing off more areas to fishing may force some individuals out of the fishery. Due to St. Croix's isolated position in the U.S. Caribbean, and its limited shelf area available to fishing, the effects of any closed area to associated users would most likely be more profound when compared to the effects stemming from the closed areas proposed off St. Thomas or Puerto Rico.

Some ancillary benefits of closed areas are briefly discussed below.

A. Direct and indirect benefits

1. The value of biological diversity associated with the protection of nature within the confines of the proposed area closures: Sobel (1993) groups threats to marine biological diversity into two classes. The first class includes those activities that involve overexploitation of marine resources, including the directed or intentional harvesting and incidental taking of marine life. The second class of threats to marine biological diversity include "...those that destroy or degrade marine habitats (p.21)," such as pollution and coastal development.

Before considering the economic benefits of biological diversity (or biodiversity), it is useful to briefly discuss what is meant by the term. Simply stated, biological diversity is a general term referring to the extent of variety in nature and can be considered at four levels. These levels include (Miller 2002): (1) genetic diversity, (i.e., the variety of information contained in all of the individual plants, animals, and microorganisms), (2) species diversity, or the variety of living species, (3) ecosystems diversity, or the variety of habitats, biotic communities, and ecological processes, as well as the tremendous diversity present within the ecosystems in terms of habitat differences and the variety of ecological processes, and (4) functional diversity, or the biological and chemical processes or functions such as energy flow and matter cycling needed for the survival of species and biological communities.

Genetic diversity refers to variation of genes within species. As noted by Polunin (1983), genetic diversity can be diminished in heavily fished stocks which, among other things, can result in fish stocks becoming more stressed from environmental perturbations. This increased stress can lead to recruitment failure, etc. Species diversity is generally classified into three groups of measurement: species richness, species abundance, and taxonomic diversity. Species diversity, no matter how it is measured, tends to be unevenly distributed around the world. Specifically, species richness is concentrated in the equatorial regions and decreases in relation to distance from the equator. In the marine ecosystem, biological diversity appears to be highest on the continental shelves. Because the boundaries of communities (i.e., associations of species) and ecosystems tend to be very fluid, defining ecosystem diversity tends to be much more complicated than that of genetic or species diversity and the measurement of ecosystem diversity is still in its early stages.

In a study of the St. John trap fishery, Garrison (1997) reports some trends suggesting relatively large changes in species composition and, indirectly, evidence of decreasing biodiversity. In relation to species composition, the author found that six species accounted for more than 50% of the total catch during the 1992-1994 period with blue tang, gray angelfish, and porgies representing the most frequently caught species. The author suggests that the six species represent a far fewer number than reported in earlier studies. Furthermore, the number of blue tang caught in traps increased from six percent in 1992 to more than 30% in 1994. As stated by the author, "[t]he dominance of tangs in this study may be an example of Jenning's and Polunin's (1996) prediction that small, fast-growing species from a lower trophic level would eventually dominate catch as a result of intense fishing pressure. Change in catch composition would result from fishers simply targeting the remaining available species or keeping species previously considered trash fish or bycatch." Similarly, in a recent summary of fishing activities Puerto Rico, Matos-Caraballo (2001) states "[s]everal species discarded by fishers in the past, have now become commercial species (*H. Rufus, Holocanthus ciliaris, Carpilus coralinus*, and *Mythrax spp*). Thus species considered with no market value in the past, are now easily sold at good price today. Probably these species are now marketable due to the decrease in landings, and an increase in the demand for more fresh products. This fact is another indication of overfishing."

The obstacles associated with measuring the value of biodiversity within an economic framework are well known. While the measurement is inherently complicated, few economists would argue that there is value to it. Hence, the creation of closed areas and the protection afforded to fish stocks and the associated ecosystem would certainly provide economic benefits. Furthermore, one would anticipate that the amount of benefits is related to the size of the closed area. Hence, the value associated with maintaining biodiversity likely increases as one moves from smaller to larger closed areas.

2. Value associated with avoidance of large potential losses that may occur when common access is the only viable alternative. There is ample evidence that closed areas are successful at increasing the biomass and the average size of fish outside the boundaries of the closed areas (Polunin and Roberts 1993). This is particularly true when considering species, such as many of the reef fish species in the Caribbean Region, that exhibit relatively limited movements and have long life spans for which current size distribution is significantly below that historically reported (Rowley 1994).[14]

[14] See Garrison (1997) for a discussion of the historical change in size of reef fish species harvested in St. John.

Benefits (value) associated with avoidance of large potential loss (even in the absence of common access) can take many forms. In the extreme, closed areas can help ensure species' survival. Less Draconian in nature, closed areas can help to provide a hedge against recruitment failure, assuming spillover and egg dispersal effects are positive. As such, closed areas can, in essence, provide insurance against the potential, and perhaps, negative impacts related to overfishing. While it may not be able to quantify it, this insurance policy is a benefit and, hence, is valued by society.

Finally, there is a growing consensus that the multi-species, multi-gear nature associated with the harvesting of reef fish assemblages, such as those prevailing in the U.S. Caribbean, makes traditional management measures somewhat ineffective in sustaining viable populations of targeted, as well as incidentally harvested, species in some cases (Roberts 1997). Management measures that limit the overall level of effort may also be ineffective due to expansion of effort within the existing fleet (e.g., increased trips and/or traps). An individual transferrable quota program, while largely untested in fisheries as complex and diverse as that of the reef fish assemblage fishery in the U.S. Caribbean, is likely to be extremely cumbersome (and costly), and it is uncertain how well it would perform. As such, area closures may be a cost effective alternative to more cumbersome and expensive programs. In addition, they can provide additional protection associated with the avoidance of large potential losses when used in conjunction with more traditional management approaches. Hence, it is relatively safe to state that benefits associated with avoidance of large potential losses would accrue *via* establishment of area closures.

3. Value associated with an (potential) increase in commercial and recreational harvests outside the area closures emanating from conserving species within the area closures. One of the core concepts of area closures is that over time (after initial establishment) stock sizes outside the area closures will be enhanced through the effects associated with spillover. The spillover effect emanates from larger fish emigrating outside the borders of the area closures over time as carrying capacity[15] within the area closure is attained. The export of larvae, similarly, may enhance recruitment into neighboring fish stocks.

While intuitively appealing, empirical evidence supporting the spillover and export of larvae effects may be limited for some species (e.g., spiny lobster). This is particularly true with respect to the export of larvae. As noted by Rowley (1992), however, much of the reason for limited empirical evidence reflects the fact that scientific proof would require rather complicated experimental designs involving multiple sites as well as the need for sampling both before and after the area is closed.

What are the expected benefits of the establishment of area closures in relation to increased stocks outside the closed areas? First, commercial harvest is expected to be enhanced resulting in a short-term increase in profits (producer surplus). Second, the increased harvest will result in

[15] Carrying capacity (K) is the maximum population of a particular species that a given habitat can support over a given period of time.

a decline in price of the landed product (assuming that the price flexibility is not equal to zero), *ceteris paribus*, increasing the total level of consumer surplus derived from consumption of the landed product. Third, increased fish stocks outside the closed area(s) will result in higher levels of catch per trip in the recreational sector, resulting in increased consumer surplus in this sector of the fishing industry. Finally, consumer surplus associated with non-consumptive activities, such a recreational diving, should be enhanced.

The short-run increase in profits in the commercial sector will, over time, induce new entrants into the fishery and is likely to encourage existing fishermen to expand individual levels of effort.[16] This expansion will, through time, lead to an erosion of profits (i.e., producer surplus) in relation to a decline in catch per unit effort. Because the stocks outside the closed areas can be maintained at higher levels than pre-closed area conditions, higher levels of consumer surplus, related to sustained higher commercial harvests in aggregate, may be maintained over a long-run period of time. With respect to recreational fishing activities, a short-run increase in catch per trip, as noted in the previous paragraph, will encourage additional recreational fishing trips, assuming the demand for trips responds positively to increases in catch per trip. The additional number of trips will, in turn, tend to result in a reduction in catch per trip over time with a commensurate reduction in the per trip consumer surplus. Total consumer surplus related to recreational fishing activities may, however, remain at an enhanced level in the long run due to the overall increase in number of trips. The long-run demand for non-consumptive activities should be enhanced in the long run in relation to sustained enhancement of stocks outside the closed areas. This should, in the absence of any congestion externalities, result in a long-run increase in consumer surplus to this segment of the population that receives utility form the non-consumptive use of the resource.[17]

B. Direct and indirect costs

1. Opportunity costs associated with displacement of fishermen from their preferred fishing grounds. Given the situation that some fishermen may no longer be able to fish in their preferred fishing grounds, one might anticipate that costs to these fishermen, stated in terms of reduced profits, would increase in the short run. As stocks outside the closed areas expand over time, however, the magnitude of these costs are likely to diminish. Obviously, these costs, at least in the short run, are expected to increase with the amount of closed area. Hence, these costs would be greater with the adoption of Alternative 3b as compared to any singular (or potential combination) closed area in Alternative 3a.

2. Costs related to stock and crowding externalities related to displacement of fishermen associated with establishment of closed areas. The displacement of effort to those areas outside

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[16] To the extent that the USVI has instituted a moratorium on the issuance of new commercial fishing licenses, effort expansion will entail, primarily, capital stuffing within the existing fleet.

[17] Congestion externalities with respect to non-consumptive activities (such as diving) may exist if, for example, utility associated with solitude is diminished due to an excessive number of divers in the immediate vicinity.

the closed areas would likely result in short-run increases in both stock and crowding externalities, particularly in light of the limited amount of shelf area available for fishing activities.[18] The stock externality is expected to result in a reduction in catch per fisherman, the extent of which depends upon: (1) the amount of displaced effort which is transferred to areas outside the closed areas, and (2) the biological status of the targeted stocks. Profits per trip will fall by a significantly larger amount than the decline in catch (or revenues) due to the overall relationship between revenues and costs (e.g., a 10% reduction in revenue may result in a 50% reduction in profit since costs will not decline in proportion to revenues). Given the heavily fished nature of many of the species (indicating that total catch will respond only minimally to further increases in effort), reduction in short-run profits may be sizeable.

The crowding externality associated with the limited shelf area is expected to result in a higher level of costs per unit of effort independent of catch or other factors. While the short-run costs associated with this externality are thought to be positive, they may be relatively minor. If stocks outside the proposed area closures expand over time as a result of spillover or dispersal effects, fleet profitability may begin to increase over time. This, however, would likely encourage additional capital in the fishery which would exacerbate crowding externalities as well as drive fleet profitability back towards zero.

3. Costs related to a short-run reduction in consumer surplus associated with establishment of area closures. As noted, establishment of closed areas is expected to result in a reduction in the overall level of harvest in the short run. Assuming price of the landed product is negatively related to quantity harvested, the short-run reduction in harvest will result in a commensurate reduction in consumer surplus.[19] Furthermore, if long-run increases in harvestable stocks, emanating from spillover and egg dispersal impacts associated with establishment of area closures do not occur, long-run losses in consumer surplus related to long-run reductions in domestic harvests become a distinct possibility. Yet, it is expected that the closed areas will yield biological benefits in the long term with the establishment of sustainable fisheries, which, in turn, will establish long-term economic benefits.

4. Costs related to deterioration of ecosystem stability outside the proposed area closures. Displacement of effort in association with establishment of closed areas could result in a short-run increase in effort in the remaining shelf area open to harvesting (assuming a significant amount of effort does not leave the industry in response to declining profitability). This may, based on the premise that contact of gears (particularly traps) with the physical environment results in environmental degradation, result in deterioration of the habitat outside the closed areas in excess of what would occur in the absence of the area closures. To a large extent, the

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[18] It is possible that the reduction in short-run profits may result in a large amount of exit from the fishery. Whether this would transpire depends, at least to some extent, upon other employment opportunities. If significant, the initial impacts related to both stock and crowding externalities will be mitigated. However, the exit from the fishery does represent an additional cost, measured by the difference in satisfaction obtained from fishing vis-a-vis alternative employment.

[19] The validity of the assumption that price responds to changes in local landings may be somewhat tenuous and depends strongly on the availability of substitute products, primarily imported product.

increased degradation would occur in state waters with the amount increasing as the amount of area closed in federal waters increases. However, without an increase in overall effort (i.e., number of traps fished), the actual extent of the potential impacts to the ecosystem would not necessarily be greater than that occurring under the status quo, but could potentially be more concentrated due to reduced fishing area.

6.3.3.4 Direct and indirect effects on administrative environment and their significance

Area closures, similar to the seasonal closures proposed in Section 6.3.2, could introduce several significant effects on the administrative environment. One of the most glaring is the difference in jurisdictions and the proportion of federal versus state waters. Due to the differences in state boundaries (i.e., 9 nm off Puerto Rico and 3 nm off the USVI) a greater percentage of fishing area in 100 fathoms of water or less can be found in EEZ waters off the USVI as compared to Puerto Rico. Furthermore, while there is a total of approximately 2,467 nm^2 off habitat found in 100 fathoms of water or less in the U.S. Caribbean, only approximately 630 nm^2 (i.e., ~25%) can be found in state and federal waters off the USVI. The remainder occurs largely within nine miles of Puerto Rico. Thus, any proposed closed areas off the USVI would most likely have a greater impact than comparable areas off Puerto Rico. Therefore, closing all EEZ waters off Puerto Rico, and a smaller amount off the USVI (i.e., Alternative 3b), may have a more equitable result when trying to achieve the necessary reductions in fishing mortality.

It should be emphasized that action must also be taken in state waters to meet the required reductions in fishing mortality. This alternative does take into consideration recently implemented closures within 100 fathoms of depth that could work to achieve the objectives in reducing fishing mortality. In federal waters, the Hind Bank MCD is being incorporated into the total reduction threshold. Likewise, year-round closed areas that have been implemented recently in Puerto Rico and the USVI could also be credited towards the required total reduction in fishing mortality in the state's jurisdiction. For example, the Desecheo Island Marine Reserve, which closes a total of 2.27 nm^2 in Puerto Rican waters, as well as the Buck Island Reef National Monument and St. Croix East End Marine Park in USVI waters, amongst others, can contribute towards the overall matching reduction in fishing mortality needed for state waters. However, due to the large amount of fishable habitat in state waters, individually each of these state closures only offer a minor contribution to the overall target reduction (Table 13). Yet, they should be considered when and if states pursue consistent actions, such as through an MOU (Section 6.3.6).

All of the area closures would need to address public outreach issues, such as site identification. Many fishermen in the U.S. Caribbean do not have global positioning systems (GPS) or other means to accurately determine their location. Without GPS, they many encroach into a closed area without knowing they are in its boundaries. While the burden is on the fishermen to always know their location, and their responsibility to comply with management regulations, this issue still needs to be recognized. All of the specific sites identified in Alternatives 3a and 3b are of sufficient size that would facilitate enforcement. Furthermore, since these are year-round closures, they would be easier to enforce than seasonal closures due to the fact that there would be no confusion over opening and closing dates. However, with specific sites that are closed to fishing, enforcement would need to insure that a potential violation was occurring within a discretely defined area. It would be possible for fishermen who encroach into a closed area to quickly flee upon observing an enforcement vessel, especially if they operated just inside the boundaries.

Permitting transit of fishing vessels in Alternative 3d could present some enforcement issues. As many of the commercial fishing vessels in the U.S. Caribbean are small, open boats, it would be difficult to determine “proper stowage,” especially for hook and line. Other closed areas that include transit allowances state that a rod and reel must be removed from the rod holder and stowed securely on or below deck; terminal gear (i.e., hook, leader, sinker, flasher, or bait) must be disconnected and stowed separately from the rod and reel; and sinkers must be disconnected from the down rigger and stowed separately. With a small open-cockpit boat, there may not be sufficient space to adequately separate the gear, or stow it so that an enforcement agent is confident the gear is not currently, or has not recently been utilized for fishing within a closed area. The closed areas in question are either of reasonably small size (i.e., Grammanik Bank) or sited far enough offshore that there would likely be little fishing activity occurring directly seaward of it. In the case of Grammanik Bank, the area is small enough that the amount of time and required distance to avoid the area would be relatively small; the burden to the fishing community to avoid this area altogether would be minimal. Therefore, due to the unique issues with the U.S. Caribbean fisheries, Alternative 3d may not be very practical, and may result in significant administrative impacts.

These alternatives would require an increase in the Caribbean enforcement presence. Due to the closed areas proposed in Alternatives 3a and 3b, several boats and additional agents would be needed. Potentially, three to six boats crewed by three agents each, would be needed for Puerto Rico in order to enforce the proposed closed areas 24 hours a day, seven days a week coverage. Furthermore, three vessels crewed by three personnel each would be required for the same coverage in the USVI.

6.3.4 Alternative 4. Eliminate the use of fish traps in the U.S. EEZ.

Alternative 4a. Implement an immediate prohibition on the use of fish traps in the U.S. EEZ.

Alternative 4b. Phase-out the use of fish traps in the U.S. EEZ over a period of (i) five years or (ii) ten years.

6.3.4.1 Direct and indirect effects on physical environment and their significance

This alternative would result in directly reducing a specific interaction with the physical environment, in the capacity that fish traps can negatively impact the seabed. Specific impacts to the benthos resulting from the use of fish traps are documented by Barnette (2001). Prohibiting the use of fish traps would benefit the physical environment. Differences between Alternatives 4a and 4b would be based on when the benefits to the physical environment begin to accrue. Alternative 4a would immediately remove an agent that can impact the benthos, while Alternative 4b would allow potential impacts to continue for as much as ten years.

Benefits originating from either of these alternatives could be wholly or partially negated by fishermen switching to alternate gear types following a prohibition on fish traps, which may indirectly affect the physical environment. However, it is unclear to what degree an effort displacement to a different gear type would impact the physical environment.

6.3.4.2 Direct and indirect effects on biological and ecological environment and their significance

Additional effects stemming from this alternative are discussed in Section 4.5.7.1 of the EFH EIS (CFMC 2004). In summary, Alternatives 4a or 4b are not expected to have any direct effect on Caribbean spiny lobster or Caribbean conch resources. The direct effects of this alternative on Caribbean reef fish, coral reef resources, and other affected resources are discussed below.

6.3.4.2.1 Caribbean reef fish

Theoretically, the prohibition of fish traps could result in an approximate reduction in fishing mortality of between 22-67%. This range is based on the fact that trap-based fisheries in Puerto Rico accounted for 22% of the overall catch in 2001 (Scharer *et al.* 2002), and traps accounted for 38% of the overall catch in the USVI (Valle-Esquivel and Díaz 2003). However, 67% of USVI reef fish specifically were landed by fish traps based on the proportion of reported/expanded landings by species category and gear type from 1994-2002 (Valle-Esquivel and Díaz 2003). This reduction in fishing mortality will probably not approach this amount due to two factors: first and foremost is that a large proportion of the fish trap harvest occurs within state waters, and second, that any reduction in fishing mortality due to a trap prohibition in federal waters is likely to be negated to some extent due to a transfer of effort by displaced fish trappers to another gear type. So, due to these artifacts, it is not possible to precisely quantify the extent to which a prohibition on fish traps would reduce fishing mortality in the region.

Regardless, a prohibition of fish traps in the EEZ, based on the ranges discussed above, could potentially result in a reduction in fishing mortality sufficient enough to end overfishing for those species currently undergoing overfishing (Table 11). A prohibition on fish traps would also afford benefits to non-target species such as aquarium trade species, that would otherwise be subject to some extent of bycatch mortality. Juveniles of important commercial species such as snapper and grouper could also experience some benefits from a trap prohibition since they are currently vulnerable to harvest, and due to the absence of size restrictions in the EEZ, could be retained by the fisherman (i.e., if states did not have minimum size limits for such species).

Differences between Alternatives 4a and 4b would be based on when the benefits to the biological environment (i.e., reduction in fishing mortality on reef fish species) begin to accrue. Alternative 4a would immediately remove the trap fishing effort in the EEZ, while Alternative 4b would allow continued trapping effort in the EEZ for as much as ten years.

6.3.4.2.2 Caribbean coral reef resources

As mentioned in Section 6.3.4.1, the prohibition of fish traps would remove a documented agent of EFH impacts, particularly to coral habitat. Coral reef species in the EEZ would directly benefit due to a reduction in gear impacts resulting from trap deployment and recovery, especially in proximity to reef habitat.

While ghost fishing can occur due to lost traps, it most likely is not a significant problem in the Caribbean. This is due in large part to the areas that trap fishermen tend to work. In many cases, traps are deployed in areas where the fishermen can still see the bottom. Thus, if a trap buoy line were to be parted, the fisherman may still be able to locate his trap visually from the surface, and utilize a grappling hook to recover it. However, trap loss and ghost fishing could still occur in deep water and on steep reef slopes where the fisherman would be unable to easily recover lost gear.

6.3.4.2.3 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. This gear has been identified to have a potential to have protected species interactions, in particular with sea turtles, so its elimination could have a beneficial effect to protected resources.

6.3.4.3 Direct and indirect effects on social and economic environment and their significance

Table 13 documents the potential economic impacts resulting from the prohibition of fish traps in the EEZ. The use of fish traps has been a contentious issue in other regions. The South Atlantic Council banned the use of fish traps in 1991, while the Gulf of Mexico Council implemented a phase-out of fish traps that will end in 2007. The South Atlantic Council's rationale for eliminating this gear type was based on bycatch of non-target species, including non-traditional food fish (i.e., aquarium trade species); trap loss and ghost fishing issues; habitat damage originating from fish trap use; bycatch release mortality; and enforcement difficulties (SAFMC 1991).

The direct and indirect effects on the social and economic environment related to the elimination of fish traps in the EEZ, either through an immediate prohibition or a gradual phase-out (i.e., Alternative 4a versus Alternative 4b), depends, overwhelmingly, on the extent to which fish traps are currently employed in EEZ waters. While information exists that suggests they are used in federal waters, the extent of such use is not documented. Given that the majority of fishable habitat is in state waters, it is likely that most of the fish trapping effort is focused there.

If usage is minimal, the direct and indirect effects on the social and economic environment, would of course be minimal. Conversely, the higher the usage in the EEZ, the larger one might anticipate the economic and social impacts to be. Specifically, an immediate prohibition on the use of fish traps in the EEZ might cause some, unknown, proportion of participants to cease fishing operations. The extent to which this scenario would transpire would likely depend largely upon income that could be earned in non-fishing activities vis-a-vis the income that could be earned in alternative fishing endeavors.[20]

The most likely alternative fishing endeavors would include: (1) movement of trap fishing activities to state waters, and (2) the deployment of alternative gears in the EEZ. Given the fact that use of fish traps in the U.S Caribbean is the preferred method of fishing among participants engaged in the practice, one could surmise that the direct impacts of eliminating the use of fish traps in the EEZ would be a reduction in profits among those participants engaged in the activity. Switching behavior (either the movement of trap fishing activities into state waters or the deployment of alternative gears in the EEZ) would indirectly impact fishermen currently involved in these activities. Specifically, increased effort in these alternative activities would result, in theory, in a reduction in catch per unit effort among all participants and, hence, a reduction in profitability. If inframarginal rents were being derived prior to adoption of Alternative 4a or 4b, increased effort would likely reduce the amount of inframarginal rents. If no rents were being earned (i.e., profits, including opportunity costs associated with labor and capital, equal to zero), a decline in catch per unit effort as a result of a redirection of effort in association with the implementation of Alternative 4 would result in negative short-term profits which, in the long run, would translate into an exit of effort from these activities.

Certainly, a phase-out of fish traps in the U.S. Caribbean EEZ would result in less social and economic disruption than an immediate prohibition. However, the general discussion presented above remains valid whether there is an immediate prohibition or a gradual phase-out of fish traps.

[20] One must also recognize that fishermen may receive satisfaction from fishing activities over and above that generated from direct income derived from fishing (Anderson 1980). As such, adoption of Alternative 4 may result in changing fishing practices rather than movement to a non-fishing employment activity even if the expected income derived from the later exceeds that of the former.

6.3.4.4 Direct and indirect effects on administrative environment and their significance

A prohibition on fish traps, whether immediate or phased out over several years, presents several direct and indirect administrative effects. Similar to the issues raised on closed areas, without a GPS unit fishermen may not realize they are fishing in the EEZ. A total prohibition of fish traps in the EEZ would be easier to enforce as compared to a discrete, site specific prohibition. The prohibition could also be enforced dockside, utilizing the trap rash regulatory language. However, this would depend on compatible regulations in state waters. Without a matching prohibition of fish traps in state waters, the effectiveness (i.e., in particular dockside enforcement) of this alternative is severely compromised. It is likely, that if fish traps are removed from the EEZ, they would merely be moved to the shallower state waters, and fishing mortality would not be effectively reduced throughout the U.S. Caribbean.

While a phase-out may be more desirable to minimize the economic impacts, the ten-year schedule offered in Alternative 4b might be viewed as excessive, and allow further expansion of the fishery before ultimate prohibition. Likewise, due to the prevalence of small-scale operators, and the lack of fishermen who possess large numbers of fish traps due to the small average size of commercial fishing vessels in the U.S. Caribbean, it is unlikely that a five-year phase out would be necessary to allow fisherman a sufficient amount of time to remove their gear. This is especially true, considering fishermen would still be permitted to fish their gear in state waters.

6.3.5 Alternative 5. Eliminate the use of gill and trammel nets in the U.S. EEZ.

Alternative 5a. Implement an immediate prohibition on the use of gill and trammel nets in the U.S. EEZ.

Alternative 5b. Phase-out the use of gill and trammel nets in the U.S. EEZ over a period of (i) five years or (ii) ten years.

Alternative 5c (Preferred). Implement an immediate prohibition on the use of gill and trammel nets in the U.S. 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.

6.3.5.1 Direct and indirect effects on physical environment and their significance

Prohibiting the use of nets in the EEZ would benefit the physical environment by reducing a specific interaction with the physical environment. Specific impacts to the benthos resulting from the use of nets are documented by Barnette (2001). Differences between Alternatives 5a and 5b would be based on when the benefits to the physical environment begin to accrue. Alternative 5a would immediately remove an agent that can impact the benthos, while Alternative 5b would allow potential impacts to continue for as much as ten years. If St. Croix fishermen continue to shift from fish traps to gill and trammel nets, Alternative 5b should result in even greater potential impacts, especially to the deep-water reef areas that they apparently are targeting in the EEZ (Carrubba, pers. comm.). Alternative 5c is not expected to result in any direct or indirect effects on the physical environment, as the use of these permitted gill nets would be directed on species such as flying fish and baitfish that are commonly found near the surface. Further, since the nets are required to be tended at all times, it is expected that any impacts to the physical environment will be negligible.

Benefits originating from either of these alternatives could be wholly or partially negated by fishermen switching to alternate gear types following a prohibition on nets, which may indirectly affect the physical environment. However, it is unclear to what degree an effort displacement to a different gear type would impact the physical environment.

6.3.5.2 Direct and indirect effects on biological and ecological environment and their significance

Additional effects stemming from this alternative are discussed in Section 4.5.7.1 of the EFH EIS (CFMC 2004). In summary, Alternatives 5a - 5c are not expected to have any direct effect on Caribbean spiny lobster or Caribbean conch resources. The direct effects of this alternative on Caribbean reef fish, coral reef resources, and other affected resources are discussed below.

6.3.5.2.1 Caribbean reef fish

The use of gill nets in the USVI has increased over the past 10 years, where they are used in conjunction with SCUBA divers to catch parrotfish (Tobias *et al.* 2000). Divers set nets in sandy offshore areas (between reefs at the shelf edge) where schools of fish congregate just before dark. The highest catches are made during peak spawning times (Tobias 2001). Valle-Equivel and Díaz (2003) documented that gill nets were responsible for 32.65% of all commercial parrotfish landings in the USVI from 1994-2002. However, gill nets appear to be a minor source of landings for grouper and snapper, accounting for approximately 1% of the harvest. This is supported by the fact that between 1997-1999, parrotfish represented 74-78% of total net landings in St. Croix (Tobias *et al.* 2000). Because nets are responsible for a greater proportion of parrotfish landings than other gear types, it is expected that the prohibition of this gear type will result in a disproportionate reduction in fishing mortality for parrotfish, and, in and of itself, will likely result in ending overfishing for the FMU; based on the preferred alternatives for stock status determination criteria and the control rules, parrotfish would require a 27% reduction in fishing mortality to end overfishing (Table 11). The use of nets occurs primarily in state waters, with the exception of activity off St. Croix, where trammel nets are used on deep reef areas in the EEZ. There has not been a major shift to nets in Puerto Rico, and fish traps are still the favored gear type in the reef fish fishery there.

Dependent on the mesh size of the nets, this alternative would reduce bycatch of reef associated fish, as well as reduce habitat damage associated with gill and trammel net fishing activities that may indirectly affect reef fish spawning aggregations, etc. The use of gill and trammel nets in the U.S. Caribbean appears to be increasing, primarily in the USVI, and is raising concern among other fishermen and resource managers. In some cases, fishermen apparently utilize divers to surgically deploy nets in migratory pathways of reef fish, so that they are captured during their diurnal migration to and from their reef habitat. This method of harvest can be highly efficient, and could result in localized depletion of fish populations. However, this practice may result in fewer impacts to habitat (i.e., coral), and reduce the chances of ghost fishing from lost or disposed gear.

Theoretically, the prohibition of gill and trammel nets should result in an approximate reduction in fishing mortality of between 9-20%. This range is based on the fact that the Puerto Rican net fisheries in 2001 accounted for 20% of the overall catch, including species not managed by the CFMC (Matos-Caraballo 2002), and the USVI net fisheries accounted for approximately 9% of the overall catch in the USVI (Valle-Esquivel and Díaz 2003). However, the Puerto Rico estimate includes beach seines and landings on non-managed species. A more realistic estimate is 10%, based on the 2002 Puerto Rico trip ticket data on Council-managed reef fish harvest derived from the use of gill and trammel nets (130,000 pounds out of a total reported commercial harvest of 1.25 million pounds). Further, only 6% of USVI reef fish specifically were landed by nets based on the proportion of reported/expanded landings by species category and gear type from 1994-2002 (Valle-Esquivel and Díaz 2003). Therefore, it would be more appropriate to use a range of 6-10% for an estimate of the predicted reduction in fishing mortality from the prohibition of nets. This reduction in fishing mortality will probably not approach this amount due to two factors: first and foremost is that a large proportion of the net harvest occurs within state waters, and second, that any reduction in fishing mortality due to a net prohibition in federal waters is likely to be negated to some extent due to a transfer of effort by displaced netters to another gear type. So, due to these artifacts, it is not possible to precisely quantify the extent to which a prohibition on gill and trammel nets would reduce fishing mortality in the region. Yet, the USVI is considering banning the use of gill and trammel nets in state waters, which would negate the above artifacts with respect to USVI waters.

Regardless, a prohibition of gill and trammel nets in the EEZ, based on the ranges discussed above, should potentially result in a reduction in fishing mortality sufficient enough to help end overfishing for those species currently undergoing overfishing (Table 11). A prohibition on nets would also afford benefits to non-target species such as aquarium trade species, that would otherwise be subject to some extent of bycatch mortality. Juveniles of important commercial species such as snapper and grouper may also experience some benefits from a net prohibition since they are currently vulnerable to harvest, and due to the absence of size restrictions in the EEZ, could be retained by the fisherman (i.e., if states did not have minimum size limits for such species).

The use of divers associated with net use is just starting to appear in landings data, so the impact of this fishing practice may be hard to quantify. Due to the use of divers to deploy and recover the net, it is expected that this gear type is not a significant issue in federal waters due to the average water depth. This would be especially evident off Puerto Rico, where the 9 nm state jurisdiction severely limits available habitat in water shallow enough to utilize nets in proximity to reef habitat.

A prohibition on nets would likely still afford benefits to non-target species such as aquarium trade species, that would otherwise be subject to some extent of bycatch mortality. Juveniles of important commercial species such as snapper and grouper may also experience some benefits from a net prohibition since they are currently vulnerable to harvest, and due to the absence of size restrictions, are most likely retained by the fisherman. A net prohibition would also remove a threat to endangered species such as sea turtles. Furthermore, coral reef species would benefit due to a reduction in gear impacts resulting from net deployment and recovery, especially in proximity to reef habitat.

While ghost fishing can occur due to lost netting, it most likely is not a significant problem. As documented in Barnette (2001), lost nets frequently ball up, and their capacity to capture fish is greatly reduced. Epifauna would begin to grow on the netting, and it would eventually be incorporated into the reef habitat.

Alternative 5c may result in continued bycatch of managed and non-managed species, to the extent that fishing activities with gill nets would encounter managed and non-managed species while harvesting flying fish, etc.

6.3.5.2.2 Caribbean coral reef resources

As mentioned in Section 6.3.4.1, the prohibition of nets would remove a documented agent of EFH impacts, particularly to coral habitat, especially in deeper depths where divers are not employed. Alternative 5c may not result in any significant direct or indirect impacts to coral, as it is expected most activity would be directed towards non-managed species found in close proximity to the surface (e.g., flying fish).

6.3.5.2.3 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Similar to Alternative 4, this gear has been identified to have a potential to have protected species interactions (e.g., sea turtles), so its elimination would be beneficial to protected resources. It is not clear what potential exists for protected resource interactions in association with the continued use of gill nets to harvest non-managed species.

6.3.5.3 Direct and indirect effects on social and economic environment and their significance

Table 13 documents the potential economic impacts resulting from the prohibition of gill and trammel nets in the EEZ. There has been a reported increase, specifically in the USVI, in the use of nets to discretely target migrating reef fish (Tobias *et al.* 2000). In some instances, particularly in St. Croix, fishermen have switched from traps to nets due to frequent trap theft and vandalism. Puerto Rican fishermen appear to still favor fish traps, and there has not been a major shift to nets. Matos-Caraballo (1997) documented 11,710 fish traps, and 1,320 gill and trammel nets being used by 1,731 fishermen in a 1995-1996 census. A similar census conducted in 2002 (Matos-Caraballo, pers. comm.) documented 10,372 fish traps, and 1,384 gill and trammel nets being used by 1,163 fishermen.

Based on the 2002 Puerto Rico trip ticket data, approximately 10% of the federally-managed commercial reef fish harvest was derived from the use of gill and trammel nets (130,000 pounds out of a total reported commercial harvest of 1.25 million pounds). It is unknown how much of this take is from the EEZ.

In a study of the use of gill and trammel nets among fishermen in Puerto Rico, Valdes-Pizzini *et al.* (1992) state "[t]he procedure used when fishing gill nets and trammel nets are similar. The main difference is in the fishing grounds, gill nets are usually fished in the inner reef and mangrove areas; trammel nets are usually fished in the outer reef (the edge of the platform and in deeper water 40 to 60 feet)." Hence, unless fishing practices have changed significantly since the time of the study by Valdes-Pizzini *et al.* (1992), one can conclude that gill nets are not used in federal waters off Puerto Rico. Furthermore, given that the minimum depth of federal waters is approximately 60 feet off the west coast of Puerto Rico, one is left with the conclusion that trammel nets are also not significantly employed in federal waters off Puerto Rico; this is subject to the assumption that fishing practices involving the use of trammel nets have not changed significantly since the early 1990s (overall, reported landings from trammel nets in Puerto Rico decreased from 309,000 pounds in 1996 to 74,000 pounds in 2001, suggesting some change in fishing practices).

The use of gill and trammel nets in the USVI appear to be a more significant component of the reef fish fishery than that in Puerto Rico, particularly for parrotfish and surgeonfish. While nets only account for approximately 1% of the landings of snapper and grouper, the gear accounts for 32.65% of parrotfish landings and 11.23% of surgeonfish landings in the USVI from 1994-2002 (Valle-Esquivel and Díaz 2003). Due to the 3 nm state boundary, there is more fishable habitat off the USVI that could be targeted by nets. Portions of Lang Bank off St. Croix is shallow enough (e.g., 40 feet) to utilize nets, where they are commonly deployed by divers that can surgically place nets in the migratory pathways of reef fish.

It is unclear what the economic significance of flying fish and baitfish harvested specifically by gill nets would be, and therefore, it is not currently possibly to quantify the economic impact of Alternative 5c. However, it is expected that it would be less of an impact as compared to a total prohibition of the gear, to the extent it is utilized in the EEZ to harvest flying fish and other non-managed species.

If either gill or trammel nets are used to any significant extent in the EEZ, however, the discussion related to Alternatives 4a and 4b (Section 6.3.4.3) is directly applicable to Alternatives 5a and 5b (i.e., elimination of gill nets and trammel nets in the EEZ). In addition to the discussion presented in Section 6.3.4.3, however, Valdes-Pizzini *et al.* (1992) suggest that non-fishing employment opportunities among net fishermen are considerably less than those available for the general commercial fishing population. Specifically, the authors note that "[t]hroughout the 80s, social research has demonstrated that half of the fishermen's population is engaged in other jobs, conforming a well known pattern of occupational multiplicity (Valdes-Pizzini 1990). In comparison with the rest of the fishermen, net fishermen are almost exclusively devoted to fishing as an economic activity. The skewedness to the upper age cohorts may be associated to this behavior, since these fishermen tend to be older, and thus out of the service and industrial economic activities due to advance age." If still accurate, this would imply very limited non-fishing employment opportunities among net fishermen. Hence, elimination of gill net and trammel net fishing in the EEZ would likely result, primarily, in a re-direction of fishing effort rather than switching to land-based employment. However, these short-term socio-economic impacts are likely to be mitigated and overshadowed by the long-term economic benefits from a sustainable reef fish fishery.

6.3.5.4 Direct and indirect effects on administrative environment and their significance

A prohibition on gill and trammel nets, whether immediate or phased out over several years, presents several administrative concerns. Similar to the issues raised on closed areas, without a GPS unit fishermen may not realize they are fishing in the EEZ. A total prohibition of nets in the EEZ would be easier to enforce as compared to a discrete, site specific prohibition.

Further, the extent of net use in federal waters is unknown. With limited exceptions, due to the bathymetric constraints faced in the EEZ, in that the depth of water would greatly curtail the use of nets, it could be assumed that net use is not a significant management concern in the EEZ. This is also supported by the amount of landings reported by gill nets in the USVI, when compared to other gear types such as fish traps.

While a phase-out may be more desirable to minimize the economic impacts, the ten-year schedule offered in Alternative 5b might be viewed as excessive, and allow further expansion of the fishery before ultimate prohibition. Likewise, due to the prevalence of small-scale operators, it is unlikely that a five-year phase out would be necessary to allow fisherman a sufficient amount of time to remove their gear or switch to other gear types. This is especially true considering fishermen would still be permitted to fish their gear in state waters. While there is a need to inform the public about an impending management action, a five- or ten-year period does not appear to be warranted.

Allowing the use of gill nets to harvest flying fish and other non-managed species (i.e., Alternative 5c) may present some enforcement issues. As mentioned previously, it is possible that the use of this gear, while targeting bait fish and non-managed species, may result in bycatch of managed species. In order to enforce this potential management action, enforcement would have to be made at-sea, requiring vessel and catch inspection. If consistent regulations are not adopted in state waters, dockside enforcement would be ineffective.

6.3.6 Alternative 6. Develop a memorandum of understanding (MOU) between NMFS and the state governments to develop compatible regulations to achieve the management objectives set forth in all Caribbean Council fishery management plans in state and federal waters of the U.S. Caribbean.

Section 4.3.6 discussed the various actions that could be included within the MOU.

6.3.6.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with the sea floor. This alternative would simply establish an agreement between state and federal management entities to develop compatible regulations. It, in and of itself, would not have a direct effect on the physical environment. However, over the long term, this alternative could indirectly impact coral and other benthic habitats through regulations that offer increased protection from fishery-related impacts.

6.3.6.2 Direct and indirect effects on biological and ecological environment and their significance

The development of an MOU between state and federal management entities would not result in any direct effects on the biological environment. However, it is expected that the MOU would forge the way for improved management of marine resources. This alternative is especially important when considering that the majority of the species depend on and are fished from state waters. Due to bathymetric constraints, the vast majority of coral habitat is found in state waters (Figure 1). This alternative could lead to regulations that rebuild overfished fish populations and afford better protection to coral and other habitats. While it is possible to speculate that this action would most likely lead to beneficial indirect effects to the marine ecosystem, in particular to managed species, it is not possible to quantify those effects. Further discussion on the indirect impacts to each FMP resulting from this alternative is discussed below.

6.3.6.2.1 Caribbean spiny lobster

The development of an MOU between state and federal management entities would not result in any direct or indirect effects on the biological environment in regards to spiny lobster. Currently, spiny lobster regulations in the U.S. Caribbean are consistent in state and federal jurisdictions.

6.3.6.2.2 Caribbean conch resources

The development of an MOU between state and federal management entities would not result in any direct effects on the biological environment in regards to queen conch. It would, however, result in indirect effects in that USVI and federal regulations are currently inconsistent in regard to recreational possession limits of queen conch. Puerto Rico also does not require queen conch to be landed whole, in the shell, which is inconsistent with federal regulations. Lastly, should the preferred alternative in Section 6.4.3.2.2 be implemented, and the commercial and recreational catch of queen conch is prohibited in the EEZ to end overfishing and rebuild the overfished species, states would likely need to address this significant inconsistency in state waters.

6.3.6.2.3 Caribbean reef fish

This alternative would result in indirect effects to the biological environment since USVI and federal regulations are currently inconsistent in regards to both the minimum size of managed species and in what species are prohibited from harvest. There currently is only a minimum size for yellowtail snapper in the EEZ, and it is inconsistent with Puerto Rico (12 in versus 10.5 in) and the USVI, which has no established minimum size for this species. The harvest and possession of Nassau grouper is not prohibited in the USVI, while it is prohibited in the EEZ and in Puerto Rican waters. This species was protected due to its overfished status; possession has been prohibited in the EEZ since 1990. This loophole may jeopardize the rebuilding of the species, and potentially allow poaching in federal waters to occur since the fish can be landed in the USVI.

Should any of the closed season alternatives in Section 6.3.2 be established, further consultation may be required to remedy any additional inconsistencies between state and federal fishery regulations.

6.3.6.2.4 Caribbean coral reef resources

The development of an MOU between state and federal management entities would not result in any direct or indirect effects on the biological environment in regards to coral reef resources. Currently, coral regulations in the U.S. Caribbean are consistent in state and federal jurisdictions.

6.3.6.2.5 Other affected species/resources

The effects of this alternative to other affected species are expected to be similar to those described in Section 6.1.1.1.2.5. Therefore, they are not repeated here.

6.3.6.3 Direct and indirect effects on social and economic environment and their significance

Given that the majority of harvest of Council-managed species occurs in state waters, there is considerable doubt as to whether actions taken only in federal waters will be adequate to conserve and manage Council-managed stocks. Hence, without state governments developing compatible regulations, stocks that are currently overfished or undergoing overfishing may become further depleted, while the status of other stocks that are currently stable, may, at some future point, be jeopardized due to insufficient action in state waters.

In general, fishery regulations aimed at protecting or rebuilding stocks impose short-term adverse impacts on fishing participants including the potential loss of employment opportunities. These short-term adverse impacts, however, can be outweighed by the positive benefits associated with healthy stocks. Short-term adverse impacts will certainly increase if fishery management regulations, *via* an MOU, are imposed in both state and federal waters. However, achievement of any significant long-term benefits associated with protection or rebuilding of Council-managed stocks would likely not be forthcoming in the absence of compatible regulations in state waters (e.g., Nassau grouper rebuilding).

6.3.6.4 Direct and indirect effects on administrative environment and their significance

Representatives of the state marine resource management entities currently serve on the Council, and therefore already have an avenue to tailor federal management actions to help address state issues. However, there is a lack of reciprocal communication and influence (i.e., federal influence on state management). This alternative would facilitate the implementation of management actions in state waters, especially for Nassau grouper, which is an overfished species. The harvest and possession of Nassau grouper has been prohibited in the EEZ since 1990, and was only recently protected in Puerto Rico (2004); it is still an allowable species in USVI waters. However, at the 117th Council meeting, representatives from the USVI stated that they would pursue the prohibition of Nassau grouper harvest and possession in state waters. Therefore, this alternative might be unnecessary.

Due to the differences in management between the USVI and Puerto Rico, establishing a protocol for resolving those differences and finding common ground would be necessary. The MOU would also need to incorporate an enforceable timetable for action, though it is unclear what action the Council and NMFS could take if the states fail to implement the necessary regulations. The Secretary already has the authority to preempt local government if certain criteria are met, though it is unlikely that those conditions could be met for the majority of federally managed species.

6.4 Rebuilding overfished fisheries

The alternative rebuilding schedules defined in this amendment for overfished stocks are consistent with the guidance provided at 50 CFR §600.310, such that the earliest rebuilding period in a defined range is bounded by T_{MIN}; the longest rebuilding period, by ten years (if $T_{MIN} < 10$) or by T_{MIN} plus one mean generation time (if $T_{MIN} > 10$). Generally, the mid-point between the shortest possible and longest allowable rebuilding periods is evaluated as a third alternative. The T_{MIN} and mean generation time of assessed stocks are determined based on assessment data and on available scientific literature on the life history characteristics of those stocks.

The theoretical dynamics of a population under the logistic (Graham-Schaefer) surplus-production model were used to calculate recovery times for non-assessed stocks (i.e., Grouper Unit 4). Surplus-production models are valuable for analyzing fish population dynamics when a stock cannot be aged, and therefore age-structured models cannot be applied. A quantity termed "surplus production" is used to characterize population dynamics at different levels of population size (measured in biomass). Surplus production is the algebraic sum of three major forces: recruitment, growth, and natural mortality. The adjective "surplus" refers to the surplus of recruitment and growth over natural mortality; i.e., the net production (Prager 1994).

Surplus-production models admittedly fail to account for important factors, such as variations in populations in response to environmental variation. But they still provide useful insight into population dynamics when data are insufficient to model real-life conditions and responses. The logistic (Schaefer) model is the simplest surplus-production model. In this model, a first-order differential equation describes the rate of change of stock biomass (B_t) due to production. In the absence of fishing, the population's rate of increase or decrease is assumed to be a function of the current population size only: $dB_t/dt = rB_t - r/K(B_t^2)$; where Bt is the population biomass at time t, K represents the maximum population size, or carrying capacity, and r represents the stock's intrinsic rate of increase (in proportion per unit time). Adding fishing mortality (F_t) to the model, it becomes: $dB_t/dt = (r - F_t)B_t - r/K(B_t^2)$ (Prager 1994).

Prager (1994) describes how integrating this equation with respect to time allows modeling the biomass and yield through time. The relationship between the starting biomass relative to B_{MSY} (B_{CURR}/B_{MSY}), the F applied during recovery ($F_{RECOVERY}$), and F_{MSY} can be used to plot recovery in a time span. Assuming the parameter, r, is equal to M, and the parameter K, is equal to 1, the recovery under each alternative combination of B/B_{MSY} and F_{MSY} considered for each stock or complex can be plotted. The results of those efforts are displayed in Sections 6.4.4 and 6.4.5, in the discussions of stock- and complex-specific rebuilding schedules.

6.4.1 Nassau grouper

The Council prohibited the catch and possession of Nassau grouper in federal waters in 1990, and has made specific recommendations to state governments related to ending overfishing and protecting EFH in state waters (CFMC 2001a). However, to date catches of Nassau grouper are not prohibited or regulated in USVI fisheries; Puerto Rico implemented new regulations on March 12, 2004, to prohibit the possession or sale of this species.

6.4.1.1 Rebuilding schedule

Fishery scientists do not have the data needed to calculate T_{MIN} for Nassau grouper. But NOAA SEFSC has concluded that it is unlikely that the stock could recover within ten years in the absence of fishing (CFMC 2001a). Thus, the Council has specified a T_{MIN} proxy of ten years for this species. Porch and Scott (2001) specify a generation time for Nassau grouper ranging from 15 to 70 years.

6.4.1.1.1 Alternative 1. No action. Do not define a schedule/time frame for rebuilding Nassau grouper.

6.4.1.1.1.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with the sea floor. Specifying a rebuilding schedule is not be expected to directly or indirectly affect the physical environment over the short or long term.

6.4.1.1.1.2 Direct and indirect effects on biological and ecological environment and their significance

The act of defining or not defining a rebuilding schedule would have no effect on any species in the Caribbean Queen Conch, Coral, or Spiny Lobster FMPs. Further, there would be no direct positive or negative impacts on Nassau grouper. Defining a rebuilding schedule simply establishes a target by which to measure the effectiveness of regulations implemented to rebuild the stock. Federal regulations prohibiting the catch and possession of Nassau grouper would not be relaxed irrespective of the length of the rebuilding period selected until there is scientific evidence that the stock is no longer overfished. However, because mortality of this species may still occur in federal waters due to regulatory discards and/or illegal catches, as well as the unregulated harvest of Nassau grouper in USVI waters, it is not clear whether the prohibition on catch would be sufficient to recover the resource. Thus, specifying a rebuilding schedule could result in indirect impacts to Nassau grouper by forcing the implementation of stricter management measures in federal and/or USVI waters. Implementing additional measures to protect Nassau grouper in federal waters could have a positive impact on stock recovery. But, in the absence of stricter management measures in USVI waters, the recovery of this resource is questionable.

6.4.1.1.1.3 Direct and indirect effects on social and economic environment and their significance

The act of defining or not defining a rebuilding schedule would have no direct positive or negative impacts on fishing communities. Defining a rebuilding schedule simply establishes a target by which to measure the effectiveness of regulations implemented to rebuild the stock. Federal regulations prohibiting the catch and possession of Nassau grouper would not be relaxed irrespective of the length of the rebuilding period selected until there is scientific evidence that the stock is no longer overfished. However, because mortality of this species may still occur in federal waters due to regulatory discards and/or illegal catches, it is not clear whether the schedule could result in indirect impacts to fishing communities by forcing the implementation of stricter management measures in federal waters. Implementing additional measures in federal waters could have a positive impact on stock recovery, but would likely result in negative short-term impacts on fishery participants. Those negative short-term impacts could potentially be outweighed by the positive impacts associated with stock recovery in the long term. But, in the absence of stricter management measures in USVI waters, the recovery of this resource is questionable.

6.4.1.1.1.4 Direct and indirect effects on administrative environment and their significance

This alternative would not comply with §304(e)(4)(A) of the MSFCMA.

6.4.1.1.2 Alternative 2 (Preferred). Rebuild Nassau grouper to B_{MSY} in 25 years, using the formula T_{MIN} (10 years) + one generation (15 years) = 25 years.

This alternative reflects the minimum amount of time likely needed to rebuild Nassau grouper.

6.4.1.1.2.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with the sea floor. Specifying a rebuilding schedule is not be expected to directly or indirectly affect the physical environment over the short or long term.

6.4.1.1.2.2 Direct and indirect effects on biological and ecological environment and their significance

The effects on the biological environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.1.2. Therefore, they are not repeated here.

6.4.1.1.2.3 Direct and indirect effects on social and economic environment and their significance

The preferred alternative has two key provisions, the recovery period (25 years) and the control rule (ABC = 0 pounds until the resource is recovered). The period of recovery accommodates the biological regenerative capacity of the resource, as affected by the fishery harvest rate. Under a given biological capacity, the choice of harvest rate will shorten or lengthen the recovery period. The allowable harvest at the point of recovery will exceed that during the recovery period. The selection of the rate of harvest during the recovery and, hence, the period of recovery, incorporates a trade-off decision on current versus future benefits. The combination of recovery period and control rule indicate that the fastest the fishery can potentially recover under zero directed harvest is 25 years, given the caveat of the absence of better data on the resource. As the fishery has been closed in federal waters since 1990, the plan proposed under the preferred alternative will maintain the status quo conditions in the fishery and result in no additional adverse economic impacts. Allowing directed harvest of the resource during this period will jeopardize the recovery of the resource and delay the potential of future harvests. Since the preferred alternative maintains status quo conditions, no additional adverse social impacts will accompany this option.

6.4.1.1.2.4 Direct and indirect effects on administrative environment and their significance

In selecting the shortest available rebuilding schedule, significant management actions associated with rebuilding the species within that schedule will be required. This presents potentially significant issues regarding the role of state (i.e., USVI) management. If the status quo remains in effect for state waters, and the continued exploitation of Nassau grouper is not restricted in some capacity, it is unlikely that this selected rebuilding schedule could be met. This is particularly evident by the fact that Nassau grouper harvest has already been prohibited in federal waters for over a decade and has yet to be rebuilt.

6.4.1.1.3 Alternative 3. Rebuild Nassau grouper to B_{MSY} in 52.5 years, using the formula T_{MIN} (10 years) + one generation (42.5 years) = 52.5 years.

This alternative reflects the mid-range amount of time likely needed to rebuild Nassau grouper.

6.4.1.1.3.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with the sea floor. Specifying a rebuilding schedule is not be expected to directly or indirectly affect the physical environment over the short or long term.

6.4.1.1.3.2 Direct and indirect effects on biological and ecological environment and their significance

The effects on the biological environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.1.2. Therefore, they are not repeated here.

6.4.1.1.3.3 Direct and indirect effects on social and economic environment and their significance

Information regarding the generation period for Nassau grouper in the U.S. Caribbean is limited and associated with considerable uncertainty. Whereas Alternative 2 assumed a generation period of 15 years, this alternative assumes a much longer generation period (42.5 years). Hence, one can surmise that a more cautious rebuilding schedule is being proposed and the harvest of Nassau grouper in federal waters will be prohibited throughout the 52.5 year rebuilding period (unless scientific evidence is presented indicating the stock has been rebuilt).

As was the case with Alternative 2, this alternative would have no direct positive or negative impacts on the human environment since the fishery has been closed in federal waters since 1990. Furthermore, should scientific evidence be presented which indicates that the stock has recovered prior to the 52.5 year period, the fishery would then be opened. Hence, one cannot conclude that there would be any long-term differences between this alternative and Alternative 2 (assuming appropriate stock assessments are routinely conducted on the fishery). This is particularly relevant in light of the uncertainty in generation period. Specifically, one would assume that if the stock has not recovered by the end of the 25-year period (Alternative 2), as indicated by a stock assessment, the fishery will remain closed.

6.4.1.1.3.4 Direct and indirect effects on administrative environment and their significance

This alternative would present potential administrative issues similar to those in Section 6.4.1.1.2.4. However, due to the protracted rebuilding time frame, the administrative impacts would be expected to be less than those experienced under a shorter time frame.

6.4.1.1.4 Alternative 4. Rebuild Nassau grouper to B_{MSY} in 80 years, using the formula T_{MIN} (10 years) + one generation (70 years) = 80 years.

This alternative reflects the maximum amount of time likely needed to rebuild Nassau grouper.

6.4.1.1.4.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with the sea floor. Specifying a rebuilding schedule is not be expected to directly or indirectly affect the physical environment over the short or long term.

6.4.1.1.4.2 Direct and indirect effects on biological and ecological environment and their significance

The effects on the biological environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.1.2. Therefore, they are not repeated here.

6.4.1.1.4.3 Direct and indirect effects on social and economic environment and their significance

As noted in Section 6.4.1.1.4, this alternative reflects the maximum amount of time needed to rebuild the Nassau grouper stock in the U.S. Caribbean. As previously mentioned (see Section 6.4.1.1.3.3) there exists a considerable amount of uncertainty regarding the generation period for Nassau grouper and this alternative assumes a much longer generation period than either Alternative 2 or Alternative 3. The impacts on the social and economic environment would be identical to those presented in Section 6.4.1.1.3.3.

6.4.1.1.4.4 Direct and indirect effects on administrative environment and their significance

This alternative would present potential administrative issues similar to those in Section 6.4.1.1.2.4. However, due to the protracted rebuilding time frame, the administrative impacts would be expected to be less than those experienced under the shorter time frames in Alternatives 2 and 3.

6.4.1.2 Rebuilding strategy

6.4.1.2.1 Alternative 1. No action. Rely on current regulations to rebuild the stock to B_{MSY} within the required time frame.

6.4.1.2.1.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with the sea floor. Specifying a rebuilding strategy, or, in this alternative, taking no action and relying on current regulations to rebuild the stock, is not be expected to directly or indirectly affect the physical environment over the short or long term.

6.4.1.2.1.2 Direct and indirect effects on biological and ecological environment and their significance

It is uncertain whether Nassau grouper could recover to B_{MSY} if additional measures are not implemented to reduce incidental catches, and to protect spawning aggregations and the habitat essential to the growth and survival of these species. If the recovery of Nassau grouper depends on implementing such additional protective measures in the EEZ, maintaining status quo could potentially lead to the commercial extinction of this species. More importantly, such protective measures may not be sufficient to rebuild the stock if fishing mortality continues to be directed on Nassau grouper in USVI waters. While the harvest of Nassau grouper has been prohibited in federal waters since 1990, the species has shown no signs of recovery, in large part due to the continued harvest of the species from USVI, and, until recently, Puerto Rican waters. In addition to leaving an important component of the population unprotected, the lack of a prohibition on catch in state waters of USVI makes the federal regulation difficult to enforce.

The commercial extinction of Nassau grouper could change the structure and function of reef ecosystems in which this species has traditionally played an important role. However, such changes may have already begun to take place as this species has been considered overfished for at least a decade. Therefore, it is likely that the commercial extinction of Nassau grouper, while having a significant social and economic impact in the region, would not have a significant ecological impact due to the already depressed status of the stock and limited abundance in the U.S. Caribbean.

6.4.1.2.1.3 Direct and indirect effects on social and economic environment and their significance

Referring to Section 6.4.1, the Council prohibited the catch and possession of Nassau grouper in federal waters in 1990, and has made specific recommendations to state governments related to ending overfishing and protecting EFH in state waters. However, to date catches of Nassau grouper are not prohibited or regulated in USVI fisheries; Puerto Rico implemented new regulations on March 12, 2004, to prohibit the possession or sale of this species.

Annual commercial landings of Nassau grouper in Puerto Rico during the 1997-2001 period averaged 16,241 pounds while estimated harvest for the USVI was 4,073 pounds (Table 5). With respect to Puerto Rico, the majority of Nassau grouper are landed on the west coast and bottom line accounts for the majority of harvest followed by fish traps.[21] Comparable information does not exist for the USVI.

If current regulations are not sufficient to rebuild the stock, enactment of Alternative 1 may lead to a status quo stock condition or, possibly, continued depletion of the stock. As long as the

[21] The report by Matos-Caraballo (2001) indicates that the majority of the harvest in 1999 was taken by gill net. This is believed to be merely a transcription error and should be bottom line.

stock does not recover, the benefits derived from a more healthy stock will not be forthcoming. The loss in these benefits (though at some point in the future rather than currently) certainly signifies a cost to society. Furthermore, if recent reported commercial harvest in Puerto Rico and the USVI (extrapolated) is a reliable estimate of total commercial catch, little additional costs would likely be incurred from imposing additional restrictions.

6.4.1.2.1.4 Direct and indirect effects on administrative environment and their significance

While the current prohibition on Nassau grouper harvest and possession reflects a very stringent management response to the species biological status, it may not represent the most comprehensive management scenario to end overfishing and rebuild the species. Therefore, this alternative could result in a longer time frame for species rebuilding, resulting in administrative impacts when the rebuilding schedule is not met.

6.4.1.2.2 Alternative 2 (Preferred). Prohibit the filleting of fish in the federal waters of the U.S. Caribbean. Require that fish captured or possessed in federal waters be landed with heads and fins intact.

6.4.1.2.2.1 Direct and indirect effects on physical environment and their significance

Prohibiting the filleting of fish at sea is not be expected to directly or indirectly affect the physical environment over the short or long term. While disposed racks of filleted fish under the status quo may present an extremely temporal and local impact due to decomposition, which could have both beneficial and adverse impacts to the affected oceanographic environment, prohibiting this activity is not expected to have an significant effect on the physical environment.

6.4.1.2.2.2 Direct and indirect effects on biological and ecological environment and their significance

Currently, while the harvest and possession of Nassau grouper is prohibited in federal waters, anecdotal information indicates that illicit harvest may still occur. Participants could fillet the fish at sea in order to hinder species identification and enforcement. Therefore, this alternative would prevent the continued harvest of Nassau grouper, whether through a directed activity or the retention of bycatch. This could produce benefits not only to Nassau grouper stocks through the prevention of poaching on spawning aggregations or the retention of Nassau grouper bycatch, but it could also provide benefits to other managed species as well; species that prey or depend on (e.g., commensal organisms) Nassau grouper could benefit from increased stock size. However, the benefit is likely to be minimal if the USVI continues to permit catches of Nassau grouper.

6.4.1.2.2.3 Direct and indirect effects on social and economic environment and their significance

This alternative could result in reduced revenues for fishermen who fillet their catches at sea, because the whole fish would take up space in the vessel that could have been used for additional, marketable fillets. However, since the typical commercial vessel does not have fish holds, and in many cases do not use coolers, this alternative should not result in any significant impacts to the fishery as a whole. Fishermen could simply head and gut the fish, while retaining the majority of the carcass for landing. Furthermore, requiring that fish be landed intact could improve the marketability of fish, and improve consumer confidence in their purchase (i.e., knowing that the fish is not a species prone to being ciguatoxic).

6.4.1.2.2.4 Direct and indirect effects on administrative environment and their significance

Anecdotal information suggests that fish, especially prohibited species like Nassau grouper, are being harvested in federal waters and filleted at sea, thereby complicating the enforcement of the prohibition on catch and possession of these species. This action would prevent fishers from landing Nassau and Goliath grouper, as well as other species, in an unidentifiable form. It would also result in improved landings/catch data.

However, this alternative could present conflicts with fishermen returning from other Caribbean locales and transporting filleted fish on board. Additionally, without compatible state regulations, enforcement of this regulation would require agents to board boats in the EEZ and inspect the catch of fishermen. While Puerto Rico recently amended its fishing regulations to prohibit the filleting of fish at sea, it is still a permitted practice in USVI waters. Therefore, once in USVI waters, it could be hard to successfully prosecute a case of either possession of Nassau grouper harvested from the EEZ, or of filleting fish at sea. If the USVI implemented matching regulations, enforcement could be facilitated by allowing dockside inspection.

6.4.1.2.3 Alternative 3. Establish a seasonal or area closure to protect spawning stock.

At this time, no specific area closures have been proposed for the protection of Nassau grouper. However, Section 6.3.3 includes several closed area scenarios that could result in Nassau grouper spawning protection.

6.4.1.2.3.1 Direct and indirect effects on physical environment and their significance

The effects of establishing MPAs, or a network of MPAs, would be the same as those resulting from the establishment of closed areas proposed in Section 6.3.3. Therefore, the effects to the physical environment associated with this alternative are not repeated here.

6.4.1.2.3.2 Direct and indirect effects on biological and ecological environment and their significance

The effects of establishing MPAs, or a network of MPAs, would be the same as those resulting from the establishment of closed areas proposed in Section 6.3.3. Therefore, the effects to the biological environment associated with this alternative are not repeated here.

6.4.1.2.3.3 Direct and indirect effects on social and economic environment and their significance

Affected fishermen could experience losses in revenue associated with closing fishing grounds for any period of time. Such losses could be recouped by fishing around the closed area or season. However, such behavior would likely reduce or eliminate the long-term benefits associated with protecting the spawning stock.

6.4.1.2.3.4 Direct and indirect effects on administrative environment and their significance

The effects of establishing MPAs, or a network of MPAs, would be the same as those resulting from the establishment of closed areas proposed in Section 6.3.3. Therefore, the effects to the administrative environment associated with this alternative are not repeated here.

6.4.1.2.4 Alternative 4 (Preferred). 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 Caribbean Fishery Management Council's Reef Fish FMP in USVI and federal waters of the U.S. Caribbean.

At the 117th Council meeting in San Juan, Puerto Rico, representatives from the USVI DFW stated that they would support a prohibition on the harvest and possession of Nassau grouper in USVI state waters.

6.4.1.2.4.1.1 Direct and indirect effects on physical environment and their significance

This alternative would not result in any direct effects to the physical environment. If a species-specific prohibition on harvest and possession were implemented in USVI waters, it is unlikely that there would be any related impacts to the physical environment, since the prohibition, in and of itself, would not necessarily inhibit any fishing activity or gear impacts.

6.4.1.2.4.1.2 Direct and indirect effects on biological and ecological environment and their significance

Currently, the USVI does not regulate the take of Nassau grouper. Since much of the habitat that supports this species is located in state waters, the recovery of the species likely depends on the implementation of more protective regulations in state waters. Thus, this administrative action may be the only action that would be capable of rebuilding the stock to B_{MSY}. The benefits of a species-specific prohibition on harvest or possession in USVI waters would largely be confined to Nassau grouper.

6.4.1.2.4.1.3 Direct and indirect effects on social and economic environment and their significance

As noted in Section 6.4.1.2.1.3, reported commercial landings of Nassau grouper in Puerto Rico since 1997 have averaged only about 16,000 pounds, while the estimated annual landings in the USVI are 10,000 pounds. No information is available regarding recreational harvest.

Despite the current 13-year closure of federal waters to the harvesting of Nassau grouper, there is little indication that the stock has been rebuilt in any significant extent. In the absence of compatible USVI regulations, therefore, one might question whether the stock could be rebuilt. If the answer to this question is no, compatible regulations at the state level would be considered a prerequisite to achieving the objectives for Nassau grouper set forth in the CFMC's Reef Fish FMP in state and federal waters of the U.S. Caribbean.

Given the fact that harvest of Nassau grouper appears to be very limited, one can conclude that there would be minimal direct social or economic impacts associated with USVI developing and implementing compatible regulations. To the extent that such actions result in rebuilding of the stock, furthermore, one could expect long-term benefits associated with higher stock sizes (assuming, upon rebuilding, that harvesting activities would be permitted). However, many of the economic benefits would be lost if a rationale effort management system is not established prior to the opening of the fishery. Social benefits may still be forthcoming, however, since an increased stock size (if maintained through appropriate regulations) would translate to increased employment opportunities.

6.4.1.2.4.2 Direct and indirect effects on administrative environment and their significance

This alternative would represent the ideal scenario. However, an MOU would need to include an enforceable timetable for action and an incentive to comply. Without some form of penalty schedule, it is unclear how the USVI could be compelled to take action, seeing that the Council, on which the USVI has active representation, has been unable to influence them to take action for over a decade.

An MOU could improve enforcement, if consistent regulations were developed in state and federal waters. In particular, if the states also implemented regulations to prohibit filleting fish at sea, it could benefit enforcement of poaching that could occur on Nassau grouper and other species.

6.4.2 Goliath grouper

The Council prohibited the catch and possession of Goliath grouper in federal waters in 1993, and has made specific recommendations to state governments related to ending overfishing and protecting essential fish habitat in state waters (CFMC 2001a). The catch and possession of Goliath grouper is prohibited in USVI fisheries, and was recently (March 12, 2004) prohibited in Puerto Rican fisheries.

6.4.2.1 Rebuilding schedule

Fishery scientists do not have the data needed to calculate T_{MIN} for Goliath grouper. But NOAA SEFSC has concluded that it is unlikely that the stock could recover within ten years in the absence of fishing (CFMC 2001a). Thus, the Council has specified a T_{MIN} proxy of ten years for this species. Porch and Scott (2001) specify a generation time for Goliath grouper ranging from 20 to 95 years.

6.4.2.1.1 Alternative 1. No action. Do not define a schedule/time frame for rebuilding Goliath grouper.

6.4.2.1.1.1 Direct and indirect effects on physical environment and their significance

The effects on the physical environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.1.1. Therefore, they are not repeated here.

6.4.2.1.1.2 Direct and indirect effects on biological and ecological environment and their significance

The effects on the biological environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.1.2. Therefore, they are not repeated here.

6.4.2.1.1.3 Direct and indirect effects on social and economic environment and their significance

The effects on the social and economic environment associated with this alternative are expected to be the same as those documented in Section 6.4.1.1.1.3. Therefore, they are not repeated here.

6.4.2.1.1.4 Direct and indirect effects on administrative environment and their significance

This alternative would not comply with §304(e)(4)(A) of the MSFCMA. The effects on the administrative environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.1.4. Therefore, they are not repeated here.

6.4.2.1.2 Alternative 2 (Preferred). Rebuild Goliath grouper to B_{MSY} in 30 years, using the formula T_{MIN} (10 years) + one generation (20 years) = 30 years.

This alternative reflects the minimum amount of time likely needed to rebuild Goliath grouper.

6.4.2.1.2.1 Direct and indirect effects on physical environment and their significance

The effects on the physical environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.2.1. Therefore, they are not repeated here.

6.4.2.1.2.2 Direct and indirect effects on biological and ecological environment and their significance

The effects on the biological environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.1.2. Therefore, they are not repeated here.

6.4.2.1.2.3 Direct and indirect effects on social and economic environment and their significance

The effects on the social and economic environment associated with this alternative are expected to be the same as those documented in Section 6.4.1.1.2.3 (other than th final number of years). Therefore, they are not repeated here.

6.4.2.1.2.4 Direct and indirect effects on administrative environment and their significance

The effects on the administrative environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.2.4. Therefore, they are not repeated here.

6.4.2.1.3 Alternative 3. Rebuild Goliath grouper to B_{MSY} in 67.5 years, using the formula T_{MIN} (10 years) + one generation (57.5 years) = 67.5 years.

This alternative reflects the mid-range amount of time likely needed to rebuild Goliath grouper.

6.4.2.1.3.1 Direct and indirect effects on physical environment and their significance

The effects on the physical environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.3.1. Therefore, they are not repeated here.

6.4.2.1.3.2 Direct and indirect effects on biological and ecological environment and their significance

The effects on the biological environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.1.2. Therefore, they are not repeated here.

6.4.2.1.3.3 Direct and indirect effects on social and economic environment and their significance

The effects on the social and economic environment associated with this alternative are expected to be the same as those documented in Section 6.4.1.1.3.3 (other than th final number of years). Therefore, they are not repeated here.

6.4.2.1.3.4 Direct and indirect effects on administrative environment and their significance

The effects on the administrative environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.3.4. Therefore, they are not repeated here.

6.4.2.1.4 Alternative 4. Rebuild Goliath grouper to B_{MSY} in 105 years, using the formula T_{MIN} (10 years) + one generation (95 years) = 105 years.

This alternative reflects the maximum amount of time likely needed to rebuild Goliath grouper.

6.4.2.1.4.1 Direct and indirect effects on physical environment and their significance

The effects on the biological environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.1.2. Therefore, they are not repeated here.

6.4.2.1.4.2 Direct and indirect effects on biological and ecological environment and their significance

The effects on the biological environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.4.2.

6.4.2.1.4.3 Direct and indirect effects on social and economic environment and their significance

The effects on the social and economic environment associated with this alternative are expected to be the same as those documented in Section 6.4.1.1.4.3 (other than th final number of years). Therefore, they are not repeated here.

6.4.2.1.4.4 Direct and indirect effects on administrative environment and their significance

The effects on the administrative environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.4.4. Therefore, they are not repeated here.

6.4.2.2 Rebuilding strategy

6.4.2.2.1 Alternative 1. No action. Rely on current regulations to rebuild the stock to B_{MSY} within the required time frame.

The impacts of this alternative would be similar to those described for Nassau grouper in Section 6.4.1.2.1. Therefore, they are not repeated here.

6.4.2.2.2 Alternative 2 (Preferred). Prohibit the filleting of fish in the federal waters of the U.S. Caribbean. Require that fish captured or possessed in federal waters be landed with heads and fins intact.

The impacts of this alternative would be similar to those described for Nassau grouper in Section 6.4.1.2.2. Therefore, they are not repeated here.

6.4.2.2.3 Alternative 3. Establish a seasonal or area closure to protect spawning stock.

The impacts of this alternative would be similar to those described for Nassau grouper in Section 6.4.1.2.3, as well as the impacts associated in Section 6.3.3. Therefore, they are not repeated here.

6.4.3 Queen conch

Nearly every Caribbean nation has taken actions to reduce fishing mortality on queen conch. Regulations implemented in some, but not necessarily all, regions include seasonal and area closures to protect spawning populations and important habitat (CFMC 2001a); size limits to protect juvenile/immature conch; a prohibition on SCUBA gear to protect deep-water reproductive populations; limited access programs to control access; total allowable catch quotas to control fishing mortality; and mariculture programs to restock diminished populations (CFMC 2001a). Conch fisheries in Florida and Bermuda, which define the northern fringe areas of the range, have been closed since 1986, but show little or no sign of improvement, suggesting that habitat degradation may be a factor (CFMC 2001a; Deluca 2002).

In the U.S. Caribbean region, the queen conch fishery occurs primarily within state waters. Rivera's (1999) preliminary assessment shows that 92% of the conch fishers operate within 9 nm of the coast. The proportion of USVI fishermen participating in the federal fishery might be higher than that of Puerto Rican fishermen, since the waters under the jurisdiction of the USVI extend to just 3 nm from shore. However, Rivera (1999) concluded that 60% of conch fishers from the USVI and Puerto Rico operate within 3 nm of the coast. Further, while queen conch landings in St. Croix averaged 38,187 lbs from 1994-2002, landings in St. Thomas/St. John averaged only 740 pounds during the same time period (Valle-Esquivel and Díaz 2003). Rivera identified a total of 18 fishers harvesting queen conch from federal waters from a total of 209 fishers from whom data were collected (CFMC 2002a). Two of those 18 fishermen were from the USVI; the remainder, from Puerto Rico (CFMC 2002a).

It is believed that a significant component of the spawning stock is located in the EEZ (CFMC 2002a). But much of the habitat essential to the growth and development of queen conch occurs in state waters. Thus, the cooperation of state governments is essential to the effective management of this species. The strictest of regulations in federal waters would not likely be sufficient to rebuild the stock if compatible regulations are not implemented in state waters. The government of the USVI has implemented compatible regulations in the waters of that state, with the exception of consistent recreational possession limits. Puerto Rico has not implemented consistent regulations in regards to the landing of conch whole in the shell, which impedes enforcement of the minimum size limits. The Council has made specific recommendations to the government of Puerto Rico on this difference between Puerto Rican and federal landing requirements (CFMC 2001a).

6.4.3.1 Rebuilding schedule

Fishery scientists do not have the data needed to calculate T_{MIN} for queen conch. But NOAA SEFSC has concluded that it is unlikely that the stock could recover within ten years in the absence of fishing (CFMC 2001a). Employing two different models, Valle-Esquivel estimates a generation time for queen conch ranging from 4.6 years to 4.9 years (pers. comm.). This resulted in the specification of a generation time for that species of five years.

6.4.3.1.1 Alternative 1. No action. Do not define a schedule/time frame for rebuilding queen conch.

6.4.3.1.1.1 Direct and indirect effects on physical environment and their significance

The effects on the physical environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.1.1. Therefore, they are not repeated here.

6.4.3.1.1.2 Direct and indirect effects on biological and ecological environment and their significance

The effects on the biological environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.1.2. Due to the life history of queen conch, specifically the dependence on seagrass beds, the impact that the continued harvest in state waters, especially the potential harvest of undersized conch (due to the lack of a requirement to land queen conch whole in the shell in Puerto Rican waters), has on the rebuilding of the stock can not be emphasized enough. Therefore, in the absence of stricter management measures in state waters, the recovery of this resource is questionable.

6.4.3.1.1.3 Direct and indirect effects on social and economic environment and their significance

The effects on the social and economic environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.1.3. Therefore, they are not repeated here.

6.4.3.1.1.4 Direct and indirect effects on administrative environment and their significance

This alternative would not comply with §304(e)(4)(A) of the MSFCMA. The effects on the administrative environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.1.4. Therefore, they are not repeated here.

6.4.3.1.2 Alternative 2 (Preferred). Rebuild queen conch to B_{MSY} in 15 years, using the formula T_{MIN} (10 years) + one generation (5 years) = 15 years.

This alternative reflects the minimum amount of time likely needed to rebuild queen conch.

6.4.3.1.2.1 Direct and indirect effects on physical environment and their significance

The effects on the physical environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.2.1. Therefore, they are not repeated here.

6.4.3.1.2.2 Direct and indirect effects on biological and ecological environment and their significance

The effects on the biological environment due to this alternative are expected to be similar to those documented in Sections 6.4.1.1.1.2 and 6.4.3.1.1.2. Therefore, they are not repeated here.

6.4.3.1.2.3 Direct and indirect effects on social and economic environment and their significance

The act of defining a rebuilding schedule would have no direct or negative impacts on queen conch. Thus, defining a rebuilding schedule of 15 years would have no direct positive or negative socioeconomic impacts on the human environment. In general, however, the adverse short-term impacts associated with management measures are likely to be greater the shorter the rebuilding schedule. Hence, the management measures associated with a rebuilding schedule of 15 years (Alternative 2) is likely to have greater short-term impacts than a 20-year rebuilding schedule (Alternative 3).[22] In the absence of short-term management measures, however, short-term impacts cannot be quantified.

It needs to be emphasized that the different rebuilding schedules represent uncertainty in the estimated times needed to rebuild the stock which is very different than in most instances wherein the rebuilding schedule depends, primarily, upon the amount of harvest that is permitted during the rebuilding schedule.[23] Given this to be the case, the issue of tradeoffs of current and future benefits becomes, to some extent, irrelevant assuming the procedures are put in place to determine when the stock is considered rebuilt. Furthermore, if a rational management system is not instituted at the time that the fishery is rebuilt and (presumably) reopened to fishing, rents from the fishery will be dissipated. This would further suggest that a rebuilding strategy may not pay if the stream of discounted costs exceeds the stream of discounted benefits.

6.4.3.1.2.4 Direct and indirect effects on administrative environment and their significance

The effects on the administrative environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.2.4. Therefore, they are not repeated here.

6.4.3.1.3 Alternative 3. Rebuild queen conch to B_{MSY} in 20 years, using the formula T_{MIN} (15 years) + one generation (5 years) = 20 years.

This alternative represents a longer schedule than that offered in Alternative 2, in large part due to the depressed status of queen conch, which may require a longer schedule.

6.4.3.1.3.1 Direct and indirect effects on physical environment and their significance

The effects on the physical environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.4.1. Therefore, they are not repeated here.

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[22] The discussion of the rebuilding schedule for queen conch differs from that of Nassau grouper or Goliath grouper because harvest of the later two species is already prohibited in federal waters. This is not the situation with queen conch (though it would be if Alternative 2 in Section 6.4.3.2 is selected).

[23] In general, the greater amount of harvest that is permitted while the stock is being rebuilt, the longer the time frame associated with the rebuilding schedule.

6.4.3.1.3.2 Direct and indirect effects on biological and ecological environment and their significance

The effects on the biological environment due to this alternative are expected to be similar to those documented in Sections 6.4.1.1.1.2 and 6.4.3.1.1.2. Therefore, they are not repeated here.

6.4.3.1.3.3 Direct and indirect effects on social and economic environment and their significance

While the generation time was the uncertain variable with respect to recovery time for Nassau grouper and Goliath grouper, T_{MIN} is the uncertain variable associated with this alternative. The reason for the uncertainty, however, is not the relevant issue. The relevant issue is that there is considerable uncertainty in the rebuilding process.

The socioeconomic impacts associated with this alternative are presented in Section 6.4.3.1.2.3 and, therefore, are not repeated here.

6.4.3.1.3.4 Direct and indirect effects on administrative environment and their significance

The effects on the administrative environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.4.4. Therefore, they are not repeated here.

6.4.3.2 Rebuilding strategy

6.4.3.2.1 Alternative 1. No action. Rely on current regulations to rebuild the stock to B_{MSY} within the required time frame.

In addition to the effects discussed below, the impacts of this alternative would be similar to those described for Nassau grouper in Section 6.4.1.2.1; more information on particular impacts to the physical, biological and ecological, social and economic, and administrative environments can be found there.

6.4.3.2.1.1 Direct and indirect effects on physical environment and their significance

As noted in Section 6.1.1.1.1, management actions or inactions that affect the physical environment mostly relate to the interactions of fishing gears with the sea floor. Since queen conch are principally harvested by hand, and the majority of harvest occurs in state waters, this is alternative is not expected to directly or indirectly affect the physical environment over the short or long term.

6.4.3.2.1.2 Direct and indirect effects on biological and ecological environment and their significance

Current regulations, which have been in effect for about six years, do not appear to be sufficient to rebuild the resource. There is evidence that the population continues to decline and that overfishing is occurring (e.g., effort shifting to offshore populations; increased use of SCUBA) (CFMC 2002a). It is unlikely that queen conch can recover to B_{MSY} without a total prohibition on catch. If the recovery of queen conch depends on eliminating fishing mortality in federal waters of the U.S. Caribbean, maintaining status quo could lead to the commercial extinction of this species and a subsequent change in the structure and function of the supporting ecosystem.

Even with more protective measures (i.e., harvest prohibition in the EEZ) it is not clear that they would be sufficient to rebuild the stock if fishing mortality continues to be directed on queen conch in state waters. In addition to leaving an important component of the queen conch population unprotected, the lack of a prohibition on catch in those waters would make the federal regulation difficult to enforce.

6.4.3.2.1.3 Direct and indirect effects on social and economic environment and their significance

As mentioned in Section 6.4.3.2.1.2, current regulations do not appear to be sufficient to rebuild the resource. Therefore, one would anticipate that long-term benefits would be less than would otherwise be the case with a rebuilt stock. If the stock is further depleted, adverse social and economic impacts would be forthcoming. Even if not further depleted, however, social and economic benefits are currently being foregone because the stock is overfished.

6.4.3.2.1.4 Direct and indirect effects on administrative environment and their significance

As queen conch have been identified to be overfished and undergoing overfishing, this alternative (i.e., no action) would be in violation of the MSFCMA.

6.4.3.2.2 Alternative 2. Prohibit commercial and recreational catch and possession of queen conch in federal waters of the U.S. Caribbean.

While it is believed that most landings and virtually all juvenile queen conch are located in state waters, it is also believed that a significant component of the spawning stock is located in the EEZ. The declining trend in landings (i.e., Puerto Rico landings have declined from over 400,000 pounds in 1983 to below 250,000 in 2001) is indicative of a problem in the fishery. The situation in the USVI was more critical than in Puerto Rico, resulting in closure of the fishery in St. Thomas for five years beginning in 1992.

6.4.3.2.2.1 Direct and indirect effects on physical environment and their significance

This alternative is not expected to result in any direct or indirect effects to the physical environment. This is large part due to the fact that conch harvest is a relatively low impact fishing activity. Furthermore, the majority of the EEZ consists of water that is either not suitable habitat for queen conch or is too deep for divers to harvest queen conch.

6.4.3.2.2.2 Direct and indirect effects on biological and ecological environment and their significance

The queen conch fishery primarily occurs in state waters: 92% of queen conch is harvested with 9 nm of shore off Puerto Rico, while 60% of queen conch is harvested within 3 nm of shore off the USVI (Rivera 1999). However, this alternative would protect the deep water (i.e., spawning) stocks of queen conch, which could result in population increases in both state and federal waters (CFMC 2002a). It is generally accepted that older conch are found in deeper water. This alternative would also benefit those predators, such as several species of crab and rays, that prey on juvenile conch. However, because a large proportion of the stock, in particular juveniles, reside in state waters, and because most of the fishery occurs in state waters, any action taken by the Council to rebuild queen conch may not be sufficient if similar actions are not adopted to protect queen conch in state waters. Therefore, it is not clear whether a prohibition on the catch and possession of queen conch in federal waters would be sufficient to recover the resource. Long-standing moratoria in Bermuda and Florida do not appear to have rebuilt queen conch (Appledorn 1993), potentially indicating that the species have been depleted to the point that reproductive success is significantly jeopardized. Additionally, fisheries in Bonaire and Cuba have been closed for extended periods because of severe overfishing (Berg and Olsen 1989).

6.4.3.2.2.3 Direct and indirect effects on social and economic environment and their significance

As a precursor to evaluating the impacts on the social and economic environment associated with this alternative, it is first worthwhile to examine the extent of commercial queen conch activities in federal waters. Rivera (1999) identified only 18 fishermen that harvested queen conch in federal waters in the U.S. Caribbean (two in the USVI and 16 from Puerto Rico). This represented less than 10% of the 209 fishermen from whom data were collected.[24] Much of the reason for the low incidence of queen conch fishing in federal waters is identified in the Regulatory Impact Review for Amendment 2 for the Queen Conch Resources of Puerto Rico and the United states Virgin Islands. Specifically, queen conch catch per trip, after controlling for crew size, was found to be a maximum at a depth of about 70 feet. After that depth, catch per

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[24] In St. Croix, where catch by distance from shore is reported, 35% of the queen conch harvest was reportedly taken from federal waters during the two-year period ending in 2001 (37,000 lbs of the 102,000 lbs total reported harvest). This figure represents a significant departure from historical numbers (both in total poundage and distance from shore). During 1998-99, for example, reported commercial harvest of queen conch totaled 44,000 lbs and almost 85% of the total was reportedly caught within the three-mile boundary.

trip declined. The minimum depth in all federal waters off Puerto Rico is generally well in excess of 70 feet, and while there are some federal waters off USVI where the depth is 70 feet or less, the total amount is relatively small.

Because the extent of queen conch harvest in federal waters appears to be very limited (particularly in Puerto Rico), the direct short-term adverse socioeconomic impacts associated with the fishery closure are likely to be relatively small. To the extent that fishermen fishing in federal waters transfer activities to state waters, there could be some indirect impacts associated with increased competition for the limited resource over a limited shelf area. This would be particularly true in St. Croix.[25] To the extent that the proposed closure of the federal waters would allow for recovery of the stock, however, any adverse impacts would likely be outweighed by long-term benefits. In the absence of any rational effort management program, however, long-term economic benefits associated with the rebuilding of the stock would be significantly less than could be achieved with a comprehensive management system that would allow rents to accrue in the long run. From a social viewpoint, however, a long-term increase in stock would provide additional employment opportunities in the harvesting and related sectors.

Finally, as noted elsewhere in the document (e.g., Section 5.3.4), SCUBA represents the primary gear used in the harvesting of queen conch. While not documented, the use of this gear undoubtedly increases with water depth, to the extent a diver could operate and not be forced into lengthy decompression (i.e., ~130 ft). In the EEZ, use of any other gear for the harvest of queen conch is not likely feasible (particularly since the use of hookah is already prohibited).

An argument can be advanced that queen conch fishing in federal waters of the U.S. Caribbean, because it is so highly dependent on SCUBA with few alternatives, results in negative producer surplus (and net benefits to society) due to health risks associated with this activity. Between August 1997 and June 1998, a total of 19 commercial fishermen from Puerto Rico and the USVI were reportedly treated at the hyperbaric chamber in San Juan, Puerto Rico (it is not known how many of these 19 commercial fishers were harvesting conch). Eighteen of these commercial fishers recovered but one had impaired movements. Costs associated with these incidences (both hospital costs and costs associated with lost productivity and health care) represent components which, while not necessarily borne by the individual fishers, are borne by society at large. It is very likely that other divers harvesting queen conch have experienced diving related maladies (e.g., decompression sickness), but have not pursued treatment due to lack of insurance, misidentification of the symptoms, or denial, and are thus not reported.

[25] Closing federal waters would also have a differential impact on fishermen harvesting conch from the west coast of Puerto Rico since they must transit through the EEZ to land the harvest in home ports. Establishing an inspection and documentation system for these fishermen would be possible, but the costs have not been estimated.

6.4.3.2.2.4 Direct and indirect effects on administrative environment and their significance

This measure would present significant administrative impacts. Without compatible regulations in state waters, the prohibition on conch harvest in EEZ waters would be hard to enforce. Any enforcement action would have to be made at sea, as once a fishermen passes back into state waters it would not be possible to determine where the conch were harvested. Additionally, this harvest prohibition would present an issue for vessels traveling from Mona and Monito Islands. While conch harvest would be allowable in state waters around those islands, technically they would currently be unable to transit across federal waters with conch on board. An inspection system would have to be established with the rangers on Mona Island, and the catch of conch from those state waters would have to be sealed while transiting back to the Puerto Rican mainland.

6.4.3.2.3 Alternative 3 (Preferred). 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.

For the purposes of this alternative, Lang Bank consists of those waters in the U.S. Caribbean EEZ east of 64° 34' W longitude.

6.4.3.2.3.1 Direct and indirect effects on physical environment and their significance

This alternative would have similar effects to those discussed in Section 6.4.3.2.2.1. While there would be some extent of fishing activity for conch allowed under this alternative, permitting the harvest of conch to continue on Lang Bank would not be expected to introduce any significant effects to the physical environment due to the low-impact nature of hand harvest.

6.4.3.2.3.2 Direct and indirect effects on biological and ecological environment and their significance

This alternative would have similar effects to those discussed in Section 6.4.3.2.2.2, with the exception that continued exploitation on the conch resource would continue off St. Croix. Based on the USVI monthly commercial trip reports, the total 2000-2001 harvest of queen conch from the area east of St. Croix equaled 27,000 lbs, or an average of less than 14,000 lbs per year. Only 22% of this total was derived from federal waters and an unknown proportion (possibly very small) of this was from Lang Bank.[26] Regardless of the amount of conch harvested from the EEZ, it would represent the continued exploitation of a resource that has been documented to be overfished.

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[26] For reporting purposes, all of the east coast is considered one grid on the trip ticket forms. Lang Bank covers only a small area in this reporting grid.

Due to the geographic isolation of St. Croix, in that a deep water body separates it from the northern islands of St. Johns and St. Thomas, the importance of Lang Bank as a source for larval output (i.e., conch larvae) is not known. Furthermore, and perhaps more important, it is not known to what extent the St. Croix conch population depends on larval contribution from other locales, or if St. Croix has a self-supporting conch population. If the latter scenario were relevant, then the continued harvest of conch from Lang Bank, regardless of the extent of that harvest, could further jeopardize the collapse of isolated conch population in St. Croix.

6.4.3.2.3.3 Direct and indirect effects on social and economic environment and their significance

In general, the social and economic impacts associated with the Preferred Alternative 2 would be relevant to Alternative 3 other than for those participants that routinely use the Lang Bank in the queen conch activities. Valle-Esquivel and Díaz (2003) reported an average of 38,187 lbs of conch harvested from St. Croix during 1994-2002. Based on the USVI monthly commercial trip reports, the total 2000-2001 harvest of queen conch from the area east of St. Croix equaled 27,000 lbs, or an average of less than 14,000 lbs per year. Only 22% (i.e., approximately 2,970 lbs) of this total was derived from federal waters, though an unknown proportion of this was from Lang Bank.

6.4.3.2.3.4 Direct and indirect effects on administrative environment and their significance

This alternative would be expected to have similar effects to those discussed in Section 6.4.3.2.2.4. Therefore, they are not repeated here.

6.4.3.2.4 Alternative 4 (Preferred). Develop a memorandum of understanding (MOU) between NMFS and the state governments to develop compatible regulations to achieve the management objectives set forth in the Caribbean Fishery Management Council's Queen Conch Fishery Management Plan in state and federal waters of the U.S. Caribbean.

6.4.3.2.4.1 Direct and indirect effects on physical environment and their significance

The impacts of these alternatives would be similar to those described for Nassau grouper in Section 6.4.1.2.4.1. Therefore, they are not repeated here.

6.4.3.2.4.2 Direct and indirect effects on biological and ecological environment and their significance

Appeldoorn (1993) reported that in the absence of management, SPR for the queen conch stock could be expected to decline below the 20% level. In the mid-1980s off La Parguera, Puerto Rico, fishing mortality was estimated at 1.14 with an SPR value of 0.09 or less than one-half the recommended value of 0.2 (20%), and landings declined 80% during that period. There is no evidence that such high fishing mortality rates are unique to this area of Puerto Rico, or that mortality rates have since declined. Therefore, it is likely that the SPR for queen conch is below the recommended value of 0.2 or 20%, throughout much of the management area.

Friedlander (1997) observed that the abundance of queen conch in 1996 around St. John was relatively lower than during the early 1980s, and that a 5-year moratorium (1988-1992) on conch harvest and implementation of bag limits, minimum size, and closed seasons did not lead to a rebuilding of abundance. He concluded that present regulations are inadequate to ensure rebuilding. However, compliance with existing harvest regulations for shell length by commercial fishermen is poor, lacking an enforcement presence (CFMC 2000).

Since much of the queen conch habitat, in particular juvenile habitat, is located in state waters, the recovery of this species is likely dependent on the implementation of compatible protective regulations in state waters. Puerto Rico has neither size nor possession limits in place, but does have a seasonal closure, which was implemented in August 1997. Thus, administrative/legal actions related to jurisdictional issues may be the only actions that would be capable of rebuilding the stock to B_{MSY}.

6.4.3.2.4.3 Direct and indirect effects on social and economic environment and their significance

As indicated in Section 6.4.3.2.1, current regulations, that have been in effect for about six years, do not appear to be sufficient to rebuild the queen conch resource. This is not totally unexpected given the fact that compatible regulations have not been enacted by Puerto Rico. In particular, while federal regulations require that queen conch harvested in federal waters be landed in shell, Puerto Rico has no compatible regulation. Hence, while Puerto Rico has enacted a size limit consistent with that in the Council's Queen Conch FMP, the size limit cannot be enforced because there is little relationship between meat weight and length in shell. Thus, the harvest of undersized queen conch in Puerto Rico has likely, at least to some extent, inhibited attempts by the CFMC to rebuild the stock.

Development of compatible regulations would, at least to some extent, assist the CFMC in achieving the objectives set forth in the Queen Conch FMP. As such, compatible regulations would certainly be beneficial. Whether compatible regulations would be sufficient in rebuilding the queen conch population is unknown. However, the issue may be moot. Specifically, Preferred Alternative 2 in this Section (i.e., rebuilding strategy) calls for the prohibition of commercial and recreational catch and possession of queen conch in federal waters of the U.S. Caribbean. If compatible regulations by the state governments are adopted in addition to Alternative 2 (prohibition of commercial and recreational catch and possession of queen conch), commercial and recreational catch and possession of queen conch will be prohibited in both state and federal waters.

This prohibition would certainly have significant direct social and economic adverse impacts. Given the recent five-year average of commercial queen conch harvest, equal to 287,364 lbs (Table 5), a complete closure of all U.S. Caribbean waters to commercial activities would result in a loss of dockside revenues of $656,627 (based on the 1998-2001 average dockside price in Puerto Rico of $2.285 per pound). Similarly, closure of federal waters would result in a direct loss in employment opportunities in the harvesting sector as well as support sectors. Given the large amount of conch imports, however, consumers would likely not be impacted from a total closure.

There would also be a loss in satisfaction by the recreational community associated with the harvesting of queen conch. Recreational harvest of queen conch throughout the U.S. Caribbean is estimated to equal 151,584 lbs annually. Translating this loss in satisfaction into dollar terms is not possible in the absence of empirical research but it is certainly positive.

However, one must ask the question whether income (commercial queen conch fishing) and satisfaction (recreational participation) is sustainable in the absence of compatible regulations by the state governments that would prohibit all catch and possession of queen conch in state waters. If not sustainable, commercial income and recreational satisfaction derived from harvesting of the resource will be diminished over time. Complete closure of the fishery, while imposing significant short-term adverse social and economic impacts, will, to the extent it is needed to rebuild the resource (and/or prevent further decline in stock size) could, in the long run, result in a rebuilding of the queen conch population. This would translate into both economic and social benefits upon the reopening of the fishery. Economic benefits, however, may be rather limited in the absence of a rational effort management system.

6.4.3.2.4.4 Direct and indirect effects on administrative environment and their significance

The impacts of these alternatives would be similar to those described for Nassau grouper in Section 6.4.1.2.4.4. The importance of compatible regulations to the successful rebuilding of the queen conch stock can not be stressed enough. The majority of the required habitat, the conch population itself, and the harvest occurs in state waters. If the Council opts to select Alternative 2 and prohibit the harvest of conch in federal waters in the absence of matching regulations in state waters, the best case scenario one could hope for is that the status of the queen conch stock is not exacerbated further. Stock recovery is unlikely, as evident through the example of Nassau grouper. The chances of queen conch recovery is even more grim, due to the reliance of the species on shallow seagrass beds, and the reproductive nature of the species.

6.4.4 Grouper Unit 4

Based on the suite of preferred stock status parameter alternatives selected by the Council, Grouper Unit 4, which consists of misty grouper, red grouper, tiger grouper, yellowedge grouper, and yellowfin grouper, would be considered overfished. Rather than conduct a rebuilding schedule and strategy for this management unit in a separate amendment, the required rebuilding measures are included in this amendment.

6.4.4.1 Rebuilding schedule

Fishery scientists do not have the data needed to calculate T_{MIN} for any of the grouper species in Grouper Unit 4 for the Caribbean. The theoretical dynamics of a population under the logistic (Graham-Schaefer) surplus-production model were used to calculate recovery times for this non-assessed stock. Additionally, since it appears that the stock is only slightly overfished (i.e., B_{CURR}/MSST = 0.91 (Table 8)), it is likely that the stock could recover within ten years based on reductions in fishing mortality that would be implemented under the control rules.

6.4.4.1.1 Alternative 1. No action. Do not define a schedule/time frame for rebuilding Grouper Unit 4.

6.4.4.1.1.1 Direct and indirect effects on physical environment and their significance

The effects on the physical environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.1.1. Therefore, they are not repeated here.

6.4.4.1.1.2 Direct and indirect effects on biological and ecological environment and their significance

The effects on the biological environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.1.2. Due to the species association with reef habitat, fishing activities in federal waters by and large are overshadowed by harvest in state waters; the effect of the unrestricted harvest of these grouper species in state waters has on the rebuilding of the stock can not be emphasized enough. Therefore, in the absence of stricter management measures in state waters, the recovery of this resource is questionable.

6.4.4.1.1.3 Direct and indirect effects on social and economic environment and their significance

The effects on the human environment resulting from this alternative are expected to be similar to those identified in Section 6.4.4.1.1.3. Therefore, they are not repeated here.

6.4.4.1.1.4 Direct and indirect effects on administrative environment and their significance

This alternative would not comply with §304(e)(4)(A) of the MSFCMA. The effects on the administrative environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.1.4. Therefore, they are not repeated here.

6.4.4.1.2 Alternative 2 (Preferred). Rebuild Grouper Unit 4 to B_{MSY} in 10 years.

This alternative reflects the maximum amount of time likely needed to rebuild species in Grouper Unit 4.

6.4.4.1.2.1 Direct and indirect effects on physical environment and their significance

The effects on the physical environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.4.1. Therefore, they are not repeated here.

6.4.4.1.2.2 Direct and indirect effects on biological and ecological environment and their significance

The effects on the biological environment due to this alternative are expected to be similar to those documented in Sections 6.4.1.1.1.2 and 6.4.5.1.1.2. Therefore, they are not repeated here.

6.4.4.1.2.3 Direct and indirect effects on social and economic environment and their significance

The effects on the socioeconomic environment associated with this alternative are similar to those documented in Section 6.4.4.1.2.3. Therefore, they are not repeated here.

6.4.4.1.2.4 Direct and indirect effects on administrative environment and their significance

The effects on the administrative environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.4.4. Therefore, they are not repeated here.

6.4.4.1.3 Alternative 3. Rebuild Grouper Unit 4 to B_{MSY} in 2 years.

Based on the recovery curves generated for species in Grouper Unit 4 (Figure 10), T_{MIN} was estimated to be approximately 2 years. This would represent the shortest time frame required to rebuild the stock.

6.4.4.1.3.1 Direct and indirect effects on physical environment and their significance

The effects on the physical environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.2.1. Therefore, they are not repeated here.

6.4.4.1.3.2 Direct and indirect effects on biological and ecological environment and their significance

The effects on the biological environment due to this alternative are expected to be similar to those documented in Sections 6.4.1.1.1.2 and 6.4.5.1.1.2. Therefore, they are not repeated here.

6.4.4.1.3.3 Direct and indirect effects on social and economic environment and their significance

The effects on the socioeconomic environment associated with this alternative are similar to those documented in Section 6.4.4.1.2.3. Therefore, they are not repeated here.

6.4.4.1.3.4 Direct and indirect effects on administrative environment and their significance

The effects on the administrative environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.2.4. Therefore, they are not repeated here.

6.4.4.1.4 Alternative 3. Rebuild Grouper Unit 4 to B_{MSY} in 6 years.

This alternative is based on the midpoint between the 2-year T_{MIN} generated by the recovery curve for Grouper Unit 4 (Figure 10), and the maximum allowable rebuilding period of 10 years.

6.4.4.1.4.1 Direct and indirect effects on physical environment and their significance

The effects on the physical environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.3.1. Therefore, they are not repeated here.

6.4.4.1.4.2 Direct and indirect effects on biological and ecological environment and their significance

The effects on the biological environment due to this alternative are expected to be similar to those documented in Sections 6.4.1.1.1.2 and 6.4.5.1.1.2. Therefore, they are not repeated here.

6.4.4.1.4.3 Direct and indirect effects on social and economic environment and their significance

The effects on the socioeconomic environment associated with this alternative are similar to those documented in Section 6.4.4.1.2.3. Therefore, they are not repeated here.

6.4.4.1.4.4 Direct and indirect effects on administrative environment and their significance

The effects on the administrative environment due to this alternative are expected to be similar to those documented in Section 6.4.1.1.3.4. Therefore, they are not repeated here.

6.4.4.2 Rebuilding strategy

The management measures described in Section 4.3 are designed to reduce fishing mortality rates to levels that are equal to or less than those prescribed by the Preferred MSY Control Rule described in Section 4.2.5. A preferred alternative in Section 4.3 would prohibit the possession of species in Grouper Unit 4 from February 1 - April 30, to reduce fishing mortality and protect spawning aggregations. It is expected to result in a 24% reduction in fishing mortality, which should be sufficient to end overfishing and rebuild the FMU sub-unit within the preferred rebuilding schedule. Because the Grouper Unit 4 Complex would be considered to be just slightly overfished (B_{CURR} is 91% of MSST) if the preferred alternatives in Section 4.2 were adopted, ending overfishing should allow Grouper Unit 4 to rebuild to B_{MSY} within any of the alternative schedules evaluated above. Therefore, no additional rebuilding measures are considered in this section.

6.5 Conserving and protecting yellowfin grouper

Yellowfin grouper, as part of Grouper Unit 4 complex, would be considered overfished based on the suite of preferred stock status parameter alternatives. Yellowfin grouper spawn during a distinct February to April period (Section 5.2.1.33.12.1, Table 12), and are documented to aggregate to spawn on Grammanik Bank south of St. Thomas. Fishermen typically target spawning aggregations due to the fact that large spawning fish can be harvested in abundant numbers in a fairly discrete area and during a fairly predictable timeframe.

6.5.1 Alternative 1. No action. Do not implement additional management measures to further protect yellowfin grouper.

6.5.1.1 Direct and indirect effects on physical environment and their significance

This alternative would obviously not result in the introduction of any further effect to the physical environment that does not already exist under the status quo. Management actions that affect fishing activities, in particular the type of gear used and how it is used, as well as the amount of allowable fishing pressure (i.e., landings) would be just some of the actions that could alter or introduce the physical environment. However, being that no additional management action is being taken under this alternative, it would not result in any direct or indirect significant physical impacts.

6.5.1.2 Direct and indirect effects on biological and ecological environment and their significance

Similarly to Section 6.5.1.1, the no-action alternative would not introduce any direct effects to the biological environment. However, when considering the overfished status of yellowfin grouper this alternative could result in some indirect biological impacts. By not taking any action to conserve or protect yellowfin grouper, it is possible that the biological status of the species could be exacerbated. This would degrade the stock to a point that could jeopardize species interactions such as predator-prey relationships, as well as compromise genetic variability within the species itself. However, it should be remembered that there are alternatives in other sections that could remedy the biological status of yellowfin grouper. For example, the control rules scenarios in Sections 6.2.6 - 6.2.7 could trigger required reductions in fishing mortality, and may result in the establishment of a closed season or area in Section 6.3, which could benefit yellowfin grouper. Therefore, this alternative, while not taking any discrete action to conserve and protect yellowfin grouper, would not necessarily jeopardize stock recovery.

6.5.1.3 Direct and indirect effects on social and economic environment and their significance

The no action alternative (Alternative 1) would impose no direct positive or adverse effects on the human environment. However, taking no action to protect the stock could result in the biological status of the stock being exacerbated. This would result in adverse effects to the human environment, including direct and indirect loss of employment opportunities tied to the resource.

6.5.1.4 Direct and indirect effects on administrative environment and their significance

As mentioned in Section 6.5.1.2, depending on other alternatives taken to reduce fishing mortality, this alternative might be the best course of action. Should the Council choose to implement one of the closed area alternatives in Section 6.3.3, it would most likely result in more comprehensive protection for yellowfin grouper than Alternatives 2 - 7.

6.5.2 Alternative 2. Close the Grammanik Bank to all fishing from February 1 to April 30 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18º 12.40' N, 64º 59.00' W; 18º 10.00' N, 64º 59.00' W; 18º 10.00' N, 64º 56.10' W; and 18º 12.40' N, 64º 56.10' W.

This alternative would define an area of approximately 4.63 km (2.5 nm) by 5.09 km (2.75 nm), resulting in a 23.57 km^2 (6.88 nm^2) area in which fishing would be prohibited from February through April. The reported spawning aggregation would be positioned slightly northeast of the closed area's center.

6.5.2.1 Direct and indirect effects on physical environment and their significance

This alternative would be expected to have similar effects to the physical environment as those described in Section 6.3.3.1. Implementing a closed area would result in a reduction in fishing effort in a localized area. That reduction in fishing effort could directly benefit the direct physical environment, in particular coral habitat, as it would eliminate fishing-related impacts within that area. Within the closed area gear impacts and anchoring of fishing vessels would be expected to be absent, allowing benthic communities to recover. Yet, any benefits incurred from the closed area could potentially be negated by increased fishing activity around the perimeter of the boundaries, as well as increased pressure to benthic communities elsewhere in the U.S. Caribbean. However, because this alternative would only establish a closed area seasonally and not the entire year, the benefits to the physical environment would not be as significant as to those of a year-round closure. Furthermore, fishing pressure just prior to and after the seasonal closure could completely or partially negate any benefits to the physical environment. Due to the lack of discrete habitat mapping for the affected area, it is not possible to determine the relative importance of spatial area versus duration in regard to benefits afforded to coral and other benthic habitats.

6.5.2.2 Direct and indirect effects on biological and ecological environment and their significance

The sedentary nature and high catchability of many grouper species, especially during spawning aggregations, make them particularly at risk (Weber 1998). While many reef fishermen do not have the basic electronic equipment typically used to locate aggregations, the strong site fidelity of some reef fish species, both to non-spawning habitat and to spawning sites, as well as the temporal predictability of their spawning aggregations, makes them easy to locate (AFS 2001; Rielinger 1999). Furthermore, fishers have historically targeted unprotected spawning aggregations (Rielinger 1999).

Luckhurst (1998) demonstrated that spawning site fidelity in red hind is an acquired trait. Additionally, the loss of spawning aggregations in several grouper species due to overfishing, despite their proximity to more healthy spawning stocks, would strongly suggest that spawning fidelity is a learned behavior in many reef fish species. When heavy fishing on aggregations removes the experienced fish, new recruits cannot find the aggregations, which can then collapse as functional spawning units (Coleman *et al.* 2000). For example, of the nearly 50 Caribbean aggregations known for Nassau grouper, at least 10 have been annihilated by fishing. Those aggregations that were fished out have yet to rebuild (Coleman *et al.* 2000).

This action would result in similar effects to those described in Section 6.3.3.2, yet this alternative would not result in as dramatic impacts to the biological environment. Because the closure is only seasonal, yellowfin grouper and other species would still be subject to harvest before and after the closure. Furthermore, due to the closure, fishing activities may increase in effort leading up to the closure, as well as directly after the end of the closed season. Anchoring and fishery-related impacts to habitat could also be amplified due to this behavior.

Alternative 2 would afford protection to the yellowfin grouper throughout the entire spawning season within the designated coordinates of Grammanik Bank. However, if coupled with Alternative 7, yellowfin grouper would be protected throughout the EEZ during its complete spawning season. While it is not possible to quantify the biological impact of this alternative, prohibiting the harvest of yellowfin grouper within a documented spawning aggregation site would obviously benefit the species. However, if fishing pressure is at a level that is unsustainable the remainder of the year, then the benefits of this alternative could be reduced or compromised. That is, if fishing reduces the abundance of grouper that are on Grammanik Bank, or return to the area to spawn the rest of the season, the effect of the spawning season closure on Grammanik Bank is negated. Regardless, this alternative, due to the size of the proposed area and the comprehensive spawning period closure, would be more conservative than Alternatives 4 - 6, but would be smaller than that offered in Alternative 3.

Anecdotal information indicates that fishing pressure on Grammanik Bank may also result in bycatch mortality of Nassau grouper, a species which also utilizes Grammanik Bank for spawning purposes; Nassau grouper are currently considered to be overfished, and their harvest and possession in federal waters of the U.S. Caribbean is currently prohibited. Therefore, this closure could afford additional protection to Nassau grouper, which may be re-establishing a spawning aggregation on Grammanik Bank. Closed areas adjacent to areas designated as critical habitat for sea turtles (i.e., areas where there may be higher concentrations of sea turtles) may reduce the number of incidental takes. Any total effort reductions as a result of area closures may be beneficial to protected resources.

6.5.2.3 Direct and indirect effects on social and economic environment and their significance

In general, protection of spawning aggregations can provide several potential areas of benefits to both commercial and recreational participants. However, protection can also provide less desirable side effects that can at least partially offset some of the potential gains.

Protection of a spawning aggregation is a classic example of foregoing short-term losses in commercial and recreational harvest (i.e., direct short-term adverse impact) in exchange for stock rebuilding that provides for larger catches in the future. In such a scenario, it can be a relatively straightforward process to determine the direction, if not the magnitude of the change in net national benefits that is expected if sufficient information exists. This can be done if there is information on short-term harvesting profits (assuming a heterogeneous fleet) and an estimate of consumer benefits (i.e., willingness to pay) associated with recreational trips. Then, with some information on the future yield stream, the discounted value of commercial benefits (profitability) and recreational benefits (increased willingness to pay) can be estimated and compared to short-term losses. In the case of this proposed closure, however, adequate information does not exist.

The 1997-2002 average annual landings of Puerto Rican yellowfin grouper is approximately 4,400 pounds, of which only a portion is landed during the spawning period. Likewise, the 1994-2002 average annual landings of all grouper from both St. Thomas and St. John is 22,368 pounds (Valle-Esquivel and Díaz 2003), of which only a portion is yellowfin grouper, of which a smaller portion is harvested from the EEZ (specifically on Grammanik Bank), and of which even a smaller portion is landed within the period of the proposed closure specified by this alternative.

Although the present amendment does not contain details on the importance of the Grammanik Bank spawning area, i.e., there is no description of the percent of yellowedge grouper represented by this aggregation or where the potential new recruits eventually go, there is, apparently, some consensus that this closure will result in some trend toward stock recovery or at least a slowing of the present rate of stock decline, if any. This should lead to benefits from the closure, even if the level of total fishing effort does not change. The reason that the total amount of effort may not change is that fishermen may elect to fish in adjacent areas. Even if this occurs, additional effort in other areas may not significantly alter the total catch because the fishery is fully utilized. Hence, increases in effort do not culminate in any significant increase in harvest.

The possible relocation of effort just alluded to does have potential adverse effects that are not related to the total fish catch. One consequence is that displaced effort may simply move to "second best" spawning aggregations. If this happens, then some of the potential long-term benefits may be dissipated. A second adverse effect, which has already been alluded to, reflects declining catch per unit effort among the fleet, in the short run, during that period of time when the spawning aggregation is taking place. This declining catch per unit effort translates into a short-run reduction in revenues and, hence, profitability.

Economic benefits associated with rebuilding the stock *via* protection of the spawning aggregation will, however, be largely dissipated through time if effort expansion in association with the rebuilding of the stock (and, hence, higher CPUE and profits) is not constrained.

As noted, finally, Alternatives 2 through 6 in this Section propose a complete closure of the spawning area with each alternative being modified slightly by size, timing, or length of the closure. One might anticipate benefits to be positively related to the size of the closure but costs will also be positively related. Given the paucity of information, there is no means of determining which of the Alternatives would yield the highest net benefits.

6.5.2.4 Direct and indirect effects on administrative environment and their significance

While this alternative would afford a level of protection to the spawning aggregation documented on Grammanik Bank, it would result in significant administrative effects, similar to those discussed in Section 6.3.3.4. Enforcement would have to be conducted at-sea. While the additional measures offered in Alternative 7 would help to remedy some of the enforcement issues, since it would prohibit yellowfin grouper harvest and possession throughout the spawning period, enforcement could still not be employed dockside without compatible state regulations. However, the size of the proposed closed area (larger than Alternatives 4 - 6), along with its positioning adjacent to the Hind Bank MCD, would facilitate enforcement efforts to some degree.

It should also be remembered that there are alternatives in other sections that could remedy the biological status of yellowfin grouper and supersede this action. For example, the control rules scenarios in Sections 6.2.6 - 6.2.7 that would trigger required reductions in fishing mortality may result in the establishment of a closed season or area in Section 6.3, which could benefit yellowfin grouper.

6.5.3 Alternative 3. Close the Grammanik Bank to all fishing from February 1 to April 15 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18º 13.20' N, 64º 59.00' W; 18º 13.20' N, 64º 54.00' W; 18º 09.50' N, 64º 59.00' W; and 18º 09.50' N, 64º 54.00' W.

This alternative would define an area of approximately 6.48 km (3.5 nm) by 9.26 km (5 nm), resulting in a 60 km^2 (17.5 nm^2) area in which fishing would be prohibited from February through April 15. The reported spawning aggregation would be centered within this closed area.

6.5.3.1 Direct and indirect effects on physical environment and their significance

This alternative would be expected to have similar effects to the physical environment as those described in Sections 6.3.3.1 and 6.5.2.1. However, because this alternative would only establish a closed area seasonally and not the entire year, the benefits to the physical environment would not be as significant as to those of a year-round closure. Furthermore, fishing pressure (i.e., gear impacts) just prior to and after the seasonal closure could completely negate any benefits to the physical environment. While this alternative would offer the best habitat protection spatially, it would only do so for 2.5 months, which is a shorter time period than Alternatives 2, 5, and 6. Therefore, the benefit from this alternative would be limited by the shorter duration of protection.

6.5.3.2 Direct and indirect effects on biological and ecological environment and their significance

This alternative would be expected to have similar effects to the biological environment as those described in Sections 6.3.3.2 and 6.5.2.2. While Alternative 3 would afford protection to the yellowfin grouper during half of its spawning season and would reduce effort on other stocks that are fished over the Grammanik Bank during that same period of time, the limited duration of the closure could compromise the potential biological benefits, especially if fishing activity was intensified just before and after the closure. Furthermore, due to this short closure, it is expected that trap fishermen would not be compelled to recover all of their traps due to the time and effort involved, and instead would allow them to soak in the closed area. This could present significant issues related to ghostfishing, as the traps could continue to effectively attract and harvest fish. In this regard, a longer closure (e.g., Alternatives 2, 5, and 6) might offer more attractive benefits to the complete ecosystem, as compared to size. Further, since the closed season does not include the full spawning period, intensified harvest on either end of the closure could compromise the intended effect of the management action.

6.5.3.3 Direct and indirect effects on social and economic environment and their significance

The social and economic impacts associated with this alternative are fully contained within the discussion associated with Alternative 2 in Section 6.5.2.3. Therefore, no further discussion is provided here.

6.5.3.4 Direct and indirect effects on administrative environment and their significance

This alternative would be expected to have similar effects to the administrative environment as those described in Sections 6.3.3.4 and 6.5.2.4. This alternative is consistent with the recommendation of the USCG, and provides a closed area with a sufficient size to facilitate enforcement. Alternative 3 presents a closed area larger than that offered in Alternative 2. Yet, the shorter duration of the closure could cause some confusion amongst the fishery, especially since the re-opening would be mid-month, versus the beginning of a month. Due to this shorter closure, it is expected that trap fishermen would not be compelled to recover all of their traps, and would allow them to soak in the closed area. Enforcement would be unable to determine if there were traps in the closed area if fishermen planned to leave them in the water and removed their buoys, and recovered them with a grapple once the season was over.

It should also be remembered that there are alternatives in other sections that could remedy the biological status of yellowfin grouper and supersede this action. For example, the control rules scenarios in Sections 6.2.6 - 6.2.7 that would trigger required reductions in fishing mortality may result in the establishment of a closed season or area in Section 6.3, which could benefit yellowfin grouper.

6.5.4 Alternative 4. Close the Grammanik Bank to all fishing from February 1 to April 15 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18º 12.00' N, 64º 58.00' W; 18º 12.00' N, 64º 57.00' W; 18º 11.00' N, 64º 57.00' W; and 18º 11.00' N, 64º 58.00' W.

This alternative would define an area of approximately 1.85 km (1.0 nm) by 1.85 km (1.0 nm), resulting in a 3.42 km^2 (1.0 nm^2) area in which fishing would be prohibited from February through April 15. The reported spawning aggregation would be centered within this closed area.

6.5.4.1 Direct and indirect effects on physical environment and their significance

This alternative would be expected to have similar effects to the physical environment as those described in Sections 6.3.3.1 and 6.5.2.1. However, because this alternative would only establish a closed area seasonally and not the entire year, the benefits to the physical environment would not be as significant as to those of a year-round closure. Furthermore, fishing pressure just prior to and after the seasonal closure could completely negate any benefits to the physical environment. This alternative would create the smallest closed area, and it would do so for only 2.5 months. The time period is similar to that offered in Alternative 3, which is a shorter time period than Alternatives 2, 5, and 6. Therefore, the benefits to the physical environment from this alternative would be extremely limited by the short duration of protection as well as the limited size.

6.5.4.2 Direct and indirect effects on biological and ecological environment and their significance

This alternative would be expected to have similar effects to the biological environment as those described in Sections 6.3.3.2 and 6.5.2.2. While Alternative 4 would afford protection to the yellowfin grouper during half of its spawning season and would reduce effort on other stocks that are fished over the Grammanik Bank during that same period of time, the limited duration of the closure could compromise the potential biological benefits, especially if fishing activity was intensified just before and after the closure. In this regard, a longer closure (e.g., Alternatives 2, 5, and 6) might offer more attractive benefits to the complete ecosystem, as compared to size. Further, since the closed season does not include the full spawning period, intensified harvest on either end of the closure could compromise the intended effect of the management action.

The very limited size of the closed area – the smallest option proposed – would also limit the ecological benefits. Relief from fishery-related impacts, specifically to coral habitat, would be confined not only in space, but time. While the closure may be beneficial to some extent to the immediate area, it is unlikely that a 2.5 month closure over a one square mile would result in any significant beneficial ecological impacts to the region as a whole.

6.5.4.3 Direct and indirect effects on social and economic environment and their significance

The social and economic impacts associated with this alternative are fully contained within the discussion associated with Alternative 2 in Section 6.5.2.3. Therefore, no further discussion is provided here.

6.5.4.4 Direct and indirect effects on administrative environment and their significance

This alternative would be expected to have similar effects to the administrative environment as those described in Sections 6.3.3.4 and 6.5.2.4. However, a one-mile square closed area may not provide enough buffer to protect yellowfin grouper spawning aggregations, and may complicate enforcement. Due to the small size and short time frame of this alternative, it would not be as beneficial or desirable as compared to the all of the other alternatives.

It should also be remembered that there are alternatives in other sections that could remedy the biological status of yellowfin grouper and supersede this action. For example, the control rules scenarios in Sections 6.2.6 - 6.2.7 that would trigger required reductions in fishing mortality may result in the establishment of a closed season or area in Section 6.3, which could benefit yellowfin grouper.

6.5.5 Alternative 5. Close the Grammanik Bank to all fishing from February 1 to May 31 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18º 13.20' N, 64º 59.00' W; 18º 13.20' N, 64º 54.00' W; 18º 09.50' N, 64º 59.00' W; and 18º 09.50' N, 64º 54.00' W.

This alternative would define an area of approximately 4.63 km (2.5 nm) by 3.70 km (2.0 nm), resulting in a 17.13 km^2 (5 nm^2) area in which fishing would be prohibited from February through May. The reported spawning aggregation would be centered within this closed area.

6.5.5.1 Direct and indirect effects on physical environment and their significance

This alternative would be expected to have similar effects to the physical environment as those described in Sections 6.3.3.1 and 6.5.2.1. Similar to Alternative 3, this alternative would offer extensive protection to the physical environment (primarily through limiting fishery-related impacts to EFH) due to the extended closed season, but it is slightly smaller than the area proposed in Preferred Alternative 2.

6.5.5.2 Direct and indirect effects on biological and ecological environment and their significance

This alternative would be expected to have similar effects to the biological environment as those described in Sections 6.3.3.2 and 6.5.2.2. This alternative would offer more benefits to yellowfin grouper, as well as other managed and unmanaged species due to the extended closed season; the length of the closed season is twice as long as that proposed in Alternative 3. Coral habitat would also benefit, due to the prohibition of fishing, and thus, fishery-related impacts such as trap damage and anchoring. However, it is slightly smaller than the area proposed in Preferred Alternative 2, thus, affording less areal protection.

6.5.5.3 Direct and indirect effects on social and economic environment and their significance

The social and economic impacts associated with this alternative are fully contained within the discussion associated with Alternative 2 in Section 6.5.2.3. Therefore, no further discussion is provided here.

6.5.5.4 Direct and indirect effects on administrative environment and their significance

This alternative would be expected to have similar effects to the administrative environment as those described in Sections 6.3.3.4 and 6.5.2.4. However, due to the extended duration of the closed season, it might lessen interpretation problems by fishermen due to an extremely short season, as offered in Alternative 3.

It should also be remembered that there are alternatives in other sections that could remedy the biological status of yellowfin grouper and supersede this action. For example, the control rules scenarios in Sections 6.2.6 - 6.2.7 that would trigger required reductions in fishing mortality may result in the establishment of a closed season or area in Section 6.3, which could benefit yellowfin grouper.

6.5.6 Alternative 6. Close the Grammanik Bank to all fishing from February 1 to May 31 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18º 12.00' N, 64º 58.00' W; 18º 12.00' N, 64º 57.00' W; 18º 11.00' N, 64º 57.00' W; and 18º 11.00' N, 64º 58.00' W.

This alternative would define an area of approximately 1.85 km (1.0 nm) by 1.85 km (1.0 nm), resulting in a 3.42 km^2 (1.0 nm^2) area in which fishing would be prohibited from February through May. The reported spawning aggregation would be centered within this closed area.

6.5.6.1 Direct and indirect effects on physical environment and their significance

This alternative would be expected to have similar effects to the physical environment as those described in Sections 6.3.3.1 and 6.5.2.1. Similar to Alternative 3, this alternative would offer extensive protection to the physical environment (primarily through limiting fishery-related impacts to EFH) due to the extended closed season, but over a very limited area.

6.5.6.2 Direct and indirect effects on biological and ecological environment and their significance

This alternative would be expected to have similar effects to the biological environment as those described in Sections 6.3.3.2 and 6.5.2.2. Similar to Alternative 3, this alternative would offer extensive protection to the biological environment (primarily through limiting fishery-related impacts to EFH) due to the extended closed season. While the entire documented spawning period for yellowfin grouper would be encompassed in this alternative, it is unclear if the small size would offer sufficient protection to any aggregation, especially considering the intensified fishing that would be expected along the boundaries of the closed area. Furthermore, the benefits to other managed species and to coral habitat would most likely not be significant due to the limited size of the proposed closure. Fishing impacts and resource exploitation that might be intensified before and after the closure might negate any ecological benefits that this alternative could produce.

6.5.6.3 Direct and indirect effects on social and economic environment and their significance

The social and economic impacts associated with this alternative are fully contained within the discussion associated with Alternative 2 in Section 6.5.2.3. Therefore, no further discussion is provided here.

6.5.6.4 Direct and indirect effects on administrative environment and their significance

This alternative would be expected to have similar effects to the physical environment as those described in Sections 6.3.3.4 and 6.5.2.4. However, due to the extended duration of the closed season, it might lessen interpretation problems by fishermen due to an extremely short season, as offered in Alternative 3.

It should also be remembered that there are alternatives in other sections that could remedy the biological status of yellowfin grouper and supersede this action. For example, the control rules scenarios in Sections 6.2.6 - 6.2.7 that would trigger required reductions in fishing mortality may result in the establishment of a closed season or area in 6.3, which could benefit yellowfin grouper.

6.5.7 Alternative 7 (Preferred). Close the Grammanik Bank to all fishing from February 1 to April 30 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18º 11.898' N, 64º 56.328' W; 18º 11.645' N, 64º 56.225' W; 18º 11.058' N, 64º 57.810' W; and 18º 11.311' N, 64º 57.913' W.

This alternative would define an area of approximately 3.0 km (1.62 nm) by 0.5 km (0.27 nm), resulting in a 1.50 km^2 (0.44 nm^2) area in which fishing would be prohibited from February through April. The reported spawning aggregation would be centered within this closed area.

6.5.7.1 Direct and indirect effects on physical environment and their significance

This alternative would be expected to have similar effects to the physical environment as those described in Sections 6.3.3.1 and 6.5.2.1. Similar to Alternative 3, this alternative would offer protection to the physical environment (primarily through limiting fishery-related impacts to EFH) during the three-month closure, but over a very limited area.

6.5.7.2 Direct and indirect effects on biological and ecological environment and their significance

This alternative would be expected to have similar effects to the biological environment as those described in Sections 6.3.3.2 and 6.5.2.2. Similar to Alternative 3, this alternative would offer extensive protection to the biological environment (primarily through limiting fishery-related impacts to EFH) during the three-month closed area. While the entire documented spawning period for yellowfin grouper would be encompassed in this alternative, it is unclear if the extremely small size would offer sufficient protection to any aggregation, especially considering the intensified fishing that would be expected along the boundaries of the closed area. For example, along the northern and southern boundaries, boats will be no further than 250 m (820 ft) from the center of the closed area. Furthermore, the benefits to other managed species and to coral habitat would most likely not be significant due to the limited size of the proposed closure. Fishing impacts and resource exploitation that might be intensified before and after the closure might negate any ecological benefits that this alternative could produce.

6.5.7.3 Direct and indirect effects on social and economic environment and their significance

The social and economic impacts associated with this alternative are fully contained within the discussion associated with Alternative 2 in Section 6.5.2.3. Therefore, no further discussion is provided here.

6.5.7.4 Direct and indirect effects on administrative environment and their significance

This alternative would be expected to have similar effects to the physical environment as those described in Sections 6.3.3.4 and 6.5.2.4. However, due to the extremely small size, enforcement of the closed area will be complicated. With a width of only 500 m (1,640 ft), a boat could easily encroach in and out of the area in a short amount of time. The short distance also allows a boat poaching in the closed area to quickly flee outside of the boundaries should an approaching boat be observed.

It should also be remembered that there are alternatives in other sections that could remedy the biological status of yellowfin grouper and supersede this action. For example, the control rules scenarios in Sections 6.2.6 - 6.2.7 that would trigger required reductions in fishing mortality may result in the establishment of a closed season or area in 6.3, which could benefit yellowfin grouper.

6.5.8 Alternative 8. Prohibit the harvest and possession of yellowfin grouper in the U.S. EEZ, in conjunction with the closure of the Grammanik Bank.

This alternative would be encompassed by Preferred Alternative 2a proposed in Section 6.3.2.

6.6 Achieving the MSFCMA bycatch mandates

6.6.1 Bycatch reporting

Currently, there are no FMP requirements for permits in the recreational, commercial, and/or for-hire sectors in the EEZ off Puerto Rico and the USVI. Permitting would be essential to identify participants in the fishery, and would also be necessary in order to establish a standardized bycatch reporting methodology, which is a MSFCMA mandate. However, both Puerto Rico and the USVI do have permitting requirements, and have indicated a willingness to collect the bycatch information on behalf of NMFS.

6.6.1.1 Alternative 1. No action. Do not establish a standardized bycatch reporting methodology program in the U.S. Caribbean.

Matos-Caraballo (1997) documented that 81% of Puerto Rican fishermen surveyed in 1995-1996 (i.e., 1,417 out of 1,758) had a DNER fishing license. Recent changes to the Puerto Rican fishing regulations now require licenses for all commercial fishermen with mandatory reporting requirements, as well as license requirements for recreational fishermen. The USVI also requires licenses for commercial fishing activities. Although the current data collection system in place in the U.S. Caribbean does not require commercial or recreational fishermen to report bycatch data, Puerto Rico has agreed to require that this information be reported and the USVI already has incorporated bycatch data into their reporting requirements.

6.6.1.1.1 Direct and indirect effects on physical environment and their significance

This alternative would obviously not result in the introduction of any further direct effect to the physical environment that does not already exist under the status quo. Management actions that affect fishing activities, in particular the type of gear used and how it is used, as well as the amount of allowable fishing pressure (i.e., landings) would be just some of the actions that could alter or introduce the physical environment. However, being that no additional management action is being taken under this alternative, it would not result in any direct or indirect physical impacts.

6.6.1.1.2 Direct and indirect effects on biological and ecological environment and their significance

Failing to implement a bycatch reporting program would have no immediate positive or negative biological or ecological impact. However, continued failure to document bycatch, to the extent that it occurs in the Caribbean, would leave scientists/managers unable to develop reliable estimates of total fishing mortality for Council-managed species. Overestimating bycatch could lead to the implementation of potentially overly precautionary management measures designed to provide additional protection to bycatch and other species. Underestimating bycatch could adversely affect the biological status of fish taken as bycatch and associated species. Further, failing to implement a bycatch reporting program could lead to adverse effects on species protected under the ESA and MMPA being undetected.

For some fisheries, primarily the queen conch fishery, a lack of bycatch reporting would not result in any direct or indirect biological impacts in the short or long term. The queen conch fishery is a hand-harvest fishery, that results in no bycatch. Furthermore, the aquarium trade under the Reef Fish and Coral FMPs also are highly selective, and would not be expected to have any associated bycatch issues. However, the trap fishery under the Reef Fish FMP could be associated with bycatch issues, although anecdotal information suggests that bycatch is minimal since the majority of the harvest is retained by fishermen.

6.6.1.1.3 Direct and indirect effects on social and economic environment and their significance

Continued failure to document bycatch and bycatch mortality would leave scientists/managers unable to develop reliable estimates of total fishing mortality for Council-managed species. Overestimation of bycatch could lead to the implementation of potentially overly precautionary management measures than are otherwise warranted; the effect being adverse socioeconomic consequences that are unnecessarily severe. Underestimating bycatch would adversely affect the biological status of fish taken as bycatch. This would negatively impact fishery participants and communities in the long run.

6.6.1.1.4 Direct and indirect effects on administrative environment and their significance

It is possible that currently established programs could be utilized or enhanced to provide necessary information on bycatch. Data collected through the established trip ticket system could be "ground-truthed" through fishery independent-surveys and/or random onboard observations. While this option may be unlikely given the current level of funding, it would most likely be more cost-effective than implementing a new permit system as proposed in Alternative 2. It could also address some of the other socioeconomic and administrative issues of Alternative 2, such as the language barrier and user buy-in. The SEAMAP database could also be used to provide additional bycatch information on the commercial sector.

This alternative would relieve NMFS/Council/state governments of some of the costs associated with establishing a reporting program. Due to the nature of the Caribbean fisheries, anecdotal information suggests that most of the commercial harvest, regardless of the species, is utilized by fishermen. Regardless, it would appear to violate §303(a)(11) of the MSFCMA.

6.6.1.2 Alternative 2. Develop and implement a federal permit system for commercial and charter boat fishermen participating in Council-managed fisheries, with an associated mandatory monthly reporting requirement.

Permits would be required for the Reef Fish, Queen Conch, and Spiny Lobster FMPs. While the Council's preferred management alternative is to prohibit the harvest and possession of queen conch in the EEZ (Section 6.4.3.2.2), a permit for the Queen Conch FMP would eventually be necessary to establish a universe of fishery participants, should the fishery re-open in the future. A permit for the Coral FMP would not be needed since the harvest of most corals is prohibited, and the preferred alternative for the aquarium trade species is retention in a data collection category (Section 6.1.2.2).

Additional background information on the permitting process is available in Section 4.6.1.2.

6.6.1.2.1 Direct and indirect effects on physical environment and their significance

This alternative would not result in any direct impacts to the physical environment. However, there could be some indirect impacts associated with this action, should future reports indicate that bycatch is a problem, which could result in an associated management action. For example, if the reporting indicated a high level of bycatch of an ecologically-sensitive species in the fish trap fishery, subsequent action to limit or prohibit the fish trap fishery could benefit the physical environment.

6.6.1.2.2 Direct and indirect effects on biological and ecological environment and their significance

Permitting fishery participants and establishing an associated mandatory reporting requirement could benefit marine ecosystems in the U.S. Caribbean by providing better information on bycatch and total fishing mortality rates. Data on total fishing mortality would assist the Council/NMFS with deciding what measures are necessary to sustain fishery resources and associated species over the long term. However, fishermen in the U.S. Caribbean generally retain the majority of their catch, therefore the impacts of bycatch would appear to be minimal. A noted exception to this would be the bycatch of ciguatoxic species. Additionally, implementing a federal permit system with an associated mandatory standardized bycatch reporting methodology in the reef fish fishery and spiny lobster fishery would be beneficial for evaluating protected species bycatch.

A permit system would not produce any positive or negative impacts in regard to some fisheries, such as the queen conch fishery. Since fishermen harvest conch by hand, and the species are not prone to be efficiently caught by other methods (e.g., trap), a reporting system that includes bycatch information would be of little benefit to this fishery. Furthermore, when considering that the Council's preferred alternative to rebuild queen conch is to close the conch fishery in the EEZ, a permit and reporting system for this FMP would not result in any useful data.

It should be noted that without compatible standardized bycatch reporting methodology in state waters, this alternative would not likely be effective. The majority of fishing activity occurs in state waters, and, therefore, it is unlikely that much information would be gained from an exclusive federal permit and reporting program.

6.6.1.2.3 Direct and indirect effects on social and economic environment and their significance

A new and potentially redundant permitting system may not be well-received by fishermen, particularly if that system requires communication with NMFS personnel not within close proximity to the fishery. Given that the majority of harvest occurs in state waters, it is unclear how beneficial this alternative would be. Unless the states also require mandatory bycatch reporting, this alternative would result in little benefit. Furthermore, due to the enforcement issues in the U.S. Caribbean, there may not be much incentive for some fishermen to pay for a federal permit or to submit accurate logbook information. The incentive for fishermen to purchase a federal permit for queen conch is even more questionable, given that the federal fishery may be closed for the foreseeable future.

NMFS is authorized to charge administrative fees for permit issuance, renewal, or transfer. The direct cost of obtaining a federal permit under the current SERO permitting process is estimated at $50 per permit (Sutter, pers. comm.). The current SERO application form is relatively complex and currently requires the submission of vessel characteristic data (e.g., horsepower, gross tonnage, net tonnage, hull identification number, hold capacity, corporation shareholder information, lease information). The administrative fee payment is not retained by NMFS, and instead is forwarded to the U.S. Treasury. Completion of the current SERO permit application form takes between 20 minutes and 60 minutes, depending on the complexity of the supporting documents.

A simpler application form (see Appendix C), requesting only vessel name or identification number, length, and vessel owner contact information, would be less expensive to administer, and therefore would provide a lower administrative fee per permit, roughly $10-$20/permit (Sadler, pers. comm.). Such an application would take only a few minutes to complete. This may be more appropriate, at least initially, for the Caribbean fisheries given the fact that a typical fishing vessel in Puerto Rico is uninspected by the USCG, and is less than 22 feet in length (Matos-Caraballo 1997). Information on horsepower, tonnage, and capacity would not be applicable to these vessels.

It is unclear how recreational fisheries would be permitted. Should a federal permit be issued to an individual versus a vessel (refer to Section 6.6.1.2.4), the system may not be effective for visiting (i.e., tourists) recreational fishermen on vacation. While it could be applied to charter vessels, permitting individual recreational fishermen may result in reduced recreational fishing in federal waters due to the burden of applying for a permit on short notice, or, conversely, lead to an increase of fishing activity that is not in compliance with fisheries regulations. However, most visiting fishermen fishing in federal waters would most likely be operating off a charter vessel and targeting pelagic species such as billfish, dolphin, and wahoo, instead of reef fish species.

Due to the separation of the state and federal permitting and reporting process, fishermen may be compelled to purchase GPS equipment, in order to ascertain if they are indeed fishing in federal waters. While a GPS unit can be purchased for approximately $200, the overall costs to the fishery can not be estimated since it is not clear how many fishermen would end up purchasing a GPS unit.

Permitting federal fishery participants and collecting data on catches and discards in federal waters could provide the Council/NMFS with improved data on: 1) participation in the fishery; 2) bycatch composition and amounts; and 3) an estimate of total fishing mortality. Data on the universe of participants in the fishery would assist the Council/NMFS with future decisions related to capacity reduction (e.g., trap reduction program, buyback) and/or effort reduction measures (e.g., trip limits, days-at-sea). Data on total fishing mortality would assist the Council/NMFS with deciding what measures are necessary to sustain fishery resources and associated species over the long term. Both could result in positive and negative socioeconomic impacts.

Sorting through and documenting catch before it is discarded would present fishermen with an additional time-cost burden, which could potentially result in a short-term reduction in revenues.

Accurate species identification could also be complicated, especially considering variety of local vernacular. But that is unlikely if bycatch in these fisheries is as minimal as expected. In any event, this alternative, which would require fishermen to complete an additional catch report, or logbook, to document catches in federal waters, would probably present a greater burden than would modifying the existing trip ticket system to accommodate this data collection effort. Any short-term losses in revenue are expected to be outweighed by the long-term benefits associated with better fishery management resulting from improved data and information.

Improved bycatch data could result in both positive and negative socioeconomic impacts in the short term. For example, data identifying bycatch “hotspots” could lead to seasonal or area closures. Further, should a particular gear be associated with excessive bycatch, future management actions may impact that segment of the fishery. Positive impacts could result from improvements in the efficiency of individual boats that were directed to areas where they would land less bycatch. Negative impacts could result from being redirected to areas that were less productive overall. In theory, the long-term benefits associated with more sustainable management would be expected to outweigh any adverse impacts that occur in the short term.

Should the Council ever want to explore a limited access system or capacity reduction program for any managed fishery, a federal permit system could produce the necessary universe of fishermen from which to construct such a system. Capacity reduction programs could lead to a short-term reduction in revenue for those fishermen who are required to reduce effort. But those impacts would be expected to be offset by increased productivity over the long term. Programs that reduce the number of people participating in the fishery could severely adversely impact those who were excluded – in the short and long term. But those impacts could be offset through program design (e.g., buyback). It should be noted that a compatible action by the states would be necessary to ensure the success of a capacity reduction or limited access program.

Establishing permits for the specific (or even secondary) purpose of limiting access or reducing capacity presents some issues worth considering. The availability of an open-access federal permit with the prospect of a potential limited access could drive some individuals who have no history in the fishery, or encourage more part-time fishermen, to obtain these permits. Further, should the queen conch fishery be closed in federal waters, per the Council’s preferred alternative, it is highly likely that this fishery will not be rebuilt without the states significantly curbing catch in their waters. The rebuilding period for queen conch could very well be on the scale of decades, even with significant state action. Given that the average age of a Puerto Rican fisherman is in the mid- to late-forties (Matos-Caraballo 1997), the benefit of a queen conch permit for use in establishing a future limited access system is questionable.

With respect to commercial fishermen, a new permitting system may not be well received for several reasons, not the least of which is the cost. Given the fact there would be virtually no means of verifying (or enforcing) the bycatch information recorded on the attached mandatory monthly reporting forms, one can hypothesize that the information provided (if any) would likely be highly unreliable, thus having little or no value for management purposes. Furthermore, given the fact that the majority of harvest occurs in state waters, one would anticipate little benefits from such a bycatch reporting system unless the state governments implemented a compatible bycatch reporting system. Finally, the MSFCMA defines bycatch as those fish which are harvested in a fishery, but which are not sold or kept for personal use. Available information indicates that the majority of the catch is retained and would, therefore, not be considered as bycatch. If this available information is correct, one might question the need for any bycatch monitoring system in the commercial sector.

While the permit system would likely provide little or no useful bycatch information that could be used in the management process (i.e., address MSFCMA requirements), it could, conceivably, provide useful information to help manage Council-managed species.[27] First, it would provide some estimate of the population of commercial fishermen that utilize the EEZ. Second, to the extent that directed catch from federal waters is accurately reported, the Council would have additional information to be used in the management process.[28] Finally, a prerequisite for any limited entry program in federal waters is a permitting system. However, as previously discussed, the benefits of a limited entry program that occurs only in federal waters are probably quite limited.

Finally, some discussion of the recreational sector is warranted. Permitting in the recreational sector (excluding charter boats) would likely be extremely burdensome and there would be virtually no incentive for this group to submit any mandatory reporting forms. There is little information on recreational fishing activity for Council-managed species in the EEZ, though information garnered at a March 11, 2004 CFMC Advisory Panel meeting in San Juan indicates that the majority of charter and recreational fishing activity in federal waters is concentrated on HMS and pelagic species. Hence, benefits to Council-managed species would likely be negligible.

6.6.1.2.4 Direct and indirect effects on administrative environment and their significance

The Council previously decided to issue permits to fishery participants to begin the process of better managing fishing effort. The discussion surrounding this new permitting system was initiated in response to problems primarily in the reef fish fishery, though the intent was to design a system that would include all fisheries operating in the EEZ. It should be noted that a permit would not be required for the Coral FMP, and that there are significant issues with the practicability of implementing a federal permit for the queen conch fishery.

Currently, both the USVI and Puerto Rico have mandatory commercial permitting and reporting systems in place. Prior to 2004, the Puerto Rican reporting system was voluntary. However,

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27 This presupposes, of course, that commercial fishermen can accurately ascertain distance from shore (i.e., a prerequisite of knowing whether fishing activity is occurring in federal waters). If not, GPS systems may be needed which would be an additional cost to the fishermen.

28 In general one might expect substantially better reporting of directed catch by commercial fishermen then bycatch. However, the lack of traditional marketing channels (particularly in the USVI) suggests that compliance may be relatively low since there would be no mechanism for verifying information (or lack thereof).

according to a census conducted by Matos-Caraballo (1997) compliance with the voluntary license program increased from 64% in 1988 to 81% for 1995-1996. Obviously, there are undocumented, unlicenced participants in the commercial fishery. Yet, due to the abundance of habitat in state waters there are probably few, if any, fishermen that fish exclusively in federal waters for CFMC-managed species, and it is likely that the majority of these fishermen are already captured in the state programs.

The permit costs (estimated at $10-20 for a rudimentary permit) and processing time (estimated at approximately one month) make it impractical to permit fishermen through the SERO permitting office. This alternative would place the administrative burden for collecting bycatch data on NMFS, including designing, printing, and distributing permits and logbooks, and collecting, computerizing, and analyzing bycatch data. If the state offices administer the federal permit system, those offices could distribute applications/permits. This would be extremely efficient since the fishers periodically visit the local offices for vessel registration issuance.

The existing SERO permitting system resources may be inadequate to implement the Caribbean permit requirements, based on the following calculations. While it is unclear how many Caribbean fishermen would apply for a federal permit, based on Matos-Caraballo's (1997) census, there were approximately 3,500 licensed fishermen in 1995-1996 just from Puerto Rico. Coupled with USVI fishermen, as well as those participants in the for-hire sector, and there could potentially be several thousand applicants for federal permits. This would cause a major re-tooling of the automatic renewal processes, even if relatively few permits are actually issued. Set up costs are estimated at $15,280.80 (160 hours at $43.55/hour; 120 hours at $57.79/hour; 40 hours at $34.45/hour, including salary and benefits). Processing costs for the initial issuance phase (when administered at SERO) are estimated at $22,978 (667 hours at $34.45/hour, including salary and benefits).

Additional modification of the SERO database to include the Caribbean permits will require translation of the permit application and regulation updates into Spanish, which will be an ongoing cost of $3,582.80/year (108 hours/year at $34.45, including salary and benefits). SERO will also need in-house resources (paper, dictionaries, etc.) for system modification to publicize the new permitting requirements using the Spanish language; none of the permitting documents are currently translated into Spanish or other non-English language, and there are no bilingual personnel on the SERO Permits Team.

All of the current SERO-issued vessel permits are printed on 8.5 by 11 inch paper, and typically list several permit types per page (other permit sizes cannot be readily issued under the existing system). Since that paper is used for multiple permit types, inclusion of the Caribbean permits in the SERO permit system would also require modification of the paper to allow for Spanish translation. However, if the system is administered outside of the SERO, it would be feasible to issue vessel permits in the form of laminated cards to facilitate fishery acceptance and enforcement.

Permitting *via* the internet (website application) or telephone cannot be used at this time since paper copies of vessel/operator documentation must be collected before these types of permits can be issued. The SERO permitting program is not yet set up to automatically distribute application forms over the internet or telephone voice mail; therefore, those communication pathways are impractical for distribution in the Caribbean. Moreover, fishers in Puerto Rico and the USVI are not accustomed to mail communication with SERO. Therefore, the standard application process and available mail distribution methods may present problems when issuing Caribbean fishing vessel permits from SERO. The unique social and cultural framework of the fishing community in the Caribbean indicates that a simple permitting requirement (without transfers) will be the most beneficial option at this time.

A simpler federal permitting system at the state vessel registration offices would be more effective, since the fishers must obtain registration materials for their vessel at those offices at a periodic basis. The local government could receive supportive funding *via* a cooperative agreement with NMFS. The existing personnel at those offices are fluent in Spanish and the local dialects, and most likely would be more readily accepted by the fishery participants. Since the fishers would be obtaining/renewing a new vessel registration at the office, problems with outdated registration would be minimal. Further, the vessel registration materials would already be available at those offices, such that applicants would not have to make copies of those materials for transmittal to NMFS. Local administration of the federal permit system would eliminate the re-tooling costs and translation costs described above, and would reduce the setup costs to $3,479 (60 hours at $57.79/hour, including salary and benefits). Processing costs that NMFS would provide to Puerto Rico and USVI for the initial issuance phase (when administered in local offices) are estimated at $22,978 (667 hours at $34.45/hour, including salary and benefits.) The local office salary and benefits associated with the permit processing, and incidental hardware/software costs, cannot be readily estimated.

The agency could require that catch logbooks be mailed to the SEFSC on a monthly basis. This would put an additional burden on SEFSC staff to compile the reporting data, as well as a burden on fishermen in the U.S. Caribbean due to mailing to the U.S. However, NMFS could increase funding to the states under the State/Federal Cooperative Fisheries Statistics Program, with a request that these data be submitted to the SEFSC annually, along with those collected under the state trip ticket programs. NMFS currently contributes $78,900 and $73,000 to commercial fisheries data gathering efforts in Puerto Rico and the USVI, respectively.

A training and education program, if adopted, would present additional costs, but would be expected to improve the reliability of data. Such a program should include information on what constitutes bycatch, how to identify species and/or species groups, and how bycatch data can improve fishery management. However, in theory, all expenses associated with this option are expected to be outweighed by the benefits of better/more efficient management. Potential impacts arising from the language barrier may also present significant issues to the administrative environment. Applications, permits, and logbooks would most likely be needed in both English and Spanish. Furthermore, reporting and dissemination of the data could be complicated, unless those compiling the information on permit applications and monthly reporting forms were bilingual.

Fishermen may be reluctant to report discards for fear that honest reporting may lead to more restrictive regulations. Catch report/logbook data could be "ground-truthed" through fishery independent-surveys and/or random onboard observations, though that may be unlikely given the current level of funding. A required retention program presents another alternative. But such a program would need to donate landed discards to a food bank or something similar so as not to provide an incentive to target prohibited or undersized species. And that would result in difficulties because, once landings arrive at port, it's not possible to determine if they were taken in state waters where regulations are less restrictive. Even with consistent regulations in federal and state waters, neither NMFS nor the states have sufficient manpower in terms of port agents or enforcement agents to ensure that bycatch is retained.

6.6.1.3 Alternative 3 (Preferred). Utilize the MRFSS database to provide additional bycatch information on the recreational and subsistence sectors.

6.6.1.3.1 Direct and indirect effects on physical environment and their significance

This alternative would not result in any direct impacts to the physical environment. Furthermore, it would be expected that the majority of this data would not be applicable to fisheries occurring in federal waters. This is due in large part to the general lack of reef fish habitat in the EEZ, as well as shore-based recreational fishing activity appearing in the data; similar to the commercial fishing activity, the majority of recreational fishing occurs in state waters. Exceptions to this would be fisheries pursuing HMS, dolphin, and wahoo.

6.6.1.3.2 Direct and indirect effects on biological and ecological environment and their significance

Incorporating data on the bycatch of individual recreational anglers and subsistence fishermen into fishery management decision making would benefit marine ecosystems in the U.S. Caribbean by providing managers with more reliable estimates of total fishing mortality and, thus, the information they need to develop regulations designed to sustain fishery resources and associated species over the long term. However, due to the lack of predominance of recreational fishing in state waters (i.e., recreational fishing involving Council-managed species), it is unclear how beneficial MRFSS bycatch information will be to federal management. Further, MRFSS currently does not collect protected species bycatch information, so this alternative would have no immediate impact in that regard. If protected species bycatch questions were added to the survey in the future, however, this alternative may be beneficial for conservation and protection of those species.

6.6.1.3.3 Direct and indirect effects on social and economic environment and their significance

The MRFSS process routinely collects information on discards (both alive and dead) by the recreational fishing sector throughout the continental U.S. and Puerto Rico. Data are not collected on the recreational activities in the USVI, however.

With respect to the MRFSS in Puerto Rico, the program was initiated in 2000. Similar data collection was attempted for the USVI but was suspended due to logistical problems associated with the survey. Approximately 2,786 field intercept angler observations were collected in Puerto Rico in 2000. At approximately 4.5 minutes per intercept, total burden time is approximately 209 hours. The random digit dialing telephone component of the survey takes approximately 7 minutes per interview.

Since discard data are being collected for Puerto Rico, this information would be readily available to be used in furtherance of this alternative and the only costs would be processing it in a manner suitable for routine bycatch monitoring in the recreational sector. Since no system currently exists in the USVI, however, there would be significant costs associated with implementing a compatible program and it would be questionable as to whether the information collected on bycatch would be worth the costs. However, the MRFSS survey collects a significant amount of other data that are useful for management purposes. Obviously, the more systematic and comprehensive the recreational data collection system, the greater the ability to properly identify dependencies on fishery resources and industries and minimize adverse affects on industries.

6.6.1.3.4 Direct and indirect effects on administrative environment and their significance

The costs (estimated at $10-20 for a rudimentary permit), processing time (estimated at one month), and location of the SERO permitting office make it impractical to permit individual recreational anglers and subsistence fishermen (Sutter, pers. comm.). However, to have comprehensive coverage of all fishery sectors, this alternative could be selected in addition to Alternative 2 to ensure that the bycatch of individual recreational anglers and subsistence fishermen is monitored in addition to that of commercial and charter boat fishermen.

The MRFSS program has several deficiencies that limit its ability to provide accurate data on recreational catches in the U.S. Caribbean. Coverage is not currently comprehensive, as the program collects data through telephone surveys of households in coastal counties and intercept (i.e., interview) surveys of anglers at fishing access sites. Participation in the program is voluntary. Currently, information on Puerto Rico fisheries must be extrapolated to USVI fisheries, as the MRFSS program was discontinued in the USVI in 2001. The costs could be considerable to re-institute USVI coverage, however, this would be the most feasible way to obtain accurate information on the USVI recreational fishery. Regardless of the deficiencies of

MRFSS, there are no programs currently in place (or capable of being implemented) that could provide more reliable data on recreational fisheries in the U.S. Caribbean.

6.6.1.4 Alternative 4 (Preferred). Consult with Puerto Rico and the USVI in an effort to modify the trip ticket system currently in place in the U.S. Caribbean to require standardized collection of bycatch data.

The current trip ticket systems were established in 1967 and 1974 in Puerto Rico and the USVI, respectively. Both programs have experienced a series of periodic lapses over the years, as well as significant under- and/or misreporting, and changes in the type of data collected (Valle-Esquivel 2002). Landings in the USVI were historically reported by gear group (e.g., pot fish; net fish), while those in Puerto Rico were reported by species or species groups (e.g., Nassau grouper; grouper). Presently, landings in both territories are recorded at the species or species-group level. Commercial catch reporting is mandatory for both Puerto Rico and the USVI. Fishermen report landings in Puerto Rico and the USVI to the Puerto Rico DNER and the USVI DFW, respectively. Both state agencies are supported by NMFS through the State/Federal Cooperative Fisheries Statistics Program. Currently, Puerto Rico does not collect bycatch data, but the USVI initiated rudimentary bycatch reporting (i.e., pounds of bycatch by gear type) in 2004. Therefore, effort would be directed on modifying Puerto Rican landings reports to include consistent and standardized bycatch data. Both Puerto Rico and USVI have agreed to collect bycatch data for NMFS. Data collection programs modified to collect bycatch data would continue to be funded, at least in part, through the NMFS grant process.

Monthly landings data for Puerto Rico are collected from fishers, fish buyers, and fishing associations by DNER port agents (four at the moment), and the program's principal investigator at 88 fishing centers in 42 coastal municipalities, including the islands of Vieques and Culebra. Prior to 2004, participation in the data collection program was voluntary, though DNER estimated that the majority of commercial fishermen participated in the program. A 1995-1996 census of Puerto Rican fishermen stated that 81% of licensed fishermen participated in the program (Matos-Caraballo 1997). Data fields on Puerto Rico's trip ticket form include fishing date; name of fish buyer, fisherman and/or helper; fishing license number; municipality; fishing center (landing area); number of trips reported; gear type; fishing effort (hours fishing); weight in pounds by species or taxonomic family; market value; depth; and fishing area (less than or greater than 10 miles from shore). Tickets use common names, and species identification is possible using Erdman's (1985) numeric codes. Data are computerized by DNER and submitted to NMFS in raw form on an annual basis (Valle-Esquivel 2002).

Landings data for the USVI fisheries are mailed or delivered to DFW on a monthly basis. DFW requires that all reports for a 12-month period (July to June) be submitted before renewing a commercial fishing license. The current trip ticket form, which was expanded to the entire territory between 1997 and 2000, requests data on family or species group harvested; gear type (hook and line, net, pot/trap, and dive); an estimate of fishing effort (the number of gear and the estimated time in hours fished during the trip); and area fished, including distance from shore (i.e., less than 3 miles, 3-200 miles, or greater than 200 miles) and location. The DFW computerizes and verifies data, and submits datasets to NMFS on an annual basis. Landings in St. Croix and St. Thomas/St. John are maintained in separate datasets (Valle-Esquivel 2002).

Both the specificity and accuracy of the data collected through the trip ticket systems is believed to have been improving in recent years. However, fishermen seldom complete the data fields that indicate what portion, if any, of their catches was taken from the EEZ. Consequently, fishery managers generally cannot always distinguish between catches taken from federal and state waters (Valle-Esquivel, pers. comm.).

In order to establish a standardized bycatch reporting methodology for the U.S. Caribbean, efforts to add data fields to Puerto Rico trip ticket forms would be required. While species-specific information on discards would be valuable, a rudimentary data field could simply request bycatch information in pounds or numbers of fish, which is the current methodology in the USVI. Additionally, protected resource interactions could be added as a separate data field in the future. More extensive reporting could be possible, but would add additional burden to the fishermen, and might not be practical given the size and scope of the fishery. That is, due to the predominance of small, open-hulled boats in U.S. Caribbean fisheries, retention of bycatch for more intensive reporting such as recording species or lengths is likely to be impractical.

6.6.1.4.1 Direct and indirect effects on physical environment and their significance

Similar to Alternatives 2 and 3, this alternative would not result in any direct impacts to the physical environment. However, there could be some indirect impacts associated with this action, should future reports indicate that bycatch is a problem, which could result in an associated management action. For example, if the reporting indicated a high level of bycatch of an ecologically-sensitive species in the fish trap fishery, subsequent action to limit or prohibit the fish trap fishery could benefit the physical environment.

6.6.1.4.2 Direct and indirect effects on biological and ecological environment and their significance

Biological and ecological impacts associated with this alternative are expected to be similar to those discussed for Alternative 2 in Section 6.6.1.2.2. Therefore, they are not repeated here.

6.6.1.4.3 Direct and indirect effects on social and economic environment and their significance

Socioeconomic impacts associated with this alternative are expected to be similar to those discussed for Alternative 2 in Section 6.6.1.2.3. However, Preferred Alternative 4 would likely result in significantly less social and economic impacts than Alternative 2. Since the currently existing programs have been implemented for more than 30 years, acceptance by fishermen is likely to be greater than to a new system, such as that proposed in Alternative 2. Modifying the existing trip ticket system to accommodate this data collection effort would likely present less of a burden that would result from requiring fishermen to submit a separate data report for catches in federal waters. That is especially true considering that the USVI already has incorporated bycatch data into their reporting requirements. Furthermore, this alternative would require less expenditure of time (i.e., reporting burden) since fishermen would only be conducting one State/Federal reporting requirement versus having two separate reporting responsibilities. Finally, as with any alternative that would require a clear determination of whether fishing activities were occurring in state or federal waters, this alternative might require fishermen to purchase a GPS system (with the cost of approximately $200).

However, as with a federal permitting system that would require information on bycatch, one must question the accuracy (as well as compliance) of information collected using any modified trip ticket system (i.e., Alternative 3). If compliance is low or if the data collected are not relatively accurate, benefits to the management process associated with use of the bycatch data in the management process may be extremely limited. In the extreme, the data may lead to additional management regulation that is not warranted or, vice versa, a lack of management regulation that would be warranted. Regardless, this alternative is likely to represent the smallest burden to fishermen, and is likely to be the most successful bycatch reporting alternative at this interim in the U.S. Caribbean.

6.6.1.4.4 Direct and indirect effects on administrative environment and their significance

While the administrative impacts associated with Preferred Alternative 4 would be similar to those discussed in Section 6.6.1.2.4 for Alternative 2, the extent of those impacts would be much less significant. The language issues (e.g., permit application, logbook, and data entry) associated with Alternative 2 would not be experienced under this alternative. While there would still be funding needs to enhance the existing reporting system, it is expected that all of the permitting and reporting alternatives in this section would require additional funding. However, this alternative would likely offer the most cost-effective scenario. The West Pacific Fishery Management Council opted for a similar action in their Coral Reef Ecosystem FMP. Due to very similar insular issues revolving around the various territorial reporting scenarios, low levels of current bycatch, and that the majority of fishing activity occurs in those waters (versus in federal waters), the WPFMC preferred to rely on continued territorial reporting in lieu of implementing a unique federal system. Unlike the WPFMC course of action, this alternative would actually result in the modification of the existing reporting forms (i.e., Puerto Rico reporting forms) to suffice the MSFCMA requirements.

This alternative would place the administrative burden for collecting bycatch data on the state governments, including redesigning, reprinting, and redistributing trip ticket forms, and computerizing additional data. In doing so, it would resolve some of the bilingual issues associated with Alternative 2. Additionally, the required funding for this alternative would obviously be less than that required to design and implement a totally new federal permitting system (i.e., Alternative 2), while still supplementing the state data efforts. The USVI recently implemented changes to their reporting requirements and are currently requiring bycatch information from commercial fishers. NMFS currently contributes $78,900 and $73,000 to commercial fisheries data gathering efforts in Puerto Rico and the USVI, respectively.

A number of deficiencies in the current trip ticket system would need to be addressed to support bycatch reporting at a level sufficient to meet the MSFCMA mandate. Action would need to be taken to ensure that all data fields, including the field differentiating catches in federal versus state waters, are completed; it may be possible to improve the data return from fishermen through an outreach and education program, similar to what is proposed under Alternative 2 to improve data on species identification. Additionally, the expanded trip ticket system would only provide information on commercial landings. Currently, there are no requirements to report recreational catches in state or federal waters, though the expansion of MFRSS (i.e., Alternative 3) could remedy this issue.

NMFS would face increased costs associated with analyzing bycatch data for U.S. Caribbean fisheries. A training and education program, if adopted, would present additional costs, but would be expected to improve the reliability of data. Such a program should include information on what constitutes bycatch, how to identify species and/or species groups, and how bycatch data can improve fishery management. However, all expenses associated with this option are expected to be outweighed by the benefits of better/more efficient management.

Fishermen may be reluctant to report discards for fear that honest reporting may lead to more restrictive regulations. Trip ticket data could be "ground-truthed" through fishery independent-surveys and/or random onboard observations. However, that would require additional funding in order to be implemented.

6.6.2 Minimizing bycatch and bycatch mortality to the extent practicable

There are scant data on commercial and recreational bycatch in the U.S. Caribbean region, however, based on anecdotal information and local fishery management officials' experience, byctach is de minimus in the U.S. Caribbean. Rosario Jimenez (1993) estimated, based on fishery-independent data from the SEAMAP-Caribbean program collected off the west coast of Puerto Rico, that about 14% by number and 17% by weight of the fish caught in the commercial hook and line fishery are species with low market value, including squirrel fishes, butterfly fishes, doctor fishes, puffers, filefish, and scorpionfish. But anecdotal information suggests that the vast majority of fish harvested in the U.S. Caribbean are retained for the market or for personal use - including species with low market value. With the exception of species that are commonly believed to be ciguatoxic, economic discards in this region appear to be minimal. Bycatch of protected species (e.g., sea turtles) in the U.S. Caribbean are unknown.

Regulatory discards may include the following species:

- Nassau grouper. Federal law requires that Nassau grouper caught in the EEZ be returned to the water (catches of Nassau grouper in USVI waters are not regulated);
- Goliath grouper. Federal law requires that Goliath grouper caught in the EEZ be returned to the water;
- Butterfly fish. The harvest of some species of butterfly fish (*Chaetodon* spp.) is prohibited in federal waters (Butterfly fish are also a prohibited species in the state waters of Puerto Rico. The USVI has permitted the catch of a small number of these species for scientific research/educational purposes);
- Sub-adult yellowtail snapper. Federal law requires that catches of yellowtail snapper under 12 inches in fork length be returned to the water (Yellowtail snapper have a 10.5 in minimum size limit, but are not regulated in USVI waters); and
- Sub-adult and berried spiny lobster. Federal law prohibits the retention of spiny lobster under 3.5 inches in carapace length and berried spiny lobsters (there are similar regulations in state waters).

Bycatch and/or discards of queen conch is not expected to be a significant issue in the Caribbean. This is due to the nature of the selective hand-harvest fishery for queen conch, as well as the general inability for queen conch to be harvested (i.e., bycatch) by other types of gear, such as fish traps.

The extent of these regulatory discards is unknown. The regulatory requirements forcing fishermen to discard these species are difficult to enforce because regulations are generally less restrictive in state waters. Therefore, in many cases, enforcement would be unable to pursue a case once a vessel is in state waters or at the dock. The mortality rates associated with commercial and recreational bycatch are also unknown, but generally increase with depth (e.g., finfish taken from deeper water generally have a lower survival rate when returned to the water).

In determining the practicability of minimizing bycatch and bycatch mortality, the National Standards provides the following guidance: "(i) A determination of whether a conservation and management measure minimizes bycatch or bycatch mortality to the extent practicable, consistent with other national standards and maximization of net benefits to the Nation, should consider the following factors:

(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 nonconsumptive uses of fishery resources;
(I) Changes in the distribution of benefits and costs; and
(J) Social effects.

(ii) The Councils should 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 any of the factors listed in this paragraph (d)(3)" (50 CFR §600.350(d)(3)).

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. However, referring to the above guidance for implementing actions to reduce bycatch, it would appear that significant action would not be practicable, in large part due to the lack of significant amounts of bycatch (due to retention and utilization of the catch). Regardless, the Council proposed several alternatives for subsequent analysis and potential implementation.

6.6.2.1.1 Alternative 1. No action. Rely on current management measures to minimize bycatch and bycatch mortality.

Current management measures that impact regulatory discards and discard mortality include minimum mesh size and escape vent requirements for traps. These apply primarily to juvenile and aquarium trade species, and do not necessarily reduce incidental catches of prohibited species, with the exception of those that are small enough to escape through the two-inch mesh. However, some portion of the populations of prohibited species is likely protected by seasonal and area closures established by the Council primarily to protect mutton snapper and red hind spawning aggregations.

This alternative would not result in any effects to the factors outlined by the National Standards not already occurring under the status quo.

6.6.2.1.2 Direct and indirect effects on physical environment and their significance

This alternative would not result in any additional impacts to the physical environment that it not already occurring under the status quo.

6.6.2.1.3 Direct and indirect effects on biological and ecological environment and their significance

The MSFCMA defines bycatch as those fish which are harvested in a fishery, but which are not sold or kept for personal use, and includes economic discards and regulatory discards. Available information indicates that the majority of catch is retained, and would therefore not be classified as bycatch. Furthermore, since the majority of fishing occurs in state waters, it could be assumed that whatever bycatch is occurring, it is probably has a minimal biological effect in federal waters due to the combination of the two above factors.

This alternative is not expected to result in any significant biological impacts to the environment, other that what already occurs under the status quo. Regardless, if economic and/or regulatory discards are having a detrimental impact on U.S. Caribbean fisheries/ecosystems, failure to further reduce discards may have a negative biological and ecological impact (decrease in diversity; declines in abundance; etc.).

6.6.2.1.4 Direct and indirect effects on social and economic environment and their significance

The MSFCMA defines bycatch as those fish which are harvested in a fishery, but which are not sold or kept for personal use, and includes economic as well as regulatory discards. Available information suggests that the majority of catch is retained and would, therefore, not be classified as bycatch. Furthermore, the majority of fishing activities transpire in state waters, particularly in Puerto Rico. Based on these two considerations, it is reasonable to assume that bycatch in federal waters does not significantly influence stock sizes.

Maintaining the status quo regarding measures to minimize bycatch and bycatch mortality is expected to have no direct impact on the human environment. Furthermore, since bycatch in federal waters likely does not significantly influence the sizes of various stocks, one can assume that any indirect impacts on the human environment would be small.

6.6.2.1.5 Direct and indirect effects on administrative environment and their significance

This alternative would not result in any additional administrative impacts, other than those that occur under the status quo. However, if this alternative is selected, it would not result in any potential benefits that could occur by minimizing bycatch.

6.6.2.2 Alternative 2. Increase the minimum allowable mesh size for fish traps.

6.6.2.2.1 Direct and indirect effects on physical environment and their significance

This alternative would not necessarily result in any direct or indirect effects to the physical environment, since it does not address the amount of effort in the trap fishery, or construction of traps that would increase/decrease fishery-related impacts (e.g., weight) aside from changes to the mesh size.

6.6.2.2.2 Direct and indirect effects on biological and ecological environment and their significance

The following addresses the factors A-D outlined in the National Standards for evaluating whether the alternative minimizes bycatch or bycatch mortality to the extent practicable.

This action could potentially have the opposite desired effect, and actually increase bycatch. Appeldoorn and Posada (1992) evaluated the effect of fish trap mesh size and found that while the smaller mesh sizes (i.e., 1.5 inches) caught significantly smaller fish, the largest mesh size (i.e., 2-inch square) accounted for the greatest percentage of bycatch. This was thought to be due to the following reasons: many small species are still commercially important; few large individuals were caught, presumably because of low availability; and the index of bycatch used (species) was crude and did not account for the size of individuals, particularly the presence of juveniles. Rosario and Sadovy (1991) also noticed an increase in bycatch with larger mesh size. Therefore, increasing the mesh size beyond the current two inch square mesh would most likely not significantly decrease bycatch, but it definitely would have a significant negative effect on overall catch rates.

While it would be assumed that an increase in mesh size would reduce regulatory discards of butterfly fish, it is quite possible that this species will continue to be caught unless mesh size is dramatically increased. This is due to the high height-to-length ratio of butterfly fish, and other similar shaped aquarium trade species. Further, many times species that can fit through the current mesh size are harvested nonetheless by fish traps, due to the behavior of the fish. For example, it is not uncommon to see small aquarium trade species darting in and out of traps due to the sheltering effect that traps can provide. Depending on the number of specimens in the trap at the time of gear recovery, species may not extract themselves from the trap before the gear is pulled from the water. This alternative would likely have no impact on protected species (e.g., sea turtles), as they are generally entangled in trap lines rather caught in the trap itself.

Reducing regulatory discards would likely benefit the biological and ecological environment, particularly if discard mortality is high. But anecdotal information suggests that economic and/or regulatory discards are minimal in the trap fishery. In addition, increasing mesh size would not reduce discards of unwanted species, such as those considered to be ciguatoxic, due to their larger size. Nor would it reduce regulatory discards of prohibited species (e.g., Nassau and Goliath grouper) that are taken incidental to fishing operations.

CFMC (2001b) indicates that bottom line gear was responsible for the majority of Nassau grouper landings in 1997 and 1998 (71% and 75%, respectively), followed by fish traps (16%

and 19%, respectively) and gill nets (1.3% and 1.1%, respectively) (CFMC 2001b). It is unlikely that increases in mesh size would benefit Nassau grouper and other large-bodied species, since a minimum mesh size is fairly irrelevant to the these species. Additionally, it would be impractical to increase the mesh size to any significant degree, due to the economic impacts that would result from decreased catch.

Most importantly, it must be remembered that the majority of harvest originates from state waters. Therefore, requiring an increase in mesh size to fish traps in federal waters would not likely result in any significant benefits to bycatch minimization, especially regarding the above example of Nassau grouper and butterflyfish, since the trap fishery would be unaffected in state waters. It is quite possible that fishermen would simply move any trap gear in federal waters to state waters, thus displacing, and possibly increasing, the discard problem inshore.

6.6.2.2.3 Direct and indirect effects on social and economic environment and their significance

The following addresses the factors E-J outlined in the National Standards for evaluating whether the alternative minimizes bycatch or bycatch mortality to the extent practicable.

Due to the lack of specifics regarding the amount by which the minimum allowable mesh size for fish traps would be increased, it is difficult to provide any detailed human environment impact associated with this alternative. Obviously, if the mesh size is increased by such an amount that virtually all fish escape from the traps, social and economic impacts could be significant in terms of lost revenues and, hence, income derived from trap fishing activities. On the other hand, if the allowable minimum mesh size is increased only very marginally, social impacts may be negligible (excluding possible costs associated with retrofitting the traps to the larger mesh). Given the lack of specificity associated with this alternative, only a few generalizations can be made.

The fish trap used in the U.S. Caribbean is, by and large, a non-selective gear being able to capture a large number of reef fish species at any given time/place. One of the few studies evaluating catch by mesh size in the U.S. Caribbean is that by Jimenez and Sadovy (1991) who analyzed mesh size effect along the west coast of Puerto Rico. As stated by the authors, "[s]pecies composition is heavily influenced by mesh size...In general, larger mesh sizes took fewer species. More importantly many species captured with the largest mesh sizes (2" x 3") were of little or no commercial importance. The most important commercial species (snappers and groupers) are captured in fewer numbers by the largest mesh sizes. None of the mesh sizes tested, with the exception of 2" x 3" vinyl coated wire, is likely to achieve one of the main goals in increasing mesh size, to decrease the number of bycatch or 'trash' fish taken. This remained high and fluctuated from 20% to 35% of total catch for all mesh sizes. This result would, however, vary depending on the classification of what constituted bycatch. This classification can vary depending on species availability and market forces (p. 27)."

Evidence does suggest that market forces have changed since the time that the study by Jimenez and Sadovy was conducted. For example, in a recent summary of fishing activities Puerto Rico, Matos-Caraballo (2001) states "[s]everal species discarded by fishers in the past, have now become commercial species (*H. Rufus, Holocanthus ciliaris, Carpilus coralinus*, and *Mythrax spp*). Thus species considered with no market value in the past, are now easily sold at good price today." In a study of the St. John trap fishery, Garrison (1997) reports some trends suggesting relatively large changes in species composition and, indirectly, evidence of decreasing biodiversity. In relation to species composition, the author found that six species accounted for more than 50% of the total catch during the 1992-94 period with blue tang, gray angelfish, and porgies representing the most frequently caught species. The author suggests that the six species represent a far fewer number than reported in earlier studies. Furthermore, the number of blue tang caught in traps increased from six percent in 1992 to more than 30% in 1994. As stated by the author, "[t]he dominance of tangs in this study may be an example of Jenning's and Polunin's (1996) prediction that small, fast-growing species from a lower trophic level would eventually dominate catch as a result of intense fishing pressure. Change in catch composition would result from fishers simply targeting the remaining available species or keeping species previously considered trash fish or bycatch (p.8.)." In short, species once considered as trash or potential bycatch are now routinely sold or kept for personal consumption. Hence, while increasing mesh size may result in a reduction in certain species, such as snapper or grouper (indicating a reduction in revenues), it would likely not reduce bycatch (since there is likely little bycatch).

Having argued the case that increasing the mesh size would likely do little to reduce bycatch but would likely reduce revenues, it is worthwhile pursuing the discussion to its natural conclusion. Specifically, lost revenues may be simply a short-run outcome of increasing mesh size. As stated by Jiminez and Sadovy (1991) "[e]conomic analysis established that although the 1.5" x 1.5" mesh currently likely provides a marginally better economic return to fishermen on a short-term basis, management of the fishery for increased yield on a long-term basis would likely require an increase of the mesh size used on traps to 2" x 2" or more, or even total elimination of trap fishing if wasteful bycatch is to be avoided is to be avoided. A full economic analysis of yield over a long-term basis is needed to establish the most appropriate management approach to enable the best use of Puerto Rico's fisheries resources (p. 27)." While the traps may no longer be catching bycatch, they could certainly be contributing to overfishing/overfished conditions. Ameliorating these conditions –*via* trap reduction, trap elimination, or increased mesh size- could, in theory, assist in rebuilding stocks. This, in the long run, would provide additional resource for all participants; hence, potential long-term benefits.

Finally, it should be noted that bottom longlining reflects the primary gear responsible for the harvest of Nassau grouper (approximately three-quarters of the poundage); presumably all in state waters due to the federal harvest prohibition. Fish traps account for less than 20% of the total harvest.

6.6.2.2.4 Direct and indirect effects on administrative environment and their significance

The following addresses factor G outlined in the National Standards for evaluating whether the alternative minimizes bycatch or bycatch mortality to the extent practicable.

This alternative would introduce significant impacts to the administrative environment. Due to a lack of discrete data, the amount of traps utilized in federal waters is unknown. Because many of the species that would be considered regulatory discards are not prohibited in state waters, the effectiveness of this alternative is jeopardized without compatible regulations in state waters. Furthermore, trap fishermen would not be required to change their mesh size in state waters, so some may choose to simply move their gear inshore rather than modify the mesh size. Also, without compatible regulations in state waters, enforcement efforts would be extremely complicated, and require at-sea interdiction.

6.6.2.3 Alternative 3. Establish a minimum mesh size of two inches and a maximum mesh size of six inches, stretched mesh, for gill and trammel nets. Additionally, gill and trammel nets must be tended at all times.

Due to the lack of data on the use of this particular gear in federal waters, it is not possible to quantify any consequences or benefits of the proposed alternative.

6.6.2.3.1 Direct and indirect effects on physical environment and their significance

To the extent that nets are used in federal waters, this alternative could benefit the physical environment. If nets are not currently tended, this alternative could minimize lost gear. However, due to the depths and expense of the gear involved, it is unlikely that fishermen would not attempt to recover lost or entangled gear. Limiting the length of a net could reduce physical impacts of nets to the seabed, to some unknown degree, when bottom set gill nets are utilized.

6.6.2.3.2 Direct and indirect effects on biological and ecological environment and their significance

The following addresses the factors A-D outlined in the National Standards for evaluating whether the alternative minimizes bycatch or bycatch mortality to the extent practicable.

Similar to Alternative 2, it is likely that the majority of net use occurs in state waters. Therefore, unless consistent regulations are implemented in state waters, this alternative would most likely not result in any significant reductions in bycatch or other biological benefits. Anecdotal information suggests that nets are being deployed and recovered with the assistance of divers. The fishermen are targeting diurnal migration pathways near the reef, and attempt to harvest fish as they leave or return from the reef to forage. Due to the depth limitations faced by divers, this activity most likely is predominantly restricted to state waters, however, to the extent it is occurring in federal waters, it is likely more significant off the USVI than Puerto Rico due to respective state boundaries (i.e., 3 nm versus 9 nm). Therefore, it is unclear to what extent this alternative would result in reducing bycatch, to the extent that it occurs.

CFMC (2001b) indicates that bottom line gear was responsible for the majority of Nassau grouper landings in 1997 and 1998 (71% and 75%, respectively), followed by fish traps (16% and 19%, respectively) and gill nets (1.3% and 1.1%, respectively) (CFMC 2001b). Furthermore, increasing the mesh size of gill and trammel nets is not a viable solution to decrease bycatch of Nassau and Goliath grouper, due to their large size.

While there is a possibility that this alternative could reduce bycatch of aquarium trade or other bycatch species, there is no evidence that there is a bycatch problem in this fishery occurring in federal waters, nor is there any way to evaluate what size the mesh should be increased to. Furthermore, there would be no way to assess if the action would have any impact in reducing bycatch, especially considering that the alternative would have no effect on activities occurring in state waters, where most of the net activity likely occurs. Establishing a minimum mesh size does not help the incidental take of protected resources. For example, sea turtles can be taken in any mesh size, however, in general, the smaller the mesh size, the less likely an entanglement will occur. Establishing a tending requirement may help to minimize the risk of protected species entanglements.

6.6.2.3.3 Direct and indirect effects on social and economic environment and their significance

The following addresses the factors E-J outlined in the National Standards for evaluating whether the alternative minimizes bycatch or bycatch mortality to the extent practicable.

Very little is known about the use of nets in the U.S. Caribbean; particularly in federal waters. In public hearings for the Draft Essential Fish Habitat Generic Amendment (September 1, 1998), one individual testified that it was her understanding that "in St. Croix they use SCUBA gear with the gill nets to entrap the fish."[29] Based on this comment and other anecdotal information, and if it can be extended throughout the entire U.S. Caribbean, the issue of tending requirements becomes a moot issue.

As with the previous alternative, due to the lack of specifics regarding the amount by which the minimum allowable mesh size for fish traps would be increased, it is virtually impossible to provide any detailed human environment impact associated with this alternative. Obviously, if the mesh size is increased by such an amount that virtually all fish escape from the nets, social and economic impacts could be significant in terms of lost revenues and, hence, income derived from trap fishing activities. On the other hand, if the allowable minimum mesh size is increased only very marginally, social impacts may be negligible. There would, however, be some possibly

[29] The individual provided no information to ascertain whether the activity was occurring in federal or Territorial waters, or both.

significant upfront costs associated with the purchase of new nets that would meet any new mesh size and length requirements.

As with any alternative that would require a clear determination of whether fishing activities were occurring in state or federal waters, this alternative might require fishermen to purchase a GPS unit (with a cost of approximately $200). Without GPS, it is unclear how fishermen and enforcement could determine if a fishermen was in compliance with regulations in federal waters.

6.6.2.3.4 Direct and indirect effects on administrative environment and their significance

The following addresses factor G outlined in the National Standards for evaluating whether the alternative minimizes bycatch or bycatch mortality to the extent practicable.

As mentioned above, this alternative would likely not produce significant benefits to bycatch reduction, but it would introduce significant administrative consequences. Currently, there is no information that indicates that net use, or more specifically, that bycatch associated with net use in federal waters is an issue. There is currently no practical way to evaluate what kind of gear modifications are needed, nor is there a way to determine the effectiveness of those modifications. As with just about every action that the Council could take, without compatible regulations in state waters it is unlikely that this alternative would result in achieving the desired goals. As with any bycatch reduction measure proposed, the underlying issue is whether or not bycatch is a significant issue in the EEZ, and whether there are practical measures available in reducing that bycatch. The available information, albeit anecdotal information, indicates bycatch is not a significant issue in this region, primarily because the majority of catch is retained for use or sale.

6.6.2.4 Alternative 4 (Preferred). Amend current requirements for trap construction such that only one escape panel be required, which could be the door.

6.6.2.4.1 Direct and indirect effects on physical environment and their significance

This alternative would not result in any direct or indirect effects to the physical environment since it does not directly affect or limit trap use on the bottom. Thus, the effects to the physical environment, particularly to coral habitat, would be expected to be the same under this alternative as under the status quo.

6.6.2.4.2 Direct and indirect effects on biological and ecological environment and their significance

The following addresses the factors A-D outlined in the National Standards for evaluating whether the alternative minimizes bycatch or bycatch mortality to the extent practicable.

Anecdotal information and the experience of local fishery management officials indicates that Caribbean fishermen tend to wire shut one of the two current escape panels in order to prevent premature opening during recovery of the traps. Apparently, if the traps are hauled in such a way that orients the trap with an escape panel facing down, the weight of the fish can break through a compromised biodegradable panel (i.e., break the biodegradable fastener, which would open the panel). Therefore, the fishermen bungee or wire-tie a panel shut to prevent this type of failure.

This alternative is not expected to result in any direct biological impacts to the environment. However, indirect impacts resulting from the use of only one escape panel could occur. Because fishermen generally utilize the majority of their catch, and there is little documented issues associated with bycatch, it would appear that ghost fishing due to lost traps would be more of a bycatch issue. If a trap is lost, and the trap is oriented in such a way that prevents the single escape panel from falling open, the trap can continue to ghost fish and result in bycatch for a finite period of time. While fish traps are generally set in areas that would allow recovery by divers or grappling, this scenario could still occur if traps are not recovered or are simply abandoned. In this regard, it would seem that two escape panels would be more effective in reducing bycatch and the effects of ghost-fishing. Fishermen are already securing at least one of the two escape panels, and trap loss rates are believed to be low in the U.S. Caribbean. Facially, the measure appears to reduce protections. However, to the extent fishermen are securing both panels, which some information indicates is occurring, persuading them to leave one unsecured would reduce the (albeit low) level of actual bycatch mortality associated with the use of illegal traps.

The effectiveness of any regulation depends heavily on the level of compliance by those subject to the regulation, and compliance in turn depends heavily on acceptance of the regulation. This alternative was developed together by affected fishermen and local fishery management officials at the 117th Council meeting. The measure was presented as one piece of a suite of various management measures all developed between, and endorsed by, the fishermen and fishery management officials from USVI and Puerto Rico. Local officials also expressed an intent to implement a compatible suite of regulations in state waters (Puerto Rico already had many of these measures enacted). Therefore, the Council believes that this measure, when adopted in conjunction with the other alternatives proposed, will in fact lead to greater compliance with the single escape panel requirement, and in turn will reduce actual bycatch mortality associated with fish trap use in the U.S. Caribbean.

As with the other alternatives in this section, there is no information available that would allow a quantitative evaluation on the effect of this alternative in reducing bycatch in federal waters. The amount of traps utilized in federal waters is not known. Currently, Puerto Rico does not require the use of escape panels (Figuerola and Torres 1997). Given the predominance of reef habitat in state waters, the fact that the majority of landings originate from state waters, and that there soon will be compatible regulations with the state governments, this alternative will likely be effective in reducing bycatch and bycatch mortality, to the extent that it occurs in the U.S. Caribbean.

6.6.2.4.3 Direct and indirect effects on social and economic environment and their significance

The following addresses the factors E-J outlined in the National Standards for evaluating whether the alternative minimizes bycatch or bycatch mortality to the extent practicable.

The issue of construction of fish traps, including escape panels, was addressed in the *Regulatory Impact Review to the Fishery Management Plan for the Shallow-Water Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands* (CFMC 1985). Two similar alternatives were considered. The first required two escape panels while the second alternative would require only one escape panel. As noted in the discussion of only one escape panel, "[the other alternative] calls for two escape panels because it was felt that the ghost-fishing phenomenon is much less likely to occur. The reasoning is that a lost trap can rest on one escape panel while another is in a position to open after the fastener deteriorates. The cost of the one panel measure is less than the two panel measure, but the gains from eliminating the possibility of ghost-fishing probably outweigh the minor extra costs involved." There is no reason to believe that this finding is no longer valid but the information presented in 6.6.2.4.2 does lead one to conclude that benefits that might be forthcoming, assuming a reasonable level of compliance, are eroded due to lack of compliance. As also stated in Section 6.6.2.4.2, the ghost fishing effect associated with only one escape panel probably contributes to bycatch more than would be the case if the trap had two escape panels, although trap loss is believed to be low. However, to the extent fishermen are securing both panels, which some information indicates is occurring, persuading them to leave one unsecured would reduce the (albeit low) level of actual bycatch mortality associated with the use of illegal traps.

The effectiveness of any regulation depends heavily on the level of compliance by those subject to the regulation, and compliance in turn depends heavily on acceptance of the regulation. This alternative was developed together by affected fishermen and local fishery management officials at the 117th Council meeting. The measure was presented as one piece of a suite of various management measures all developed between, and endorsed by, the fishermen and fishery management officials from USVI and Puerto Rico. Local officials also expressed an intent to implement a compatible suite of regulations in state waters (Puerto Rico already had many of these measures enacted). Therefore, the Council believes that this measure, when adopted in conjunction with the other alternatives proposed, will in fact lead to greater compliance with the single escape panel requirement, and in turn will reduce actual bycatch mortality associated with fish trap use in the U.S. Caribbean

6.6.2.4.4 Direct and indirect effects on administrative environment and their significance

The following addresses factor G outlined in the National Standards for evaluating whether the alternative minimizes bycatch or bycatch mortality to the extent practicable.

This alternative would result in direct and indirect impacts to the administrative environment. While the Council expects there will be improved compliance and buy-in from fishermen, one must note the current difference in state and federal trap construction requirements. Because Puerto Rico does not require escape panels, enforcement would not be able to inspect traps at the dock and determine if they were in violation of the regulations. At-sea inspections would be required, which presents significant cost and safety issues (due to the lack of equipment to haul traps onto enforcement boats). However, in light of the intent of the local governments as expressed at the 117th Council meeting to implement compatible regulations, and the apparent support of fishermen in attendance, the measure should enhance the enforcement costs and management effectiveness.

Two underlying issues remain: that there apparently is not a significant bycatch problem in Caribbean fisheries due to the general utilization of the catch; and the lack of compatible regulations compromises efforts in federal waters.

6.7 Achieving the MSFCMA EFH mandates

The MSFCMA mandates that all FMPs shall "...describe and identify essential fish habitat for the fishery based on the guidelines established by the Secretary under section 305(b)(1)(A), minimizing to the extent practicable adverse effects on such habitat caused by fishing...." (MSFCMA §303(a)(7)). This section describes the alternatives the Council is considering to meet these EFH mandates.

6.7.1 Describe and identify EFH

6.7.1.1 Alternative 1. No action.

The direct and indirect effects on the environment and their significance related to this alternative are detailed in Section 4.3 of the EFH FSEIS (CFMC 2004).

6.7.1.2 Alternative 2 (Preferred). Describe and identify EFH according to functional relationships between life history stages of federally-managed species and Caribbean marine and estuarine habitats.

This alternative specifies functional relationships for life stages and habitat types that might be regarded as meriting special attention for their importance to managed species. The MSFCMA defined EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." These are the functions that marine and estuarine habitats support. Under this alternative, the distribution of species and life stages is inferred from information on these functional relationships. In particular, EFH is defined as:

- EFH for the spiny lobster fishery in the U.S. Caribbean consists of all waters from mean high water to the outer boundary of the EEZ – habitats used by phyllosome larvae – (Figure 2.2; EFH FSEIS) and seagrass, benthic algae, mangrove, coral, and live/hard bottom substrates from mean high water to 100 fathoms depth – used by other life stages – (Figure 2.38; EFH FSEIS), shown in the aggregate as Figure 2.39 (EFH FSEIS);
- EFH for the queen conch fishery in the U.S. Caribbean consists of all waters from mean high water to the outer boundary of the EEZ – habitats used by eggs and larvae – (Figure 2.2; EFH FSEIS) and seagrass, benthic algae, coral, live/hard bottom and sand/shell substrates from mean high water to 100 fathoms depth – used by other life stages – (Figure 2.40; EFH FSEIS), shown in the aggregate as Figure 2.39 (EFH FSEIS);
- EFH for the reef fish fishery in the U.S. Caribbean consists of all waters from mean high water to the outer boundary of the EEZ – habitats used by eggs and larvae – (Figure 2.2; EFH FSEIS) and all substrates from mean high water to 100 fathoms depth – used by other life stages – (Figure 2.41; EFH FSEIS), shown in the aggregate as Figure 2.39 (EFH FSEIS); and
- EFH for the coral fishery in the U.S. Caribbean consists of all waters from mean low water to the outer boundary of the EEZ – habitats used by larvae – (Figure 2.2; EFH FSEIS) and coral and hard bottom substrates from mean low water to 100 fathoms depth – used by other life stages – (Figure 2.42; EFH FSEIS), shown in the aggregate as Figure 2.39 (EFH FSEIS).

The identification and description of EFH will not result in any direct physical, biological, social or economic, or administrative impacts. However, there may be indirect impacts associated with EFH consultations and subsequent fishery management actions that could result in increased protection of EFH and dependent species, including protected resources. To the degree that consultations or minimization of adverse impacts reduces damage or enhances EFH, these species will benefit from protected EFH. Additional discussion on the indirect effects on the environment and their significance related to this alternative are detailed in Section 4.3 of the EFH FSEIS (CFMC 2004).

6.7.1.3 Alternative 3 (Preferred). Designate 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.

The EFH regulations encourage regional Fishery Management Councils to designate these HAPCs within areas identified as EFH in order to focus conservation priorities on specific habitat areas that play a particularly important role in the life cycles of federally managed fish species. The following HAPCs would be designated for the various FMPs:

Alternative 3a. Designate HAPCs in the Reef Fish FMP at the following areas based on the occurrence of confirmed spawning locations:

I. Puerto Rico
   A. Tourmaline Bank/Buoy 8 (Figure 2.29; EFH FSEIS) (50 CFR 622.33(a));
   B. Abrir La Sierra Bank/Buoy 6 (Figure 2.29; EFH FSEIS) (50 CFR 622.33(a));
   C. Bajo de Sico (Figure 2.29; EFH FSEIS) (50 CFR 622.33(a)); and
   D. Vieques, El Seco (Figure 2.30; EFH FSEIS).
II. St. Croix
   A. Mutton snapper spawning aggregation area (Figure 2.29; EFH FSEIS) (50 CFR 622.33(a));
   B. East of St. Croix (Lang Bank) (Figure 2.29; EFH FSEIS) (50 CFR 622.33(a)).
III. St. Thomas
   A. Hind Bank MCD (Figure 2.29; EFH FSEIS) (50 CFR 622.33(b)); and
   B. Grammanik Bank (Figure 2.29; EFH FSEIS).

Alternative 3b. Designate HAPC for the Reef Fish FMP as those EFH habitat areas or sites identified as having particular ecological importance to Caribbean reef fish species:

I. Puerto Rico
   A. Hacienda la Esperanza, Manití (Figure 2.31; EFH FSEIS);
   B. Bajuras and Tiberones, Isabela (Figure 2.31; EFH FSEIS);
   C. Cabezas de San Juan, Fajardo (Figure 2.31; EFH FSEIS);
   D. JOBANNERR, Jobos Bay (Figure 2.31; EFH FSEIS);
   E. Bioluminescent Bays, Vieques (Figure 2.31; EFH FSEIS);
   F. Boquerón state Forest (Figure 2.32; EFH FSEIS);
   G. Pantano Cibuco, Vega Baja (Figure 2.31; EFH FSEIS);
   H. Piñones state Forest (Figure 2.31; EFH FSEIS);
   I. Río Espiritu Santo, Río Grande (Figure 2.31; EFH FSEIS);
   J. Seagrass beds of Culebra Island (nine sites designated as Resource Category 1 and two additional sites) (Figure 2.31; EFH FSEIS); and
   K. Northwest Vieques seagrass west of Mosquito Pier, Vieques (Figure 2.33; EFH FSEIS).
II. St. Thomas
   A. Southeastern St. Thomas, including Cas Key and the mangrove lagoon in Great St. James Bay (Figure 2.34; EFH FSEIS); and
   B. Saba Island/Perseverance Bay, including Flat Key and Black Point Reef (Figure 2.34; EFH FSEIS).

III. St. Croix
   A. Salt River Bay National Historical Park and Ecological Preserve and Marine Reserve and Wildlife Sanctuary (Figure 2.36; EFH FSEIS);
   B. Altona Lagoon (Figure 2.36; EFH FSEIS);
   C. Great Pond (Figure 2.36; EFH FSEIS);
   D. South Shore Industrial Area (Figure 2.36; EFH FSEIS); and
   E. Sandy Point National Wildlife Refuge (Figure 2.36; EFH FSEIS)

Alternative 3c. Designate HAPC for the Coral FMP as those EFH habitat areas or sites identified as having particular ecological importance to Caribbean coral species:

I. Puerto Rico
   A. Luis Peña Channel, Culebra (Figure 2.31; EFH FSEIS);
   B. Mona/Monito (Figure 2.31; EFH FSEIS);
   C. La Parguera, Lajas (Figure 2.32; EFH FSEIS);
   D. Caja de Muertos, Ponce (Figure 2.32; EFH FSEIS);
   E. Tourmaline Reef (Figure 2.32; EFH FSEIS);
   F. Guánica state Forest (Figure 2.32; EFH FSEIS);
   G. Punta Petrona, Santa Isabel (Figure 2.31; EFH FSEIS);
   H. Ceiba state Forest (Figure 2.31; EFH FSEIS);
   I. La Cordillera, Fajardo (Figure 2.31; EFH FSEIS);
   J. Guayama Reefs (Figure 2.31; EFH FSEIS);
   K. Steps and Tres Palmas, Rincon (Figure 2.31; EFH FSEIS);
   L. Los Corchos Reef, Culebra (Figure 2.31; EFH FSEIS); and
   M. Desecheo Reefs, Desecheo (Figure 2.31; EFH FSEIS)

II. St. Croix
   A. St. Croix Coral Reef Area of Particular Concern, including the East End Marine Park (Figure 2.36; EFH FSEIS);
   B. Buck Island Reef National Monument (Figure 2.36; EFH FSEIS);
   C. South Shore Industrial Area Patch Reef and Deep Reef System (Figure 2.36; EFH FSEIS);
   D. Frederiksted Reef System (Figure 2.36; EFH FSEIS);
   E. Cane Bay (Figure 2.36; EFH FSEIS); and
   F. Green Cay Wildlife Refuge (Figure 2.36; EFH FSEIS).

Identified sites in Alternative 3a, with the exception of Vieques – El Seco, have been documented in other Council actions to be sites of particular importance to specific reef fish species (e.g., red hind at Tourmaline Bank). Identification of these areas as HAPCs is consistent with other Council actions to afford them either seasonal or annual protection. Identifying these sites as HAPCs will not result in any direct effects to the environment. Vieques – El Seco is in state waters, and is therefore out of the Council's jurisdiction. Likewise, the sites identified in Alternatives 3b and 3c are in state waters. Therefore, the Council and NMFS cannot take direct action to manages fisheries in these areas. It should be noted that portions of La Parguera, Tourmaline Reef, and Caja de Muertos extend partially into the EEZ, and the Council and NMFS could implement management actions to protect and conserve EFH in the portion that resides in federal waters. Additional discussion on the indirect effects on the environment and their significance related to these alternatives are detailed in Section 4.4 of the EFH FSEIS (CFMC 2004).

6.7.2 Minimize adverse effects on EFH

6.7.2.1 Alternative 1. No action

The direct and indirect effects on the environment and their significance related to this alternative are detailed in Section 4.5 of the EFH FSEIS (CFMC 2004).

6.7.2.2 Alternative 2 (Preferred). Establish modifications to anchoring techniques; establish 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.

The measures include the following:

- Require at least one buoy that floats on the surface on all individual traps/pots;
- Require at least one buoy at each end of trap lines linking traps/pots for all fishing vessels that fish for or possess Caribbean spiny lobster or Caribbean reef fish species in or from the EEZ under the Spiny Lobster and Reef Fish FMPs;
- Require an anchor retrieval system that insures the anchor is recovered by its crown in order to prevent 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 towards the crown. For a fluke or plow-type anchor (e.g., Danforth, Delta, Fortress, etc.), a trip line consisting of a line from the crown of the anchor to a surface buoy (Figure 2.43; EFH EIS) would be required. This would apply to all commercial and recreational fishing vessels that fish for or possess Caribbean reef species in or from the EEZ; and
- Prohibit 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 (as defined by the preferred alternative in Section 4.5) in the EEZ under the Spiny Lobster and Reef Fish FMPs.

6.7.2.2.1 Direct and indirect effects on physical environment and their significance

Alternative 2 represents the Council's selection from a suite of alternatives detailed in Section 4.5 of the EFH FSEIS (CFMC 2004). In addition to the discussions below, other direct and indirect effects on the environment and their significance as related to Alternative 2 are herein incorporated by reference from the EFH FSEIS.

6.7.2.2.2 Direct and indirect effects on biological and ecological environment and their significance

As discussed in Section 5.2.2.1.1, marine mammals are known to become entangled in trap and pot lines. The proposed measures would increase the amount of vertical lines in the water, thus increase potential entanglements. Such an action would contradict the overriding principles of the Atlantic Large Whales Take Reduction Plan (ALWTRP), which seeks to reduce the risk of serious injury to or mortality of large whales due to entanglement by reducing the quantity of vertical lines in the water.

As discussed in Section 5.2.2.1.2, sea turtles, particularly leatherbacks, are also known to become entangled in trap and pot lines. The proposed measures would therefore also increase potential sea turtle entanglements. This may be particularly troublesome in the USVI, where one of five leatherback strandings from 1982 to 1997 were because of entanglement (Boulon 2000). NMFS and others are currently researching ways to reduce risk associated with vertical line, such as investigating the profiles of vertical line with different buoy line configurations (i.e., sinking/neutrally buoyant vs. polypropylene; toggles) and scope (requiring a minimum number of traps per trawl. Gear markings are needed to better monitor and understand where (i.e., federal or state waters) and how interactions with trap and pot gear occur. Additional direct and indirect effects on the environment and their significance related to this alternative are detailed in Section 4.5 of the EFH FSEIS (CFMC 2004).

The preferred alternative would likely have a *de minimus* positive impact on HMS by potentially reducing the negligible level of sharks landed in the U.S. Caribbean shark bottom longline fishery. Possible reductions in the level of bycatch of other species that are caught incidentally to shark bottom longline activities in the Caribbean are also expected to be *de minimus* given the minimal amount of effort and landings in this fishery. Currently available data as discussed in the 2003 Biological Opinion for Atlantic Shark Fisheries, suggest that continued operation of the shark bottom longline fishery will not jeopardize protected species.

The fishing gears and methods of the HMS fisheries do not appear to have adverse impacts on HMS EFH. Even if there were any adverse impacts, such impacts are not expected to be "more than minimal and not temporary in nature" (50 CFR 600.815(a)(2)(ii)). There is the possibility that other (non-HMS) fisheries may adversely impact HMS EFH, and some HMS gear may impact other EFH; however, the degree of that impact is difficult to ascertain from the data currently available. Of the approved gears that are use in the HMS fisheries, only bottom longline, principally targeting large coastal sharks, make contact with the bottom. If bottom longline gear becomes hung or entangled on bottom substrate such as rock, hard and soft corals, it could have some adverse impact. Therefore, the prohibition of this gear type within the existing seasonally closed areas and Grammanik Bank may result in benefits to EFH in the U.S. Caribbean.

6.7.2.2.3 Direct and indirect effects on social and economic environment and their significance

This alternative would prohibit the use of traps and pots, gill and trammel nets, and bottom longlines year-round in currently existing seasonal closed areas for red hind and mutton snapper. This would directly affect the social and economic environment by prohibiting the use of several traditional gear types in certain areas, in particular fish traps, and therefore potentially result in loss of revenues and other associated impacts. In particular, this alternative could be especially burdensome to St. Croix fishermen who depend on Lang Bank, especially considering the loss of area through closures in state waters (e.g., Buck Island Reef National Monument, St. Croix East End Marine Park). The majority of fishable habitat off St. Croix is primarily isolated to Lang Bank. The red hind seasonal closure encompasses approximately the easternmost half of Lang Bank. Prohibiting fish traps, bottom longlines, and gill and trammel nets would result in short-term loss in revenues due to reduced catch, but it could result in long-term benefits from increased abundance of commercially important species (e.g., red hind) from both a reduction in fishing mortality and from protection of EFH at a documented spawning aggregation site. Additional direct and indirect effects on the environment and their significance related to this alternative are detailed in Section 4.5 of the EFH FSEIS (CFMC 2004).

Specific to the HMS fisheries, the preferred alternative would likely have *de minimus* or no adverse social or economic impacts on HMS fishermen or fishing communities, including fish processors, fish dealers, or supply houses. Documented landings of sharks from the U.S. Caribbean in recent years (1997 - 2002) are negligible, consisting of 66 individual sharks weighing less than 3,200 pounds in aggregate for this six-year period. The majority of landings during this period occurred in 1997, when 59 sharks totaling 2,925 lbs were landed. Between 1998 and 2002 only six sharks totaling 243 lbs were reported (see Section 5.3.7.2). However, these data may not be fully reflective of the actual size or value of the U.S. Caribbean shark fishery due to the possibility of unreported landings. Based on available data, NMFS does not anticipate that the preferred alternative would result in a measurable reduction or redistribution of HMS related effort, including shark bottom longline, or any changes in HMS fishing practices. The preferred alternative is not expected to impact fishing costs, ex-vessel prices, or market availability given the limited and unpredictable quantities of sharks landed in the U.S. Caribbean.

6.7.2.2.4 Direct and indirect effects on administrative environment and their significance

This alternative would prohibit the use of traps and pots, gill and trammel nets, and bottom longlines in the currently existing red hind and mutton snapper seasonal closed areas in the U.S. Caribbean throughout the entire year. This could present some direct administrative impacts, in particular for two closed red hind closures off the west coast of Puerto Rico. The seasonal closed areas on Bajo de Cico and Tourmaline Bank (Figure 11) straddle Puerto Rican waters, with approximately half of the closed area in state waters and half in federal waters. However, due to recent revisions to the Puerto Rican fisheries law, Puerto Rico no longer enforces these boundaries. Instead, Puerto Rico has implemented a complete seasonal closure for all state waters from December 1 - February 28 of each year. As the Council only has jurisdiction in federal waters, implementing these gear prohibitions in state waters would therefore present some significant administrative difficulties. Furthermore, enforcement of these site-specific gear prohibitions could be complicated, and require at-sea investigations. Additional direct and indirect effects on the environment and their significance related to this alternative are detailed in Section 4.5 of the EFH FSEIS (CFMC 2004).

6.8 Cumulative effects analyses

As directed by NEPA, federal agencies are mandated to assess not only the indirect and direct impacts, but the cumulative impacts as well. NEPA defines a cumulative impact as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 C.F.R. 1508.7). Cumulative effects can either be additive or synergistic. A synergistic effect is when the combined effects are greater than the sum of the individual effects.

The cumulative effects analysis requirement presents a challenge. In terms of the present state of information, cumulative effects analyses (CEA) are often too complex to permit a level of analysis equivalent to that performed for direct or indirect impacts. NMFS and the Council are examining ways to improve the collection and analysis of scientific data to better meet NEPA's CEA requirements.

The Council on Environmental Quality (1997) offers guidance on conducting a cumulative effects analysis, and outlines 11 steps for consideration in drafting a CEA for a proposed action:

1. Identify the significant cumulative effects issues associated with the proposed action and define the assessment goals;
2. Establish the geographic scope of the analysis;
3. Establish the time frame for the analysis;
4. Identify other actions affecting the resources, ecosystems, and human

communities of concern;

5. Characterize the resources, ecosystems, and human communities identified in scoping in terms of their response to changes and capacity to withstand stresses;
6. Characterize the stresses affecting these resources, ecosystems, and human communities and their relation to regulatory thresholds;
7. Define a baseline condition for the resources, ecosystems, and human communities;
8. Identify the important cause and effect relationships between human activities and resources, ecosystems, and human communities;
9. Determine the magnitude and significance of cumulative effects;
10. Modify or add alternatives to avoid, minimize, or mitigate significant cumulative effects; and
11. Monitor the cumulative effects of the selected alternative(s) and adapt management.

The CEA for the physical, biological and ecological, social/economic, and administrative environments are grouped together following the above 11 steps.

6.8.1 Identify the significant cumulative effects issues associated with the proposed action and define the assessment goals

The CEQ cumulative effects guidance states that this step is done through three activities: identifying the direct and indirect effects of the proposed actions (Section 6.0); identifying which resources, ecosystems, and human communities are affected (Section 5.0); and identifying which effects are important from a cumulative effects perspective (information revealed in this CEA).

6.8.2 Establish the geographic scope of the analysis

The immediate impact area (i.e., project impact zone) for this CEA is the U.S. Caribbean EEZ (Figure 1). While the MSFCMA only has jurisdiction over federal waters, due to the structure and nature of the fisheries, as well as the biology of managed species, it is anticipated that the alternatives will impact activities in state waters to some extent as well. While there have been few studies explicitly conducted on juvenile and adult fish movement in the U.S. Caribbean and the Caribbean basin as a whole, other studies have documented that many species have extended larval periods, and thus local populations may depend on remote spawning populations not under the Council's jurisdiction. Conversely, other areas (e.g., British Virgin Islands) may depend on the larval input originating from the U.S. Caribbean. The EFH EIS (CFMC 2004) documents EFH, spawning sites, and other information on discrete area of importance within the project impact zone. In light of the available information, the extent of the boundaries would depend upon the degree of fish immigration/emigration and larval transport, whichever has the greatest geographical range. Because of the limited information available, the CEA cannot define the spatial boundary in terms of discrete geographic coordinates, but it recognizes that the spatial boundary should perhaps consider the effects on the environment on a scale larger than the U.S.

Caribbean EEZ. Since boundaries are solely political in nature and they do not prevent the immigration and emigration of fish, fish larvae, and coral planulae, the geographic scope of the CEA could be expanded beyond the jurisdiction of the EEZ, but the lack of available information and differences in political jurisdiction, fishery regulations, and biological and human communities does not make this practicable unless regional fishery agreements are put in place.

6.8.3 Establish the time frame for the analysis

Establishing a time frame for the CEA is important for Section 6.8.4, when the past, present, and reasonably foreseeable future actions are discussed. Many feel that the CEA should go back to a time period when there was a natural, or some modified (but ecologically sustainable) condition. Landings data exist for the USVI and Puerto Rico since the early 1980s, however, any inferences made from this data should be used cautiously because of past species identification problems and the voluntary nature of the reporting of landings (at least in Puerto Rico). Therefore, it is prudent to use a shorter time frame. For the purposes of this CEA, the time frame begins in 1997.

In determining how far into the future to analyze cumulative effects, the length of the effects will depend on the alternatives selected. Most likely the effects will last past that date. However, it is not possible to bracket a time frame with a future date for those alternatives that establish closed areas, since it is assumed these will be permanent (at least for the foreseeable future). It is possible that some of the impacts may be eliminated or reduced should the Council opt to take a different management tact (e.g., permits and limited access or a gear prohibition to replace closed areas). This is discussed in the amendment under "short-term" and "long-term" management alternatives to reduce fishing mortality. There is no precise definition of when short-term end, and long-term begins, but it would depend on when the Council decides to replace the short-term or (potentially) temporary action with a long-term (potentially) permanent one. For the rebuilding alternatives, it is possible to bracket the time frame by the (preferred) rebuilding time or generation time for each species, which, in some instances could be as much as 95 years (e.g., Goliath grouper).

Additionally, changes to state regulations could ease or exacerbate the temporal effects of the alternatives considered in this amendment. For example, if Puerto Rico adopted a limited access system, the immediate and future impacts (social, economic, and administrative) could be significantly larger than from a stand-alone federal system because the majority of the landings occur in state waters. In comparison, if the USVI adopted a limited access system, the immediate and future impacts (social, economic, and administrative) could be significantly smaller than from a stand-alone federal system because a greater extent of the landings from the USVI occur in federal waters than landings from Puerto Rico.

It is likely that the effects stemming from the stock status parameter alternatives will last at least five years, as this amendment is structured in such a way that allows for periodic review of landings information and other data, which could result in new stock status parameters, or at least a review of the status of the fisheries. While the Council has recommended that a five-year review should be conducted based in part on the current use of a five-year time scale of the landings data (i.e., the next review would be based on 2002-2006 data), it is not possible to define a discrete upper boundary for this CEA time frame for many of the alternatives within the amendment (e.g., closed area alternatives).

6.8.4 Identify the other actions affecting the resources, ecosystems, and human communities of concern

Listed in Table 6.8.4 below are past, present, and reasonably foreseeable actions occurring in the geographic scope identified in Section 6.8.2. These actions, when added to the proposed alternatives included in this amendment, may result in cumulative effects on the physical and/or biological and ecological environments.

	PAST	PRESENT	REASONABLY FORESEEABLE
ANTHROPOGENIC ACTIONS			
Other fisheries	• Foreign reef fish fisheries • state reef fish fisheries • state lobster fishery • state conch fishery	• state reef fish fisheries • state lobster fishery • state conch fishery • state crab fishery • Seti fishery • Incidental catch	• state reef fish fisheries • state lobster fishery • state conch fishery • state crab fishery • Seti fishery • HMS fisheries • Incidental catch
Scientific research	• Oceanographic • Biological	• Oceanographic • Biological • Social science	• Oceanographic • Biological • Social science
Invasive species	• Non-native species	• Non-native species	• Non-native species
Pollution	• Marine spills and pollution • Sewage output (nutrient loading) • Dredge projects • Industrial pollution	• Marine spills and pollution • Sewage output (nutrient loading) • Dredge projects • Industrial pollution	• Marine spills and pollution • Sewage output (nutrient loading) • Dredge projects • Industrial pollution
Subsistence	• Fishing	• Fishing	• Fishing
Aquaculture	• Cobia	• Cobia • Mutton snapper • Shrimp	• Cobia • Mutton snapper • Shrimp • Amberjack • Tuna
Other maritime issues	• Military activity • Vessel groundings	• Vessel groundings	• Vessel groundings

Economic development	• Infrastructure development • Tourism	• Infrastructure development • Tourism • Gentrification	• Infrastructure development • Tourism • Gentrification
NATURAL ACTIONS			
Climate variability	• Basin-wide regime shift • Short-term variability	• Basin-wide regime shift • Short-term variability	• Basin-wide regime shift • Short-term variability
Weather/seasonal events	• Hurricanes • Increased turbidity	• Hurricanes • Increased turbidity	• Hurricanes • Increased turbidity
Other influences	• African dust storms (pathogen vector)	• African dust storms (pathogen vector)	• African dust storms (pathogen vector)

Table 6.8.4. Past, present, and reasonably foreseeable actions occurring in the geographic scope of this CEA.

6.8.4.1 Past actions

The reader is referred to Section 2.2 for past regulatory activities for all federally-managed species. Other past actions that may result in cumulative impacts are those that originate from the state fishery management entities. Historically, U.S. Caribbean fisheries have being managed primarily using conventional management measures such as gear restrictions, minimum size limits, and seasonal and area closures. These measures alone were not sufficient to mitigate the increased fishing effort resulting from technological advancements and government subsidies. The increased fishing effort led to lower stocks, which forced the local fleets to operate in deeper waters. Foreign fleets also impacted local fishery resources, as well as the socioeconomic environment, however, it is not possible to quantify the impacts of their past participation. Whether other non-Council actions negatively affected the fish populations within the geographic scope of the CEA cannot be determined at this time.

In addition to considering the cumulative effect of past fishing activities, it is important to recognize the impact of coastal development, pollution and dredging, which may have a deleterious effect on nursery habitat for many species, which, in turn, could have adversely impacted landings, industry profits, and the stability of fishing communities. Because these linkages are poorly understood, their cumulative impacts cannot be quantified. The impact of the aquaculture facilities is believed to be minor given that most of operations, particularly for cobia and mutton snapper, are in research and development stage. Military activity, in particular U.S. Navy actions involving the island of Culebra, may have also impacted biological, physical, and socioeconomic communities in the past.

In terms of natural disturbances, annual storm activity and hurricanes have been a regular impact to the Caribbean ecosystem, and is not expected to result in any long-term biological changes. However, hurricane activity may result in lost gear and other related socioeconomic impacts to fishermen that can influence landings and other fishery trends. Coral diseases and die-offs have been reported in other regions, possibly attributed to global warming and other ecosystem changes (e.g., African dust), but it is not possible to quantify any impact to the U.S. Caribbean environment.

6.8.4.2 Present actions

The reader is referred to Section 4 for current regulatory actions proposed for all federally-managed species. Recently, Puerto Rico amended their fisheries law (*Ley de Pesquerias de Puerto Rico*), which introduced significant changes. The new regulations established a tiered licensing and permitting system (e.g., full-time, part-time and beginner commercial fishing licences, and charter and headboat licenses), and also made reporting requirements mandatory. In addition, the new regulations established minimum size limits; prohibited the harvest, possession, or sale of several species; included a phase-out of beach seines by 2007; and established MPAs (e.g., Desecheo, Mona and Monito, and Culebra).

Because of the uncertainty regarding the Council's future actions, it is difficult to anticipate and quantify the cumulative impacts of forthcoming actions may have on the related physical, biological, and socioeconomic environments. For example, if the Council pursues a federal limited entry regime, it is likely that the socioeconomic on fishers and the administrative impacts to NMFS would be greater than a state-managed system. If a new federal limited entry regime were implemented, there would be additive costs to commercial fishermen in addition to the fees they would be required to pay for a USVI or Puerto Rico permit. Permit requirements by the states, as well as rising costs for fuel, marina rates, and other supplies may also add to the socioeconomic burden of fishermen. Some fishermen maybe displaced from fishing and forced to seek employment in other sectors of the economy. Depending on the local employment conditions, the stability of fishing communities could be threatened. It is likely that regulations may impact fishermen and their communities in the short-run, however, the remaining fishermen and their communities will likely benefit in the long-run as the biological and economic conditions of the fishery improve. Failure to adopt policies to strengthen the current management regime may further exacerbate the poor biological and economic condition of the fishery and may require additional, more burdensome management policies in the future.

6.8.4.3 Reasonably foreseeable future

The Council plans to consider a limited entry and effort reduction system for federal fisheries, which could not only impact the biological environment by facilitating sustainable fisheries, but it could also impact the socioeconomic environment by preventing some fishermen access to managed resources in federal waters. Depending on the success or failure of the preferred alternatives selected by the Council, in particular those alternatives to end overfishing and rebuild overfished species, it is possible the Council may be required to re-examine other alternatives in the future to insure sustainable fisheries.

6.8.5 Characterize the resources, ecosystems, and human communities identified in scoping in terms of their relation to regulatory thresholds

In terms of the biological environment, the resources/ecosystems are identified in Sections 5.1 and 5.2 of this comprehensive amendment. Likewise, the human environment is described in Section 5.3.

Landings information and anecdotal information suggests that managed species are heavily exploited in the U.S. Caribbean. Life history characteristics of many snappers and groupers – relatively long-lived, slow growing, late maturing – make them vulnerable to excessive exploitation, which slows their recovery. In general, the capacity of snappers grouper species to recover depends upon many factors, including age at maturity, generation time, environmental conditions, available habitat, harvesting pressure, age at removal, ability to reach mature age, and predation. Coral reef habitat is especially vulnerable to impacts, not just fishery-related impacts but more importantly pollution and water quality issues, and any recovery would be extremely long in duration (i.e., decades to centuries). Failure to adequately protect these resources will lead to a long-lasting decline in fishermen and their communities socioeconomic conditions.

6.8.6 Characterize the stresses affecting these resources, ecosystems, and human communities and their relation to regulatory thresholds

Table 6.8.4 lists many of the potential actions and influences that can stress Council-managed resources. Discussion on the stresses to EFH including corals are included in the EFH EIS (CFMC 2004). It should be noted that anthropogenic stresses in the immediate impact area (i.e., EEZ) would not be as numerous or as significant as those that occur in state waters. Yet, sustainability of the resource depends directly on state waters due to the importance of habitat, particularly for its role as nursery areas for juveniles.

Management thresholds are detailed in Sections 4.2 and 6.2. Numeric overfishing and overfished thresholds are included in this amendment for all managed species through development of fishing parameters on which a rebuilding plan is based, with the exception of those species that are retained strictly for monitoring purposes (i.e., aquarium trade and other Caribbean conch species). These parameters include maximum sustainable yield (MSY), the minimum stock size threshold below which a stock is considered to be overfished (MSST), the maximum fishing mortality threshold above which a stock is considered to be undergoing overfishing (MFMT), and optimum yield (OY). Once these numeric benchmarks are determined, species will have biomass-based targets and thresholds. None of the alternatives for setting SFA parameters produces any direct effects on the fishery or fishing communities. From the perspective that satisfactory specification of these benchmark parameters establishes a viable FMP and the platform for subsequent responsible management, the adoption of appropriate benchmarks will result in indirect and cumulative effects in the form of economic and societal benefits associated with a healthy and prosperous fishery.

6.8.7 Define a baseline condition for the resources, ecosystems, and human communities

The purpose of defining a baseline condition for the resource and ecosystems in the area of the proposed action is to establish a point of reference for evaluating the extent and significance of expected cumulative effects. Due to changes in reporting and the nature/composition of the fisheries, it is difficult to offer a quantitative baseline for the resources or ecosystems in question. Similarly, given the scarcity of socioeconomic data it is difficult to offer a quantitative baseline. It is relatively accepted, however, that many of the fisheries have been exploited at high levels, and therefore current fish populations in some cases are not as abundant as in the past.

6.8.8 Identify the important cause-and-effect relationships between human activities and resources, ecosystems, and human communities

The relationship between human activities and biophysical ecosystems within the context of this CEA is solely related to extractive activities and the installment of regulations as outlined in Table 1 and in Section 4. The impact of these regulations would facilitate the establishment of sustainable fisheries and protection of EFH. Due to the predominance of fishable habitat in state waters, it is expected that the impact on the human environment will be limited. However, since state boundaries for USVI extend out only 3 nm, while Puerto Rico's boundaries extend out 9 nm, USVI fishermen rely more on federal waters as compared to their counterparts in Puerto Rico, and therefore any impact on the human environment is expected to be more significant to USVI's associated communities than to those in Puerto Rico. These impacts are discussed in more detail throughout Sections 6.1-6.7.

6.8.9 Determine the magnitude and significance of cumulative effects

In regard to stock status parameters, cumulative impacts will, at a minimum, equal indirect impacts. Depending upon other actions taken, however, they could be considerably different from the indirect impacts. Until such time that all actions are fully developed, one cannot identify, or determine the magnitude and significance of any cumulative impacts stemming from the selection of stock status parameter alternatives with any certainty.

Because the majority of fishing activity in Puerto Rico primarily occurs in state waters, the overall cumulative effects may be minimal. In contrast, due to the USVI's greater dependence on the EEZ resulting from their 3 nm state boundary, the overall cumulative effects may be more pronounced. Regardless of the overall effect, because the Council has such a limited impact on the resources in the EEZ, within the EEZ itself (i.e., excluding state waters) cumulative effects may be viewed as significant, particularly if the Council opts to pursue a closed area alternative(s), which could potentially close 20% or more of the EEZ.

6.8.10 Modify or add alternatives to avoid, minimize, or mitigate significant cumulative effects

Numerous alternatives were added to address potential cumulative impacts on the biological and physical environment, as well as the social and economic environment. For example, the inclusion of an alternative to rely on current state permitting and reporting efforts would avoid the potential impacts of establishing a new, independent federal permitting and reporting system. Aside from the administrative impacts that would be avoided, both the economic impacts that would result from fishermen being required to purchase two separate permits to fish off Puerto Rico and the USVI, and the social impacts from the time required to fill out separate and potentially significantly divergent formatted reporting forms would be avoided by working with the currently-established state systems.

6.8.11 Monitor the cumulative effects of the selected alternative(s) and adapt management

The effects of the proposed action are, and will continue to be, monitored through scientific experiments and observations, and by landings reports that are used to determine proxies for stock status parameters. As mentioned earlier, the structure of the amendment allows for the periodic (i.e., five-year) review of landings information, and the potential generation of current stock status parameters based on new information.

6.9 Unavoidable adverse effects

Unavoidable adverse effects are considered impacts that are directly related to the proposed action and deleterious to the environment, the health of biological resources, and social systems. These effects have been distilled from the direct and indirect impacts listed in Sections 6.1 - 6.7. Cumulative impacts are discussed in Section 6.8.4. Commercial and recreational fisheries in the U.S. Caribbean have existed for over five decades. While fishery-related impacts have already occurred, in many instances they have been eliminated or minimized (e.g., prohibition of explosives). Regardless, all fishing has an effect on the marine environment to some extent (Barnette 2001). Even with completely sustainable fisheries, there will be some impact to the environment.

Due to the current status of U.S. Caribbean fisheries and the required provisions of the MSFCMA, it is necessary to reduce fishing mortality on several managed species. And since this reduction in fishing mortality will require a reduction in actual harvest, there will be some unavoidable socioeconomic impacts stemming from the selection of preferred alternatives in this amendment.

6.10 Mitigation measures

Section 102(2)(c)(ii) of NEPA states that an EIS must discuss "Any adverse environmental effects which cannot be avoided should the proposal be implemented." Mitigation is defined by CEQ as:

1. Avoiding the impact altogether by not taking a certain action or parts of an action;
2. Minimizing impacts by limiting the degree or magnitude of the action and its implementation;
3. Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
4. Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and
5. Compensating for the impact by replacing or providing substitute resources or environments.

The direct and indirect impacts associated with implementing the proposed alternatives discussed in this amendment are discussed in Sections 6.1 - 6.7; cumulative impacts are discussed in Section 6.8.4.

Many of the alternatives in this amendment, particularly those in Section 6.2, are not expected to result in any significant adverse impacts to the environment because only a small portion (14%) of fishable habitat occurs in federal waters to support any associated fisheries that would be influenced by federal fishery management actions. Any impacts associated with alternatives in this section could be reduced over time through generation of more accurate and discrete data.

The majority of direct impacts associated with the implementation of management actions in this amendment would result from those offered to reduce fishing mortality in Section 6.3. Due to the potential for significant economic and administrative impacts stemming from alternatives in Section 6.3, the closed area sub-alternatives analyzed in this section offer a range of size and areas. The difference in the state boundaries, in that Puerto Rican waters extend out to nine miles while the USVI's waters end at three miles, present some equitability issues. Therefore, Alternative 3b proposes to close all waters off Puerto Rico to balance the conservation responsibility between the two jurisdictions. Regardless, due to the need to reduce fishing mortality, it is likely that any proposed alternative designed to meet the required targets as specified by the control rules would result in some substantial impacts. In order to reduce impacts to the human environment, the coordinates for corners of the closed area were sited so as to facilitate both user interpretation, mapping, and enforcement. The coordinates were selected to provide whole numbers, or at most, to the tenth of a minute (i.e., DD MM.M), rather than extending the coordinates out two or more decimal minutes (e.g., DD MM.MMM).

It is possible that gear-specific prohibition (i.e., Alternative 4 or 5) could be applied to the closed areas, versus closing the areas down to all fishing. This would reduce the benefits to the biological and physical environments, and would not likely result in the desired reductions in fishing mortality needed to meet the control rule thresholds, but it would result in a less dramatic economic impact to fishermen. Though it would complicate enforcement, a gear specific closure would be much more attractive to fishermen, especially off St. Croix. The MOU alternative was developed to address some of the shortcomings of other proposed actions. The disparity between state and federal management entities has been an issue in the past (e.g., Nassau grouper), and will undoubtedly present significant issues following the implementation of federal regulations designed to address other MSFCMA requirements.

In order to reduce or eliminate any of the impacts discussed in Section 6.7, relative to protected resource interactions with vertical lines, buoy lines could be required to be made of sinking material (nylon instead of polyethylene) or heavier line.

6.11 Relationship between short-term uses and long-term productivity

The short-term effects and uses of various components of the environment in the EEZ of the U.S. Caribbean are related to long-term effects and the maintenance and enhancement of long-term productivity. Short term refers to the period during which fishing activities would occur within the EEZ based on the preferred alternatives selected in this amendment. Based on a periodic review, this would be roughly five years. Many of the effects discussed in Sections 6.1 - 6.7 are considered to be short term. Long term refers to an indefinite period beyond the five-year periodic review.

No sensitive environmental resources would be adversely affected in the short or long term. The potential for effects was evaluated for such sensitive resources as endangered species (particularly sea turtles and marine mammals) and EFH. NMFS' Protected Resources Division will be conducting a Section 7 consultation on the DEIS and that consultation will be summarized in the FEIS. No significant impacts would occur to air quality, water quality, or other resources.

6.12 Irreversible and irretrievable commitments of resources

Irreversible commitments as those actions that cannot be reversed (e.g., species extinction), except perhaps in the extreme long term, and irretrievable commitments as those that are lost for a period of time (e.g., overfished species closed to fishing). Therefore, this amendment would result in the continued irretrievable commitment in regard to Goliath grouper and Nassau grouper, both which have been considered overfished for over a decade and whose possession is prohibited. Furthermore, the amendment would result in the irretrievable commitment in regard to queen conch; queen conch is also considered overfished, and this amendment proposes to prohibit all harvest and possession of queen conch in the EEZ.

Implementation of a federal permit system would require a substantial expenditure of federal funds, which are not retrievable. Subsequent monitoring and re-evaluation of stock status parameters would likewise commit human and fiscal resources. The commitment of these resources is considered irretrievable.

6.13 Any other disclosures

This amendment is not expected to result in any effects on urban quality, or on historical and cultural resources.

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 manner.

The RIR also serves as the basis for determining whether any proposed regulations are a Asignificant regulatory action@ under certain criteria provided in Executive Order 12866 and whether the proposed regulations will have a Asignificant economic impact on a substantial number of small business entities@ in compliance with the Regulatory Flexibility Act of 1980 (RFA).

The RIR analyzes the probable impacts on fishery participants of the amendment to the Caribbean Fishery Management Plans for the Spiny Lobster Fishery of Puerto Rico and the U.S. Virgin Islands, Queen Conch Resources of Puerto Rico and the U.S. Virgin Islands, The Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands, and the Coral and Reef Associated Invertebrates of Puerto Rico and the U.S. Virgin Islands.

7.2 Problems and objectives

The general problems and objectives are found in the respective FMPs, as amended. The purpose and need for the present amendment area found in Section 2.3 of this document. The current plan amendment addresses the following issues: (1) defining fishery management units and sub-units, (2) defining biological reference points and stock status determination criteria, (3) regulating fishing mortality, (4) rebuilding overfished fisheries, (5) conserving and protecting yellowfin grouper, (6) achieving the MSFCMA bycatch mandates, and (7) achieving the MSFCMA EFH mandates.

7.3 Impacts of proposed alternatives

The socioeconomic impacts of the individual alternatives are discussed in two main sections of this amendment (Sections 4 and Section 6) associated with each alternative.

7.4 Private and public costs

Council costs of document preparations, meetings, public hearings, and information dissemination..$776,000
NMFS administration costs of document preparation, meetings, and review.. ....$400,000

Law enforcement costs.. unknown

Compliance costs (costs to regulated entities)... unknown

TOTAL..$1,176,000

The Council and federal costs are based on staff time, travel, printing and any other relevant items where funds were expended directly for this specific action. The various cost items have not yet been estimated.

7.5 Summary of economic impacts

Defining fishery management units and sub-units: Measures associated with defining fishery management units and sub-units, additional options for aquarium trade species, and additional options for Caribbean conch resources will generally have no direct or indirect economic impacts.

Defining biological reference points and stock status determination criteria: The specification of MSY, OY, MSST, and MFMT for the various fishery units will generally have no direct economic impacts on fishery participants. Economic impacts occur when current fishing conditions are compared to the benchmark established by these standards and additional measures are required to either restrict or expand harvests. Most of the proposed measures are proxies of the true values and detailed analysis of the potential impacts of the measures is prevented due to the data poor nature of the respective fisheries. However, given the proposed definitions of MSY, MSST, and MFMT, many of the stocks will be defined as being overfished or undergoing overfishing. This would indicate that current prosecution of the stocks, if continued at status quo, would necessitate the imposition of management measures that would impose costs on participants. Finally, the proposed levels of OY, with the exception of coral reef resources, are uniformly estimated at 94% of proposed definition of MSY. The proposed level of OY relative to MSY implies necessary restrictions on harvest from status quo levels with accompanying economic losses. These losses would be offset, however, by fishery stability and the avoidance of more restrictive recovery plans. That is, sustainable fisheries would allow for a stable fisheries management scenario absent of continually changing regulations. Additionally, preventing overfishing and rebuilding overfished fisheries before their status becomes further exacerbated would avoid overly restrictive management actions (e.g., Goliath and Nassau grouper closures).

Establish appropriate rebuilding schedules and rebuilding strategies for stocks believed to be at risk to ensure long-term benefits from the resource: The act of defining a rebuilding schedule will have no direct economic impacts. The strategy for rebuilding the stocks believed to be at risk, particularly that established for queen conch, could impose direct economic impacts. With respect to queen conch, the rebuilding schedule proposes the prohibition of all harvest and possession of queen conch in federal waters. Due to the limited amount of queen conch fishing activity in federal waters, closure of federal waters to queen conch harvest would likely have relatively minor economic impacts on fishery participants. This does not preclude the possibility that at least one queen conch fisherman harvests queen conch in federal waters only. Consequently, closure of federal waters to that activity would give fishermen, who historically fish only in federal waters, three options: 1) Continue to harvest queen conch in federal waters, but do so illegally, 2) discontinue queen conch fishing, or 3) relocate to state waters. If it is assumed that compliance is perfect, then the fisherman could lose up to 100% of queen conch revenue, with the exception of those fishermen who fish on Lang Bank off St. Croix, which would be a significant loss to that or any other and any other similar fisherman. It is highly likely that fishermen who potentially fish only in federal waters could relocated to state waters, so that losses could be mitigated.

However, it is recognized that species-specific closure of the federal waters may not provide protection of the resource necessary to rebuild it. Hence, a proposed management measure would develop a MOU that states impose compatible regulations. If these compatible regulations are adopted, both federal and state waters would be closed to queen conch harvesting and possession. In this situation, economic impacts would be significant; including a loss in gross revenues to the commercial sector of approximately $657,000 annually based on recent total commercial landings of 287,364 lbs (Table 5) and the 1998-2001 Puerto Rico average ex-vessel price of $2.285/lb (Matos-Caraballo 2002).

Conserve and protect yellowfin grouper: Proposed measures to conserve and protect yellowfin grouper would entail establishing a seasonal closure of the Grammanik Bank as well as prohibiting the harvest and possession of yellowfin grouper in EEZ waters. Based on species-specific commercial fishing data for Puerto Rico and extrapolated data from USVI, landings of yellowfin grouper in the U.S. Caribbean appears to be extremely limited and, hence, prohibition of harvest and possession of the species in federal waters would likely have only minimal impacts. That is, recent average commercial catch of Puerto Rican yellowfin grouper for the entire year, including in state waters, is 4,429 lbs (Table 5). According to Valle-Esquivel and Díaz (2003), annual average landings for all grouper species harvested in the USVI is 38,392 lbs from 1994-2002. Extrapolated landings for all species in Grouper Unit 4 for USVI for the entire year, including in state waters, is 15,482 lbs. The seasonal closure (during spawning season) of the Grammanik Bank could have some economic impact on those commercial participants who currently fish in the area during the time frame of the proposed closure. It is possible that one or more fishermen harvests yellowfin grouper only in federal waters. Consequently, while the possibility is unlikely, the proposed closure would have significant impacts on those fishermen. The closure, to the extent that it protects the stock during the spawning season and contributes to the rebuilding of the stock, could provide long-term benefits to fishing participants in terms of increased harvests.

Achieving MSFCMA bycatch mandates: The proposed measure to achieve MSFCMA bycatch mandate would require fishermen participating in Council-managed species to have a permit and complete and submit monthly reports. There would likely be a nominal fee (approximately $10-20 for a rudimentary permit) and an unknown amount of time involved in completing and submitting the monthly forms. However, it is expected that costs associated with the preferred alternative of modifying the currently existing state reporting methodology would result in much less significant impacts, especially considering fishermen are already required to comply with the permitting and reporting requirements as imposed by the states.

7.6 Determination of significant regulatory action

Pursuant to E.O. 12866, a regulation is a "significant regulatory action" if it is likely to result in: (a) an annual effect on the economy of $100 million or more; (b) a major increase in cost or prices to consumers, individual industries, federal, state, or local government agencies, or geographic regions; (c) significant adverse effects on competition, employment, investment, productivity, innovation, or on the ability of United states-based enterprises to compete with foreign-based enterprises in domestic or export markets; or (d) raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in this Executive Order.

The measures proposed in this amendment are required components of FMPs necessary to: (a) define management units and sub-units for management purposes, (b) establish appropriate benchmarks to support responsible management, (c) establish appropriate rebuilding schedules and rebuilding strategies for stocks believed to be at risk to ensure long-term benefits from the resource, (d) conserve and protect yellowfin grouper, and (e) achieve MSFCMA bycatch mandates. Such management may result in fishery regulations that reduce harvests, fishing opportunities, and, consequently, the number of businesses, vessels, or participants in the fisheries. The long-run profitability of remaining business operations should be enhanced, however, and long-term prospects and opportunities will benefit from responsible management. The total harvest of all reef fish if MSY were harvested is approximately 3.2 million pounds (Table 8). Commercial catch approximates two-thirds of this total. At $1.99351/lb, as utilized from Puerto Rico trip ticket data for reef fish species, 1995-2002, total dockside value from commercial reef fish fishing activities averages approximately $6.4 million for the period 1997-

2001. Recreational values are unknown. The total harvest of queen conch if MSY were harvested is 452,000 pounds (Table 8). Commercial catch approximates two-thirds of this total. At $2.285/lb, as utilized from 1998-2001 Puerto Rico average ex-vessel price (Matos-Caraballo 2002), total dockside value from commercial queen conch fishing activities averages approximately $1.03 million for the period 1997-2001. Recreational values are unknown. The total harvest of spiny lobster if MSY were harvested is 547,000 pounds (Table 8). Commercial catch approximates two-thirds of this total. At $5.265/lb, as utilized from 1998-2001 Puerto Rico average ex-vessel price (Matos-Caraballo 2002), total dockside value from commercial spiny lobster fishing activities averages approximately $2.9 million for the period 1997-2001. Recreational values are unknown. Total dockside value from managed commercial fishing activities would exceed $10 million based on fishing at MSY. Recreational values are unknown. The largest potential immediate loss would be that for queen conch which, if closed in both federal and state waters, would generate lost dockside revenues of about one million dollars annually. There would also be some losses in the recreational sector, but relatively limited. Thus, while the net effect of the lost fishing opportunities and profitability among remaining participants is certainly not zero, it also certainly does not reach the $100 million threshold on an annual basis.

The measures in this amendment do not interfere or create inconsistency with any action of another agency, including state fishing agencies or to affect the entitlements, grants, user fees, or loan programs. The proposed measures, for the most part, institute necessary measures of fishery status or activity and, thus, do not raise novel legal and policy issues

The foregoing discussion establishes the basis for the conclusion that this amendment, if enacted, would not constitute a “significant regulatory action.”

8 Regulatory Flexibility Act Analysis

The purpose of the Regulatory Flexibility Act (RFA) is to ensure that federal agencies consider the economic impact of their regulatory proposals on small entities, analyze effective alternatives that minimize the impacts on small entities, and make their analyzes 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 or Final Regulatory Flexibility Analysis) or to certify that the proposed rule will not “have a significant economic impact on a substantial number of small entities.” This analysis assumes that this rule may have a significant economic impact on a substantial number of small entities. Consequently, the subsequent analysis is an Initial Regulatory Flexibility Analysis (IRFA). According to the RFA, an IRFA must have the following six parts: 1) a description of the reasons why action by the agency is being considered; (2) a succinct statement of the objectives of, and legal basis for, the proposed rule; (3) a description and, where feasible, an estimate of the number of small entities to which the proposed rule will apply; (4) a description of the projected reporting, record-keeping, and other compliance requirements of the proposed rule, including an estimate of the classes of small entities which will be subject to the requirements of the report or record; (5) an identification, to the extent practical, of all relevant federal rules which may duplicate, overlap, or conflict with the proposed rule; and 6) a description of any significant alternatives to the proposed rule that minimize significant economic impacts on small entities while accomplishing the agency's objectives.

Description of the reasons why action by the agency is being considered: The need and purpose of the actions are set forth in the previous sections of this document and are included herein by reference.

Statement of the objectives of, and legal basis for, the proposed rule: The specific objectives of this action are: (1) to define FMUs and FMU sub-units, (2) to specify biological reference points and stock status determination criteria, (3) to regulate fishing mortality, (4) to rebuild overfished fisheries, (5) to conserve and protect yellowfin grouper, (6) to achieve the MSFCMA bycatch mandates, and (7) to achieve the MSFCMA EFH mandates. The MSFCMA, as amended, provides the legal basis for the rule.

Description and estimate of number of small entities to which the proposed rule will apply: Small entities, according to the RFA, are small businesses, small not-for-profit organizations, and small governmental jurisdictions. This proposed rule would apply to small commercial fishermen and small charter services in Puerto Rico and the USVI. In Puerto Rico, there are approximately 1,758 commercial fishermen, with 1,262 fishing full-time and 496 fishing part-time (Matos-Caraballo 1997). The number of commercial fishers in the USVI, based on 1998-1999 annual license reports is 349 (Valle-Esquivel and Díaz 2003). The number of year-round for-hire charter services in the U.S. Caribbean is approximately 50 with the majority located in the USVI. These fishers operate within the following industries: Finfish fishing (NAICS 114111), shellfish fishing (NAICS 114112), other marine fishing (NAICS 114119), and charter fishing (NAICS 487210). The Small Business Administration (SBA) size standards for the finfish, shellfish, and other marine fishing industries are the same, at $3.5 million in annual sales. The SBA size standard for charter fishing is $6.0 million in annual sales. We expect that all of the 1,758 commercial fishermen in Puerto Rico, all of the 349 commercial fishermen in the USVI, and all of the approximately 50 for-hire charter services in the U.S. Caribbean are small businesses.

Description of the projected reporting, record keeping and other compliance requirements of the proposed rule, including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary: This proposed rule will: 1) prohibit queen conch fishing in federal waters, with the exception of Lang Bank near St. Croix; 2) implement seasonal closures; 3) implement an immediate prohibition on the use of gill and trammel nets in the EEZ, with the exception of those nets used for catching ballyhoo, gar, and flying fish; 4) prohibit the filleting of fish in federal waters of the U.S. Caribbean; 5) close Grammanik Bank to all fishing from February 1 to April 30 of each year; 6) prohibit the use of traps and pots, gill and trammel nets, and bottom longlines year-round in currently existing seasonal closed areas for red hind and mutton snapper; and 7) require fishermen to complete and submit monthly bycatch reports.

There is one primary measure that will, if fully adopted, result in a significant reduction in short-term profitability among the small businesses that harvest queen conch. This proposed measure is the prohibition of harvest and possession of queen conch in the EEZ, with the exception of Lang Bank off St. Croix. If implemented only in federal waters, the closure will have relatively small impacts (particularly in Puerto Rico) since the majority of queen conch activities transpire in state waters. It is believed, however, that closure of federal waters may be insufficient in rebuilding the queen conch stock due to the high level of activity in state waters vis-a-vis federal waters. Hence, also considered as a preferred measure is the development of a MOU between NMFS and state governments to develop compatible regulations to achieve the management objectives in the FMP. If adopted, this would lead to the prohibition of queen conch harvest and possession throughout the U.S. Caribbean, in both federal and state waters. Given the multi-species nature of commercial harvesting activities throughout the U.S. Caribbean, it is difficult to quantify the exact number of commercial fishermen that would be impacted. One estimate, by Rivera (1999), suggests 209 queen conch fishermen in Puerto Rico and another 51 in the USVI. This estimate, however, almost certainly understates the number of fishermen who receive revenues and, hence, profits from the harvest of queen conch because queen conch is often taken in conjunction with other fishing activities, primarily lobster. While all of the "directed" queen conch fishermen will be significantly impacted by the proposed closure, other fishermen who harvest queen conch on an opportunistic basis will also be impacted, though to a somewhat lesser extent.

In some limited attempt to put the queen conch closure into perspective, however, the estimated value of the U.S. Caribbean's commercial landings (i.e., managed species) during the 1997-2001 period has averaged about $7.2 million annually. ($4,562,248 for reef fish; $1,952,557 for spiny lobster; and $656,627 for queen conch). The estimated value of queen conch landings is about nine percent of the total landings value. These estimates are based on Puerto Rico ex-vessel values for reef fish (1995-2002), spiny lobster (1998-2001), and queen conch (1998-2001). Estimated values for USVI reef fish, spiny lobster, and queen conch are slightly higher, but this is due to the difference in marketing between USVI and Puerto Rico; USVI fishermen typically sell directly to restaurants and other consumers, and does not reflect a true ex-vessel value. Therefore, for the purposes of the analyses herein, ex-vessel values for Puerto Rico have been applied to both Puerto Rico and USVI landings.

There are some other measures that will, if implemented, also impact profitability. One relates to the protection of yellowfin grouper by implementing a seasonal closure of an identified spawning aggregation area in federal waters. Since landings of yellowfin grouper are extremely limited (at least in Puerto Rico; species-specific landings data are unavailable in the USVI); however, this proposed measure will not significantly affect profitability.

Similarly, federal waters have been closed to Nassau grouper harvest and possession since 1990, though USVI waters are not closed. A proposed measure would, like queen conch, develop a MOU between NMFS and the USVI to develop compatible regulations. Since Nassau grouper landings in USVI waters are extremely limited, this proposed measure would have little or no affect on profitability.

Regulations proposed to monitor bycatch will require various reporting and/or record keeping by various participants in the fisheries. Specifically, the proposed preferred alternative for monitoring bycatch requires an additional reporting requirement for bycatch to existing state monthly trip ticket reporting requirements for fishermen participating in Council-managed fisheries. Prior to 2004, a voluntary trip ticket reporting system was utilized in Puerto Rico, though a large percentage (81% during 1995-1996 according to Matos-Caraballo 1997) of the commercial fishermen participated in the system. The system is very detailed, requesting catch information by species. Recently, Puerto Rico amended its fishery laws, and now monthly commercial catch reporting is mandatory. Since anecdotal information suggests that bycatch is very limited though, one might anticipate that bycatch reporting requirements will entail little additional time or effort. The fact that compliance with the older voluntary reporting system in Puerto Rico was relatively high leads to the conclusion that most small businesses in Puerto Rico have the professional skills required for the preparation of the records. The USVI has a monthly mandatory reporting system though the information requested on the reporting forms is less extensive than that requested for Puerto Rico. While the proposed measure does not list the information that would be required on the monthly reporting forms, one might anticipate, based on information generally requested on federal trip ticket forms, that information requirements would be greater than those currently established. Given that Puerto Rico fishermen are able to complete rather detailed forms, however, it seems reasonable to assume that the small USVI businesses would also be able to complete required paperwork.

Identification of all relevant federal rules which may duplicate, overlap or conflict with the proposed rule: No duplicative, overlapping, or conflicting federal rules have been identified.

Description of significant alternatives to proposed rule and discussion of how the alternatives attempt to minimize economic impacts on small businesses: The identification of MSY, OY, MSST, and MFMT, as well as rebuilding schedules for overfished resources, are required components of an FMP. Specific standards and requirements for each measure and acceptable proxies have been established that dictate acceptable values or plans. Therefore, very little flexibility exists in identifying alternatives. The alternatives presented in the proposed rule generally reflect either proxies that may previously been acceptable, but are no longer acceptable due to new standards, or maintain the status quo definition, which would be in violation of the requirements of the FMP.

The primary rule that restricts harvest is, as noted, the prohibition of harvest and possession of queen conch in federal waters (both commercial and recreational) with a concomitant request that states develop compatible regulations *via* an MOU. In general, two other alternatives were presented with respect to the closure and one alternative to development of a MOU. With respect to prohibition, the primary alternative was that of no action (i.e., rely on current regulations to rebuild the stock). This alternative would not have been consistent with MSFCMA guidelines. The other alternative is similar to the adopted measure but excludes one small area off the east coast of St. Croix. While this alternative would have minimized economic impacts to a relatively few number of participants, the prevailing thought was that the significant overfished status of the resource warranted complete closure.

Other actions that restrict harvest are the seasonal and area closures. Alternatives that were considered, but ultimately rejected as stated elsewhere, varied the length of time an area would be closed and the size and location of the closed areas.

With respect to the MOU and other proposed actions, the adopted measures do not attempt to minimize adverse impacts on small businesses. However, these measures do give the affected small businesses legal options to mitigate most, and in some cases all, of the economic losses caused by actions within this proposed rule, either by relocating fishing effort from the EEZ to state waters or harvesting more of other species within the EEZ. Given the mandate to rebuild overfished stocks within a given time frame, the long-term economic benefits to these small businesses will outweigh the short-term adverse economic impacts.

9 Other applicable law

The MSFCMA (16 U.S.C. 1801 et seq.) provides the authority for U.S. fishery management. But 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 within which those fisheries are conducted. Major laws affecting federal fishery management decision making are summarized below.

9.1 Administrative Procedures Act

All federal rulemaking is governed under the provisions of the Administrative Procedure Act (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, NOAA Fisheries 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.

9.2 Coastal Zone Management Act

The Coastal Zone Management Act (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, NOAA Fisheries 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.

9.3 Data Quality Act

The Data Quality Act (DQA) (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 FMPs and amendments and the use of best available information is the second national standard under the MSFCMA. To be consistent with the Act, FMPs and amendments must be based on the best information available, properly reference all supporting materials and data, and should be reviewed by technically competent individuals. With respect to original data generated for FMPs and amendments, it is important to ensure that the data are collected according to documented procedures or in a manner that reflects standard practices accepted by the relevant scientific and technical communities. Data should also undergo quality control prior to being used by the agency.

9.4 Endangered Species Act

The Endangered Species Act (ESA) of 1973 (16 U.S.C. Section 1531 et seq.) requires that federal agencies use their authorities to conserve endangered and threatened species, and that they ensure actions they authorize, fund, or carry out are not likely to harm the continued existence of those species or the habitat designated to be critical to their survival and recovery. The ESA requires NOAA Fisheries, when proposing a fishery action that "may affect" critical habitat or endangered or threatened species, to consult with the appropriate administrative agency (itself for most marine species, the U.S. Fish and Wildlife Service for all remaining species) to determine the potential impacts of the proposed action. Consultations are concluded informally when proposed actions "may affect but are not likely to adversely affect" endangered or threatened species or designated critical habitat. Formal consultations, including a biological opinion, are required when proposed actions may affect and are "likely to adversely affect" endangered or threatened species or designated critical habitat. If jeopardy or adverse modification is found, the consulting agency is required to suggest reasonable and prudent alternatives.

On April 28, 1989, NOAA Fisheries Southeast Region (SERO) completed a formal consultation, including a Biological Opinion (Opinion), on the effects of commercial fishing activities in the Southeast Region on threatened and endangered species. Caribbean fisheries were reviewed for their impacts on ESA-listed species as part of that consultation. The reef fish and spiny lobster trap fisheries and haul seines and beach fisheries in the U.S. Caribbean were identified in the list of Southeast fisheries that may adversely affect sea turtles. However, the Opinion concluded that commercial fisheries are not likely to jeopardize the continued existence of any listed species. Further, consultations on Caribbean FMPs and amendments since that time have concluded that the proposed actions are not likely to adversely affect ESA-listed species.

NOAA Fisheries Office of Sustainable Fisheries has requested initiation of a Section 7 consultation with the SERO's Division of Protected Resources for this amendment. Although ESA-listed species may benefit from some of the additional management measures proposed, NOAA Fisheries believes the impacts of continued operation of Caribbean fisheries on ESA listed species warrant reassessment. The results of the consultation will be complete before the Secretary makes a decision on the approvability of the amendment.

9.5 Executive Orders

9.5.1 E.O. 12612: Federalism

The Executive Order on federalism requires agencies in formulating and implementing policies that have federalism implications, 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 that are 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 amendment given the overlapping authorities of NOAA Fisheries, the states, and local authorities in managing coastal resources, including fisheries, an 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 state, tribes and local entities (international too).

9.5.2 E.O. 12866: Regulatory Planning and Review

Executive Order 12866: Regulatory Planning and Review, 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, NOAA Fisheries 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 RFA. A regulation is significant if it is likely to result in an annual effect on the economy of at least $100,000,000 or has other major economic effects.

9.5.3 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. Management measures limiting fishing seasons, areas, quotas, fish size limits, and bag limits do not appear to have any taking implications. There is a takings implication if a fishing gear is prohibited, because fishermen who desire to leave a fishery might be unable to sell their investment, or if a fisherman is prohibited by federal action from exercising property rights granted by a state.

9.5.4 E.O. 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations

This Executive Order requires that federal agencies conduct their programs, policies and activities in a manner to ensure that individuals or populations are not excluded from participation in, or denied the benefits of, or subjected to discrimination because of their race, color, or national origin. In addition, and specifically with respect to subsistence consumption of fish and wildlife, federal agencies are required to collect, maintain and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence. Impacts of commercial and recreational fishing on subsistence fishing is a concern in fisheries management.

9.5.5 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 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 NOAA Fisheries and the U.S. Fish and Wildlife Service to develop a joing agency policy for administering the ESA.

9.5.6 E.O. 13084: Consultation and Coordination With Indian Tribal Governments

This Executive Order recognizes and reaffirms the U.S. governments responsibility for continued collaboration and consultation with tribal governments in the development of federal policies that have tribal implications. This Order relates to indigenous fishing.

9.5.7 E.O. 13089: Coral Reef Protection

The Executive Order on Coral Reef Protection 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).

9.5.8 E.O. 13158: Marine Protected Areas

Executive Order 13158 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. The broad definition of MPAs will include many sites in the U.S. EEZ as part of the National MPA System.

9.5.9 E.O. 13186: Responsibilities of Federal Agencies to Protect Migratory Birds

Executive Order 13186 directs each federal agency taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations to develop and implement a MOU with the United States Fish and Wildlife Service (USFWS) to conserve those bird populations. The MOU will address actions taken by NOAA Fisheries that have, or are likely to have, a measurable negative effect on migratory bird populations. In the instance of unintentional take of migratory birds, NOAA Fisheries would develop and use principles, standards, and practices that will lessen the amount of unintentional take, developing any such conservation efforts in cooperation with the USFWS. Additionally, the MOU would ensure that NEPA analyses evaluate the effects of actions and agency plans on migratory birds, with emphasis on species of concern.

The required MOU is currently being developed, which will address the incidental take of migratory birds in commercial fisheries under the jurisdiction of NOAA Fisheries. NOAA Fisheries must monitor, report, and take steps to reduce the incidental take of seabirds that occurs in fishing operations. The United States has already developed the U.S. National Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries, and many potential MOU components are already being implemented under that plan. Development of the plan was a collaborative effort between NOAA Fisheries, USFWS, and the Department of State, carried out in large part by the Interagency Seabird Working Group consisting of representatives from those three agencies.

9.6 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) (16 U.S.C. 1361 et seq.), originally enacted in 1972, 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, and on the importing of marine mammals and marine mammal products into the United States. The Secretary of Commerce is responsible for the conservation and management of all pinnipeds, other than walruses; the Secretary of the Interior for all other marine mammals. This responsibility includes maintaining populations of marine mammals at optimum levels, defined as "…the number of animals which will result in the maximum productivity of the population or the species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element," and developing conservation plans for populations that fall below this threshold level. Marine mammal stock assessments, take reduction plans for stocks reduced or depleted as a consequence of interacting with commercial fisheries, and studies of pinniped-fishery interactions are all components of a new system established by the 1994 amendments to the MMPA to control marine mammal mortality in commercial fisheries. Under this new system, all U.S. commercial fishing operations are characterized as one of three types based on their levels of incidental and serious injury of marine mammals. At a minimum, vessel owners must register for an Authorization Certificate and may also be required to carry fishery observers.

Under section 118 of the MMPA, NOAA Fisheries must publish, at least annually, a List of Fisheries that places all U.S. commercial fisheries into one of three categories based on the level of incidental serious injury and mortality of marine mammals that occurs in each fishery. The Final Rule for the 2003 List of Fisheries classifies all U.S. Caribbean commercial fisheries under the Caribbean Fishery Management Council's jurisdiction as Category III fisheries, meaning that the annual mortality and serious injury of a stock resulting from each fishery is less than or equal to 1% 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 (68 FR 41725). The 2004 Proposed List of Fisheries was published on April 13, 2004 (69 FR 19365).

9.7 Migratory Bird Treaty Act

Under the Migratory Bird Treaty Act (MBTA), it is unlawful to pursue, hunt, take, capture, kill, possess, trade, or transport any migratory bird, or any part, nest, or egg of a migratory bird, included in treaties between the United States and Great Britain, Mexico, Japan, or the former Union of Soviet Socialists Republics, except as permitted by regulations issued by the Department of the Interior. Violations of the MBTA carry criminal penalties; any equipment and means of transportation used in activities in violation of the MBTA may be seized by the United States government and, upon conviction, must be forfeited to it. To date, the MBTA has been applied to the territory of the United States and coastal waters extending three miles from shore. Furthermore, Executive Order 13186 (see Section 9.5.9) was issued in 2001, which directs federal agencies, including NOAA Fisheries, to take certain actions to further implement the MBTA.

9.8 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. Under NEPA and its implementing regulations, NOAA Fisheries is required to prepare environmental impact statements for major fishery actions that significantly affect the quality of the human environment.

9.9 National Marine Sanctuaries Act

Under the National Marine Sanctuaries Act (NMSA) (also known as Title III of the Marine Protection, Research and Sanctuaries Act of 1972), as amended, the Secretary of Commerce is authorized to designate National Marine Sanctuaries to protect distinctive natural and cultural resources whose protection and beneficial use requires comprehensive planning and management. The National Marine Sanctuary Program is administered by the Sanctuaries and Reserves Division of the NOAA. The Act provides authority for comprehensive and coordinated conservation and management of these marine areas. The National Marine Sanctuary Program currently comprises 13 sanctuaries around the country, including sites in American Samoa and Hawaii. These sites include significant coral reef and kelp forest habitats, and breeding and feeding grounds of whales, sea lions, sharks, and sea turtles. A complete listing of the current sanctuaries and information about their location, size, characteristics, and affected fisherie can be found at http://www.sanctuaries.nos.noaa.gov/oms/oms.html. No national marine sanctuaries are located in the U.S. Caribbean.

9.10 Paperwork Reduction Act

The Paperwork Reduction Act 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 NOAA Fisheries to obtain approval from the Office of Management and Budget before requesting most types of fishery information from the public.

9.11 Regulatory Flexibility Act

The purpose of the Regulatory Flexibility Act (RFA) 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 (IRFA or Final Regulatory Flexibility Analysis) 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 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.

9.12 Small Business Act

Enacted in 1953, the Small Business Act requires that agencies assist and protect small-business interests to the extent possible to preserve free competitive enterprise.

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11 Appendices

Appendix A - Tables and Figures

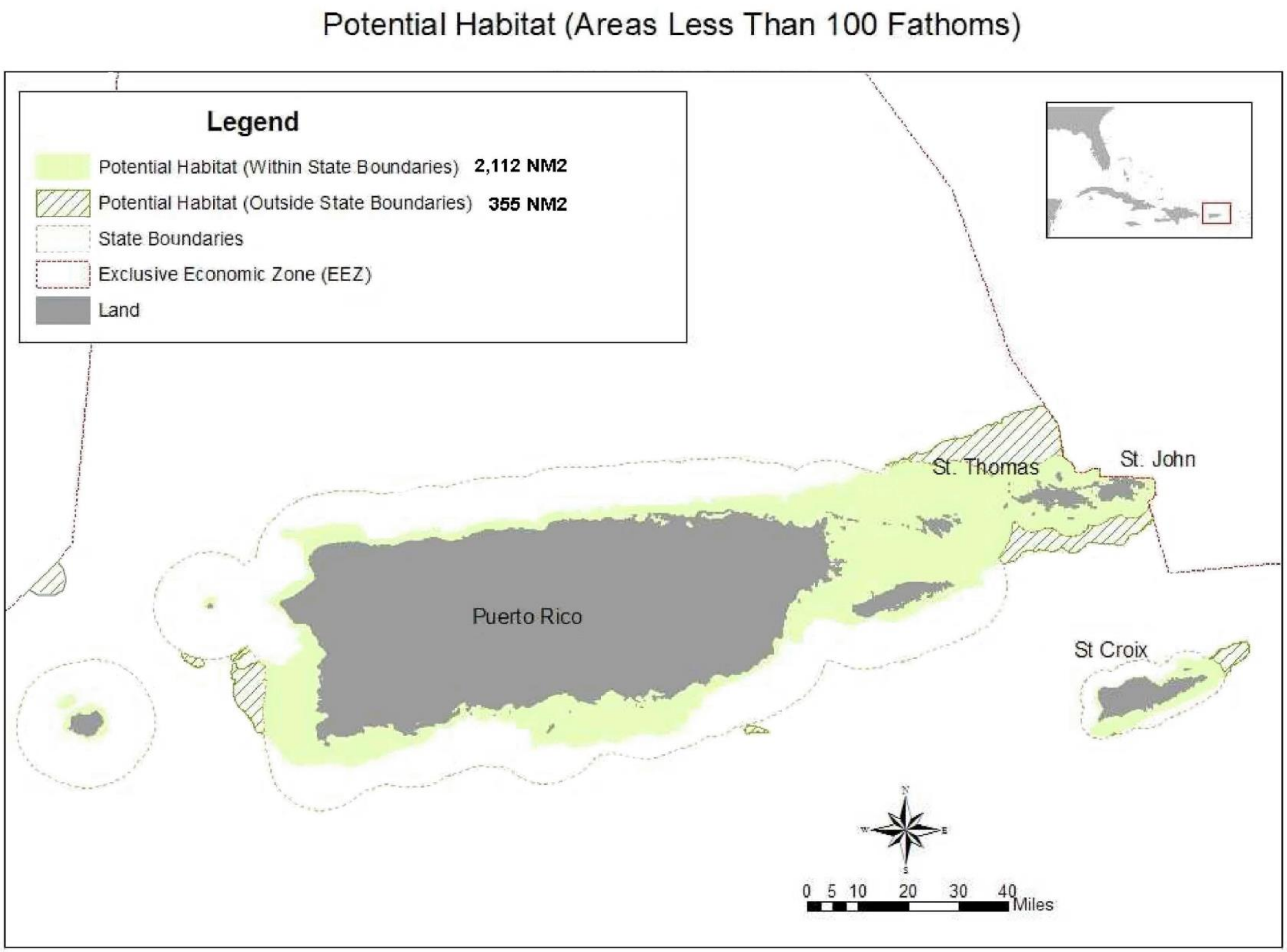

Figure 1. Map of the U.S. Caribbean and the 100-Fathom Contour.

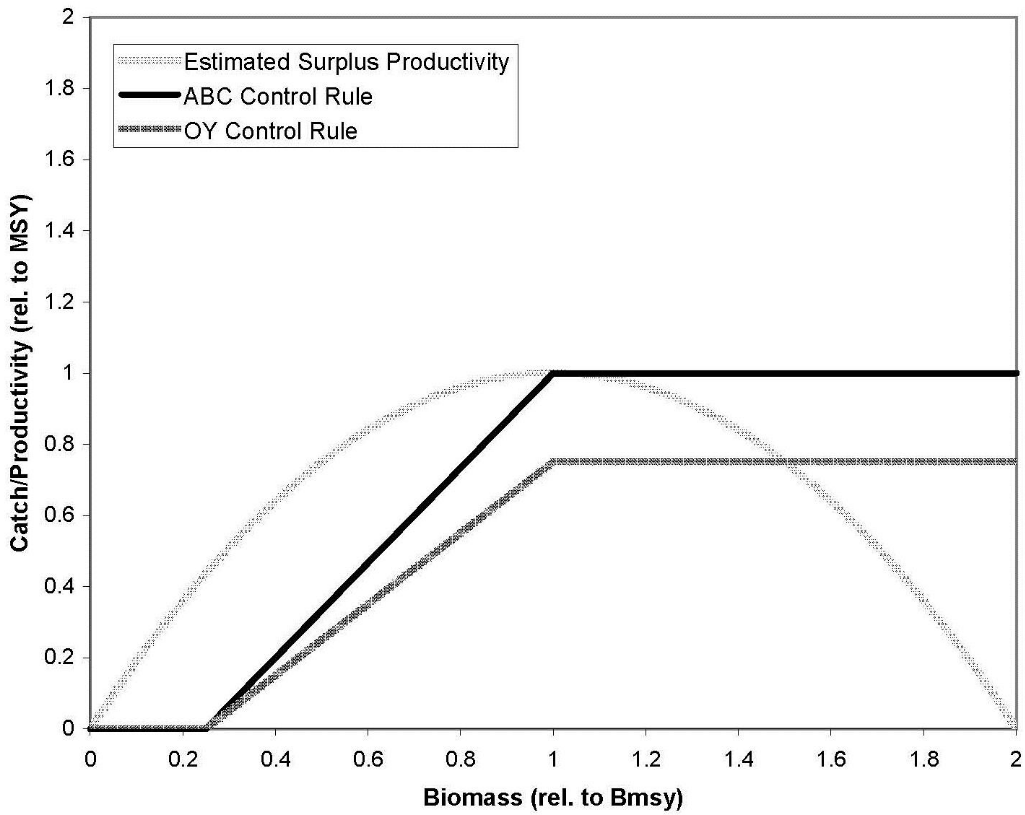

Figure 2. Illustration of Control Rule Alternative 2.

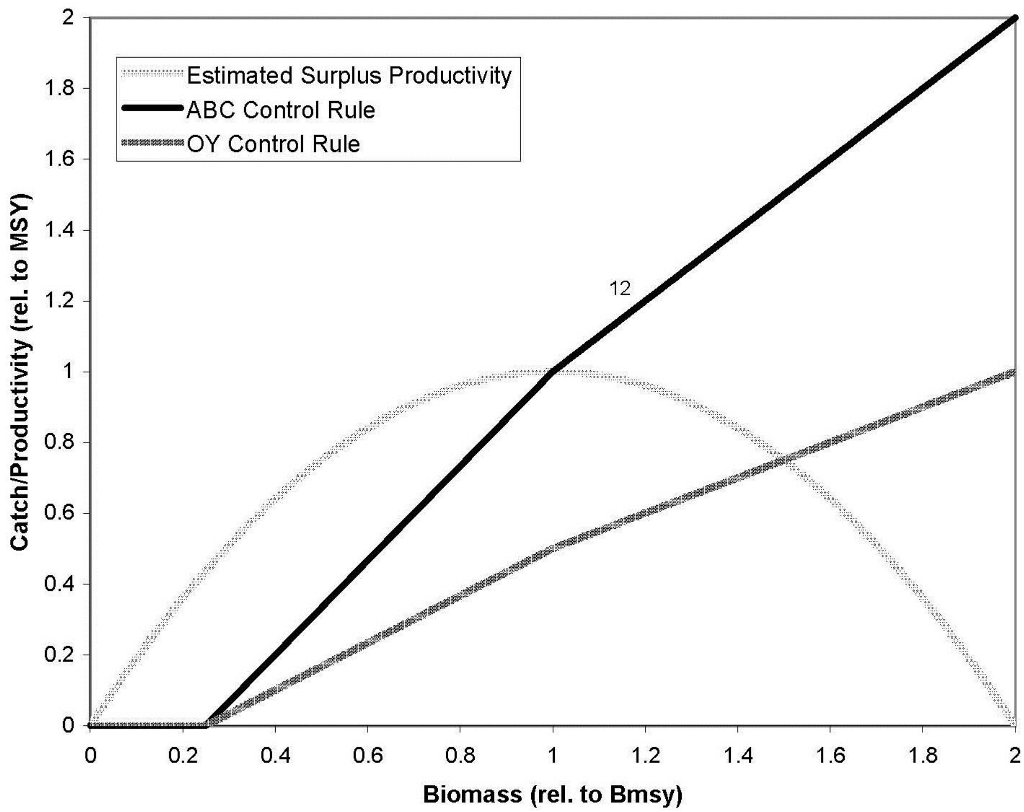

Figure 3. Illustration of Control Rule Alternative 4.

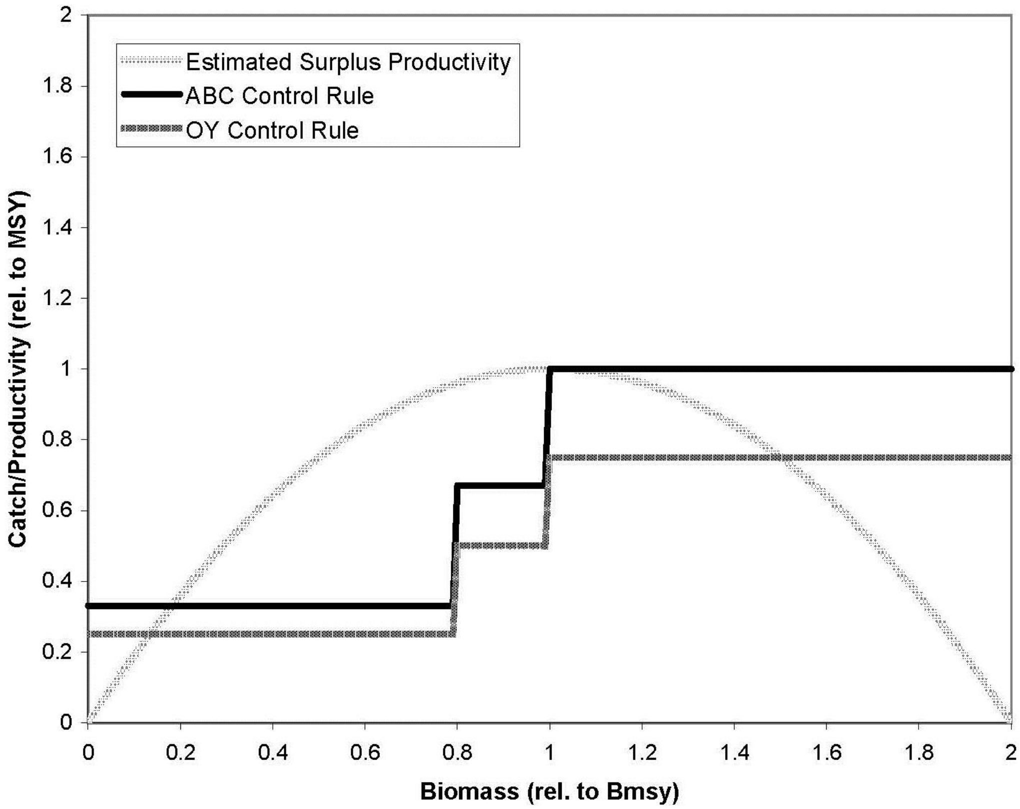

Figure 4. Illustration of Control Rule Alternative 5.

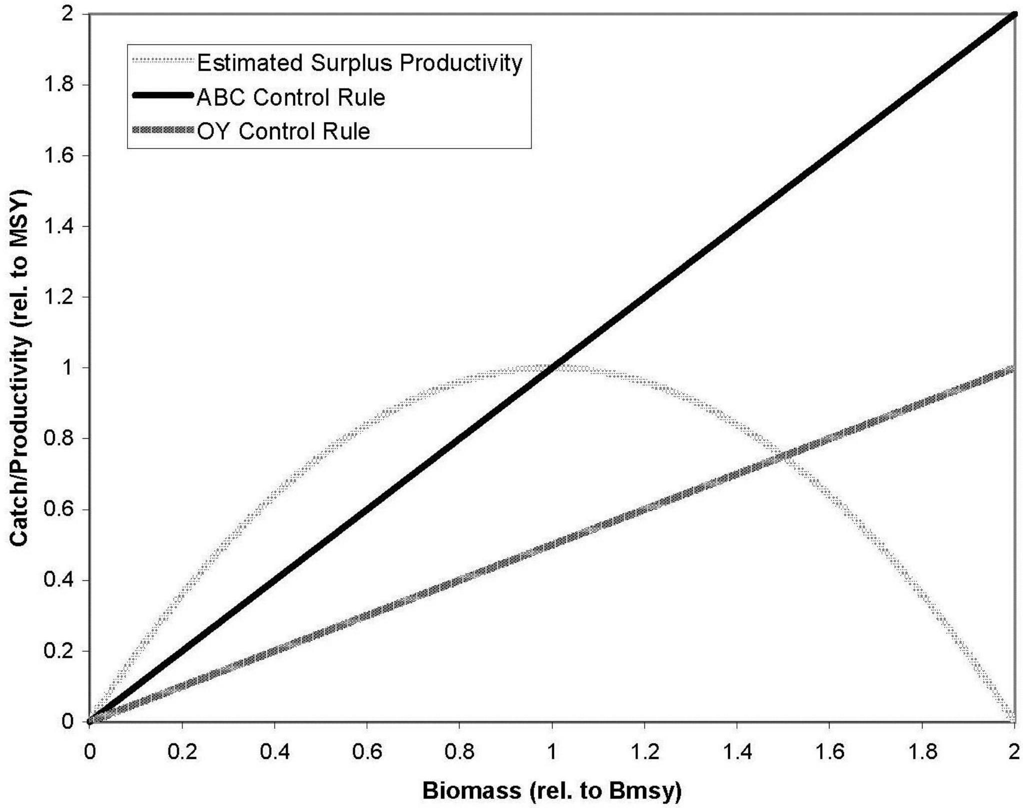

Figure 5. Illustration of Control Rule Alternative 6.

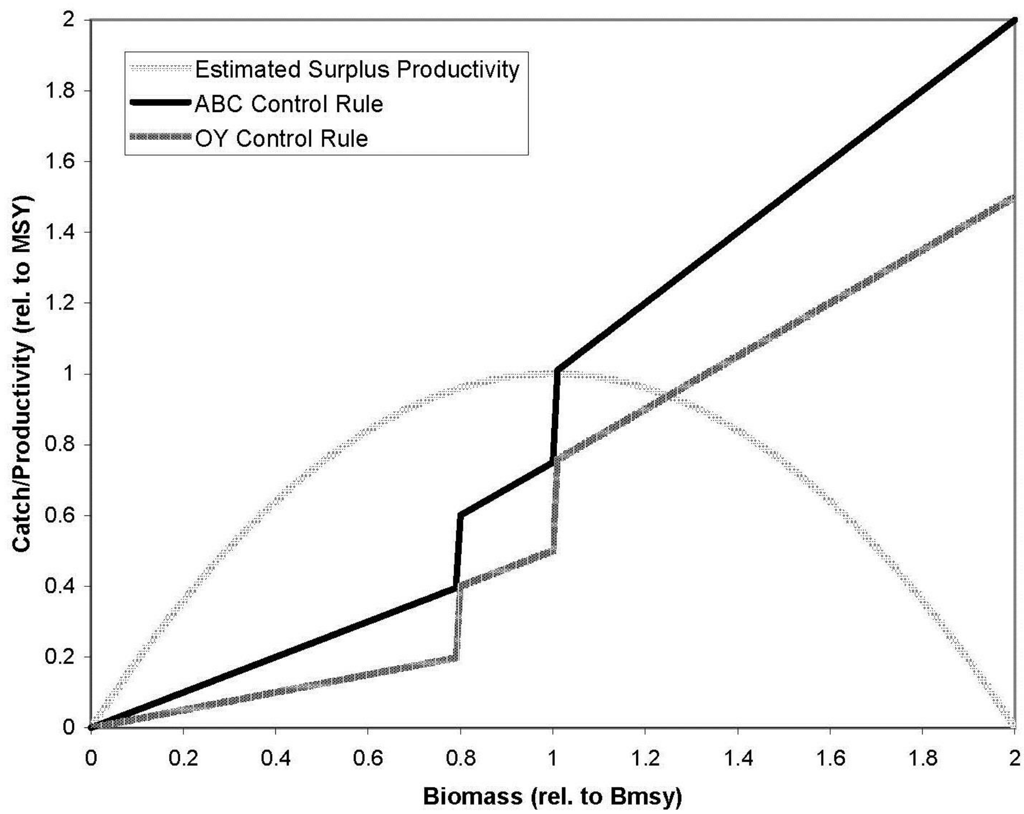

Figure 6. Illustration of Control Rule Alternative 7.

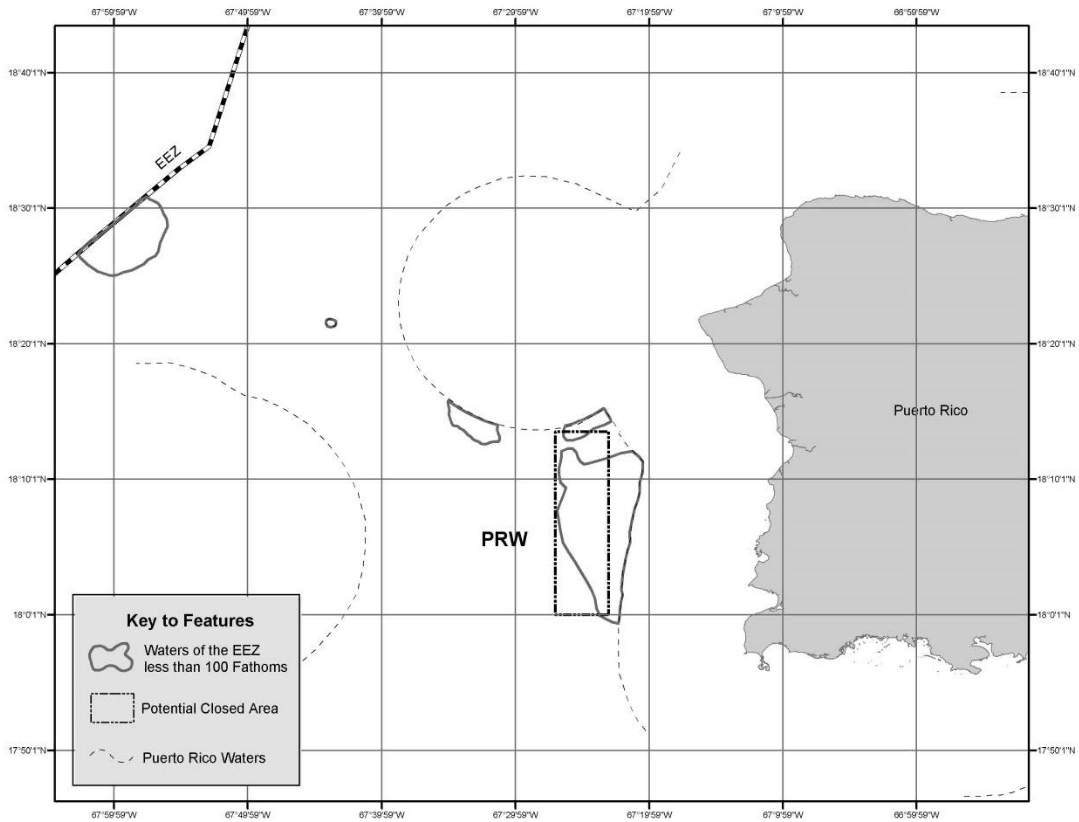

Figure 7. Proposed closed area off west coast of Puerto Rico.

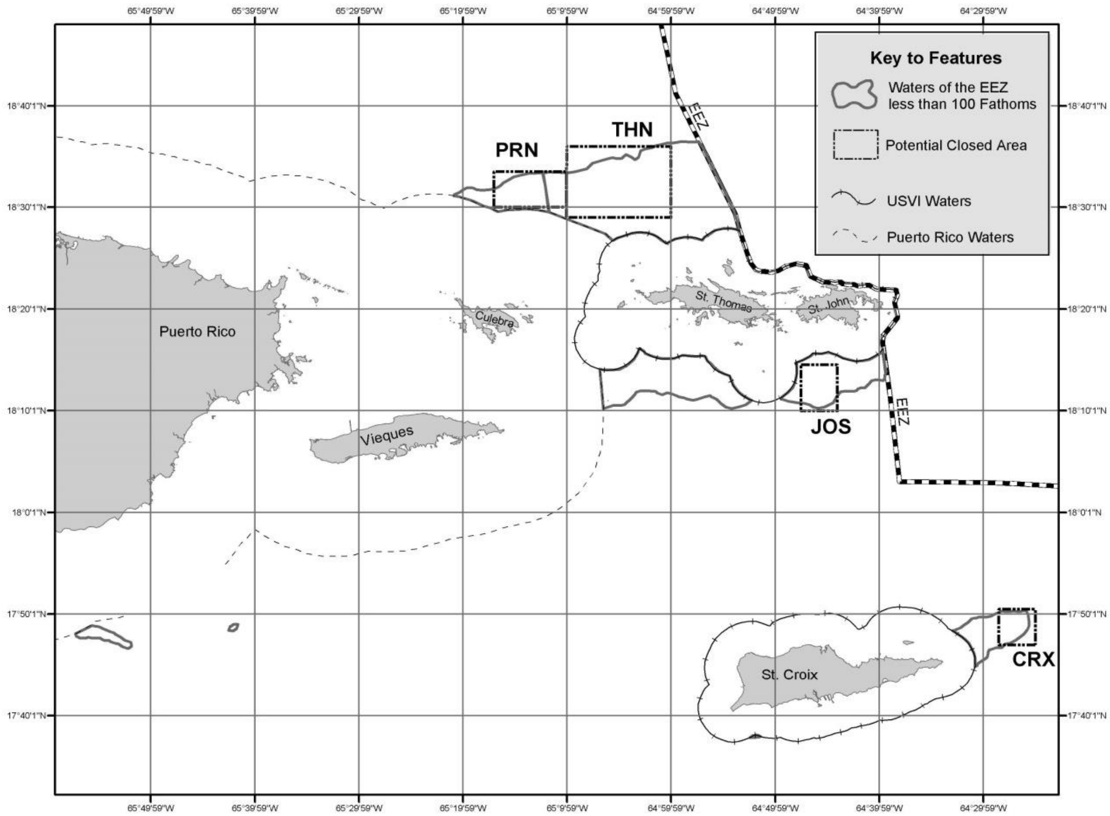

Figure 8. Proposed closed area off the east coast of Puerto Rico, and proposed closed areas off the USVI.

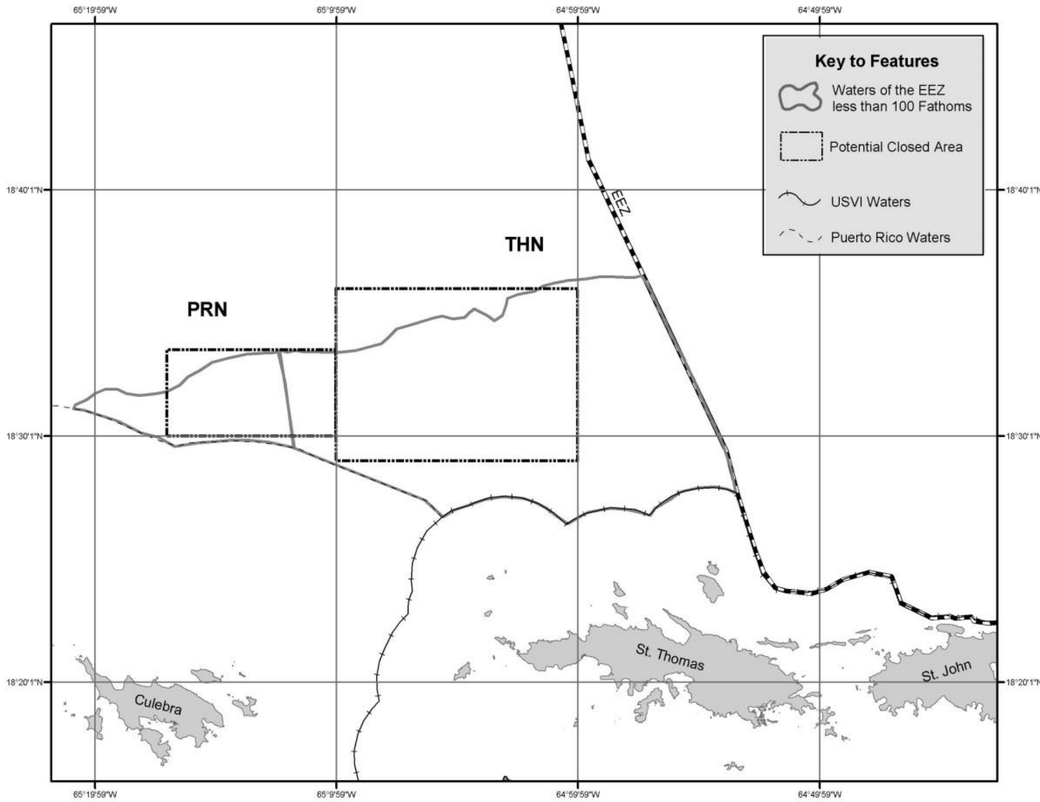

Figure 9. Proposed closed areas off the east coast of Puerto Rico and north of St. Thomas, USVI.

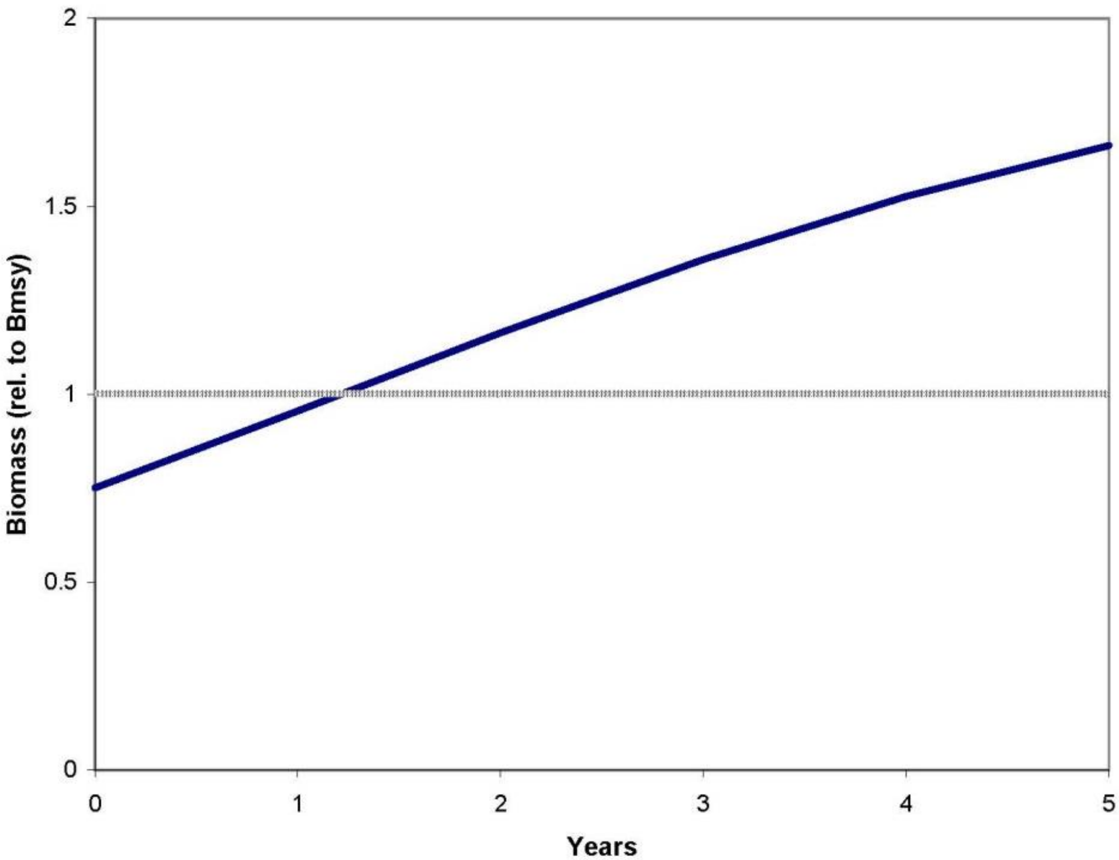

Figure 10. Recovery plot illustration for Snapper Unit 4.

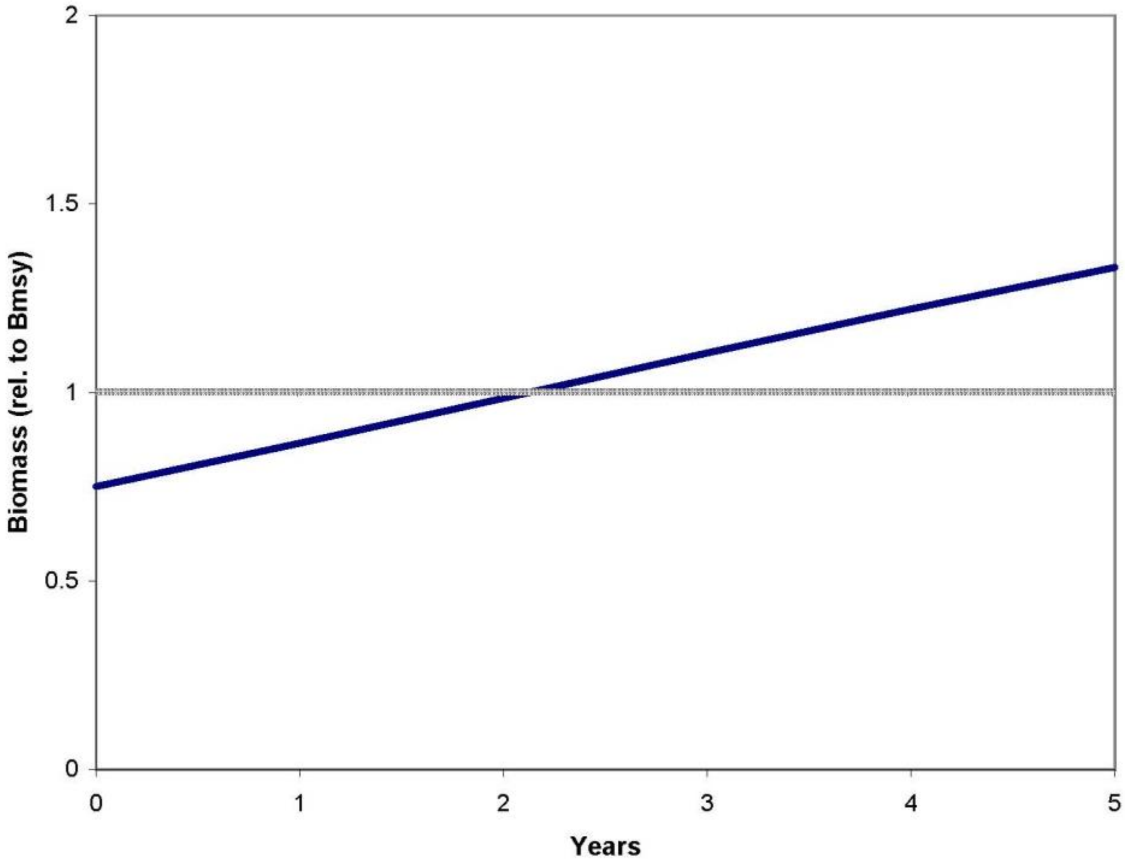

Figure 11. Recovery plot illustration for Grouper Unit 4.

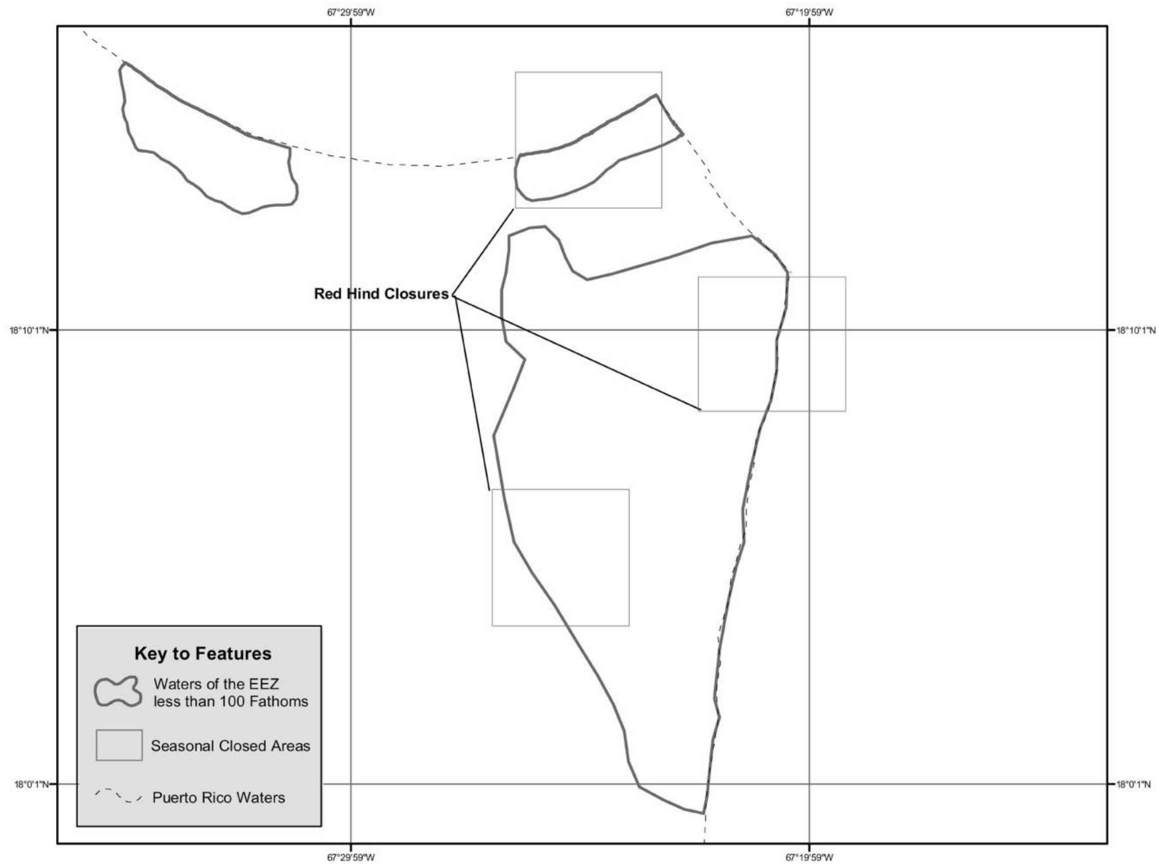

Figure 12. Seasonal closures for red hind spawning aggregations off the west coast of Puerto Rico.

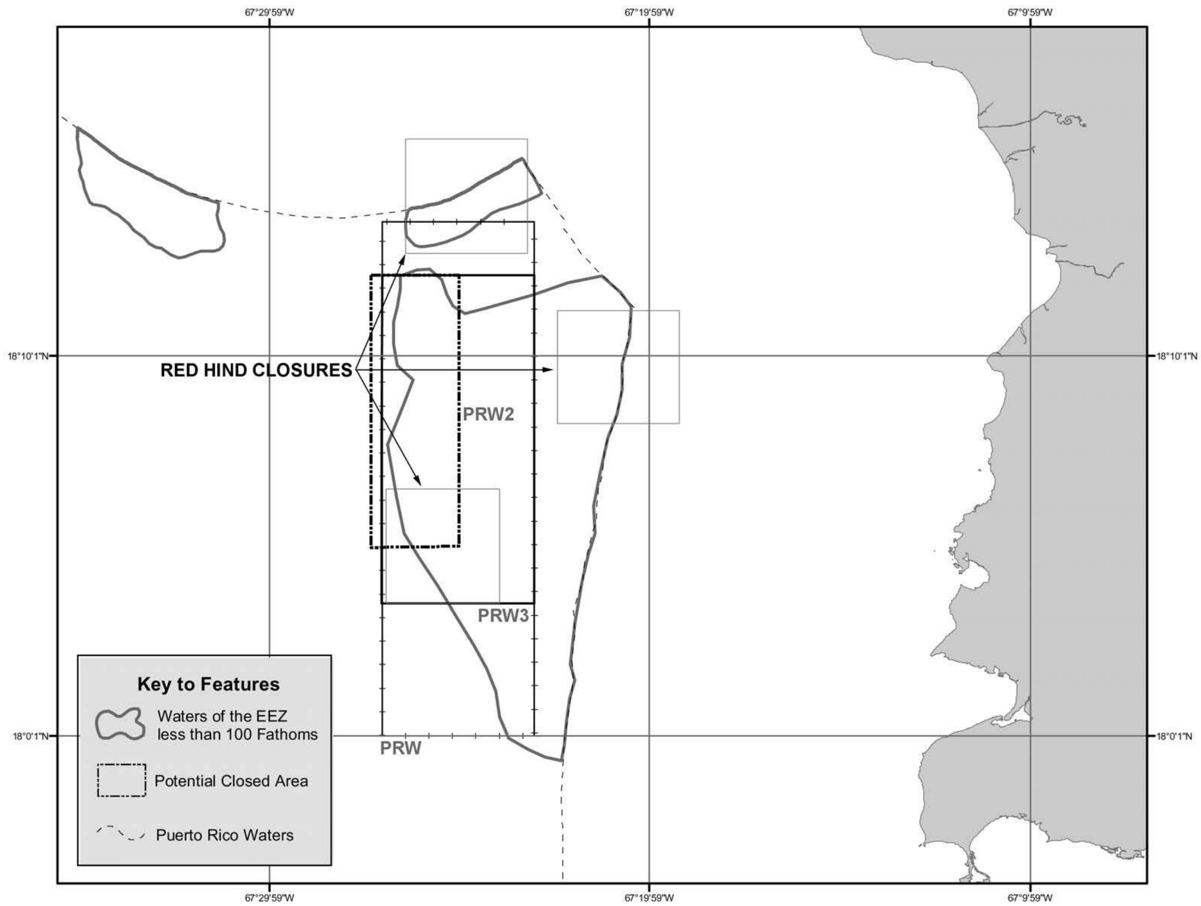

Figure 13. Proposed closed areas (PRW, PRW2, and PRW3) off the west coast of Puerto Rico.

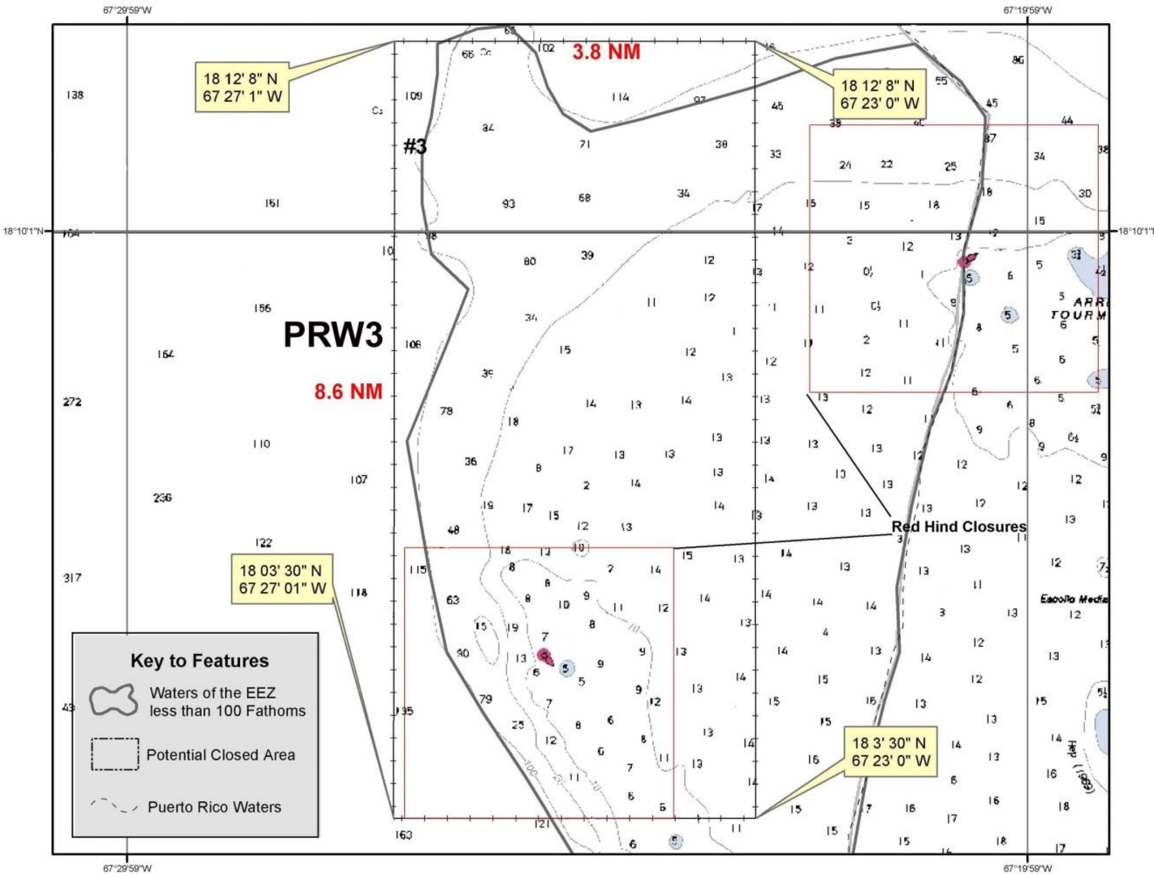

Figure 14. Proposed closed area (PRW3) and bathymetry off the west coast of Puerto Rico.

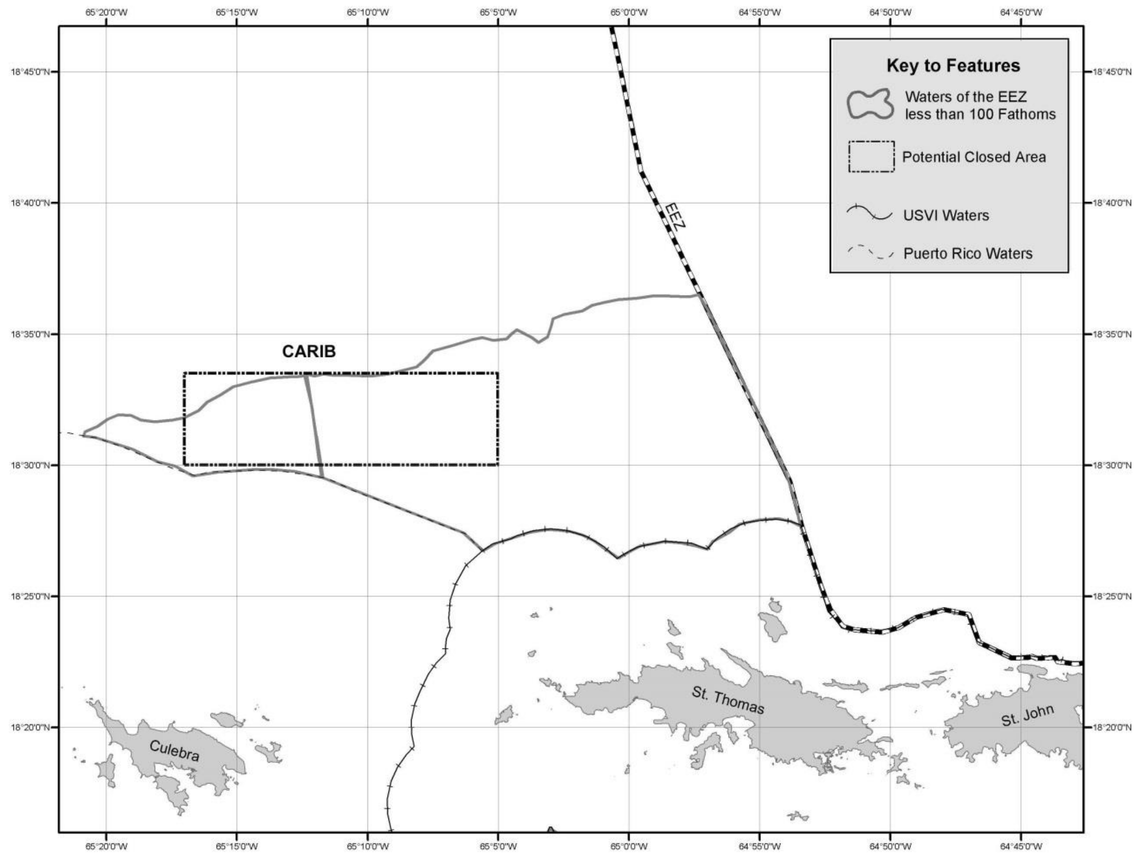

Figure 15. Proposed closed area (CARIB) north of Culebra, Puerto Rico and St. Thomas, USVI.

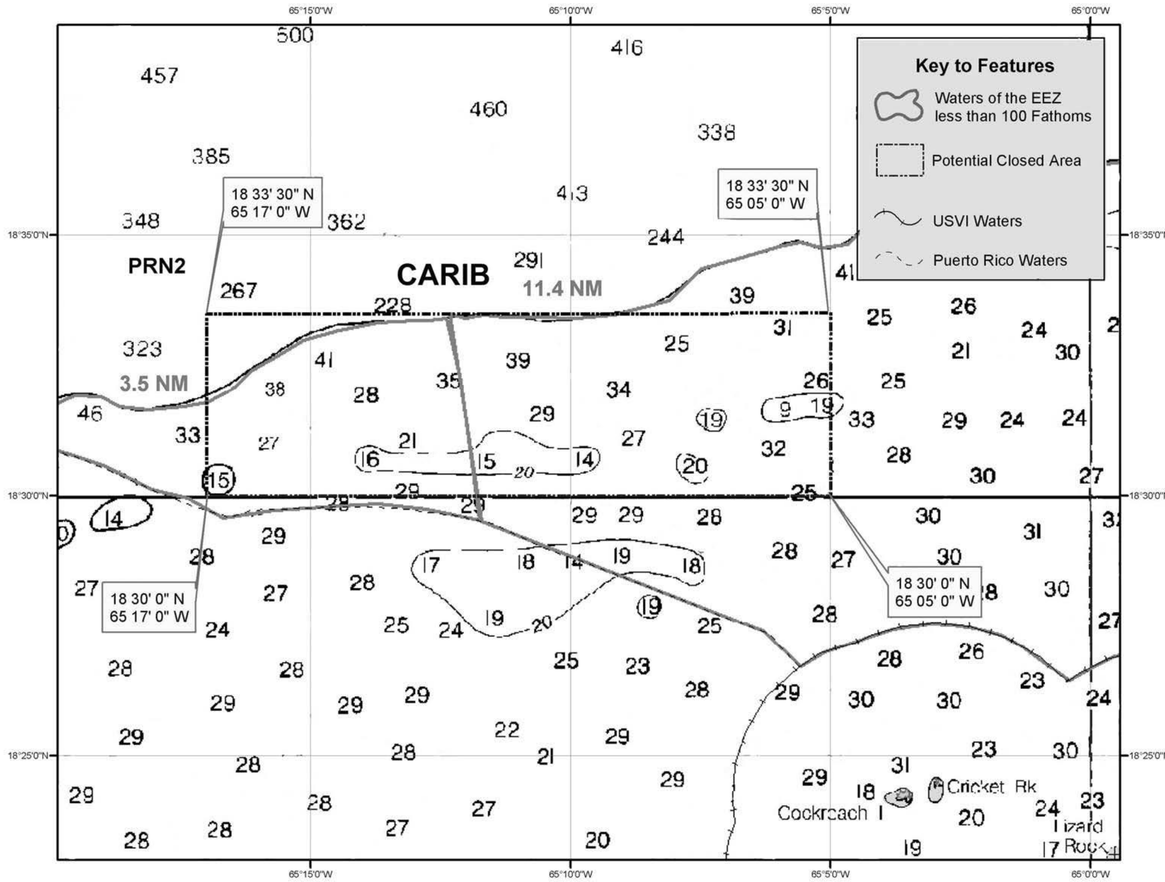

Figure 16. Proposed closed area (CARIB) and bathymetry north of Culebra, Puerto Rico and St. Thomas, USVI.

Table 2. Species in the Caribbean Conch Resource FMU.

Atlantic triton's trumpet, *Charonia variegata*	Milk conch, *Strombus costatus*
Cameo helmet, *Cassis madagascarensis*	Queen conch, *Strombus gigas*
Caribbean helmet, *Cassis tuberosa*	Roostertail conch, *Strombus gallus*
Caribbean vase, *Vasum muricatum*	True tulip, *Fasciolaria tulipa*
Flame helmet, *Cassis flammea*	West Indian fighting conch, *Strombus pugilis*
Green star shell, *Astrea tuber*	**Whelk (West Indian top shell), *Cittarium pica***
Hawkwing conch, *Strombus raninus*	

NOTE: Species in bold are those that would be deleted from the FMU proposed in Section 4.1.1.2.

Table 3. Species in the Caribbean Reef Fish FMU.

Acanthuridae -- Surgeonfishes
- Ocean surgeonfish, *Acanthurus bahianus*
- Doctorfish, *Acanthurus chirurgus*
- Blue tang, *Acanthurus coeruleus* [2]

Antennariidae -- Frogfishes
- Frogfish, *Antennarius* spp. [1]

Apogonidae -- Cardinalfishes
- Flamefish, *Apogon maculatus* [1, 2]
- Conchfish, *Astrapogen stellatus* [1]

Aulostomidae -- Trumpetfishes
- Trumpetfish, *Aulostomus maculatus* [1]

Balistidae -- Leatherjackets
- Scrawled filefish, *Aluterus scriptus*
- Queen triggerfish, *Balistes vetula*
- Whitespotted filefish, *Cantherhines macrocerus*
- Ocean triggerfish, *Canthidermis sufflamen*
- Black durgon, *Melichthys niger*
- Sargassum triggerfish, *Xanthichthys rigens* [2]

Blenniidae -- Combtooth blennies
- Redlip blenny, *Ophioblennius atlanticus* [2]

Bothidae -- Lefteye flounders
- Peacock flounder, *Bothus lunatus* [1]

Carangidae -- Jacks
- Yellow jack, *Caranx bartholomaei*
- Blue runner, *Caranx crysos*
- Horse-eye jack, *Caranx latus*
- Black jack, *Caranx lugubris*
- Bar jack, *Caranx ruber*
- Greater amberjack, *Seriola dumerili*
- Almaco jack, *Seriola rivoliana*

Chaetodontidae -- Butterflyfishes
- Longsnout butterflyfish, *Chaetodon aculeatus* [1]
- Foureye butterflyfish, *Chaetodon capistratus* [1]
- Spotfin butterflyfish, *Chaetodon ocellatus* [1]
- Banded butterflyfish, *Chaetodon striatus* [1]

Cirrhitidae -- Hawkfishes
- Redspotted hawkfish, *Amblycirrhitus pinos* [2]

Dactylopteridae -- Flying gurnards
- Flying gurnard, *Dactylopterus volitans* [1]

Ephippidae -- Spadefishes
- Atlantic spadefish, *Chaetodipterus faber*

Gobiidae -- Gobies
- Neon goby, *Gobiosoma oceanops* [1]
- Rusty goby, *Priolepis hipoliti* [1]

Grammatidae -- Basslets
- Royal gramma, *Gramma loreto* [2]

Haemulidae -- Grunts
- Porkfish, *Anisotremus virginicus*
- Margate, *Haemulon album*
- Tomtate, *Haemulon aurolineatum*
- French grunt, *Haemulon flavolineatum*
- White grunt, *Haemulon plumieri*
- Bluestriped grunt, *Haemulon sciurus*

Holocentridae -- Squirrelfishes
- Squirrelfish, *Holocentrus adscensionis*
- Longspine squirrelfish, *Holocentrus rufus*
- Blackbar soldierfish, *Myripristis jacobus* [2]
- Cardinal soldierfish, *Plectrypops retrospinis*

Labridae -- Wrasses
- Spanish hogfish, *Bodianus rufus* [2]
- Creole wrasse, *Clepticus parrae* [1]
- Yellowcheek wrasse, *Halichoeres cyanocephalus* [1]
- Yellowhead wrasse, *Halichoeres garnoti* [2]
- Clown wrasse, *Halichoeres maculipinna* [1]
- Puddingwife, *Halichoeres radiatus* [1]
- Pearly razorfish, *Hemipteronotus novacula* [1]
- Green razorfish, *Hemipteronotus splendens* [1]
- Hogfish, *Lachnolaimus maximus*
- Bluehead wrasse, *Thalassoma bifasciatum* [2]

Lutjanidae -- Snappers
- Black snapper, *Apsilus dentatus*
- Queen snapper, *Etelis oculatus*
- Mutton snapper, *Lutjanus analis*

Lutjanidae -- Snappers (cont.)
- Schoolmaster, *Lutjanus apodus*
- Blackfin snapper, *Lutjanus buccanella*
- Gray snapper, *Lutjanus griseus*
- Dog snapper, *Lutjanus jocu*
- Mahogany snapper, *Lutjanus mahogani*
- Lane snapper, *Lutjanus synagris*
- Silk snapper, *Lutjanus vivanus*
- Yellowtail snapper, *Ocyurus chrysurus*
- Wenchman, *Pristipomoides aquilonaris*
- Vermilion snapper, *Rhomboplites aurorubens*

Malacanthidae -- Tilefishes
- Blackline tilefish, *Caulolatilus cyanops*
- Sand tilefish, *Malacanthus plumieri*

Mullidae -- Goatfishes
- Yellow goatfish, *Mulloidichthys martinicus*
- Spotted goatfish, *Pseudupeneus maculatus*

Muraenidae -- Morays
- Chain moray, *Echidna catenata* [1]
- Green moray, *Gymnothorax funebris* [1]
- Goldentail moray, *Gymnothorax miliaris* [1]

Ogcocephalidae -- Batfishes
- Batfish, *Ogcocepahalus* spp. [1]

Ophichthidae -- Snake eels
- Goldspotted eel, *Myrichthys ocellatus* [1]

Opistognathidae -- Jawfishes
- Yellowhead jawfish, *Opistognathus aurifrons* [2]
- Dusky jawfish, *Opistognathus whitehursti* [2]

Ostraciidae -- Boxfishes
- Spotted trunkfish, *Lactophrys bicaudalis*
- Honeycomb cowfish, *Lactophrys polygonia*
- Scrawled cowfish, *Lactophrys quadricornis*
- Trunkfish, *Lactophrys trigonus*
- Smooth trunkfish, *Lactophrys triqueter*

Pomacanthidae -- Angelfishes
- Cherubfish, *Centropyge argi* [2]
- Queen angelfish, *Holacanthus ciliaris*
- Rock beauty, *Holacanthus tricolor* [2]
- Gray angelfish, *Pomacanthus arcuatus*
- French angelfish, *Pomacanthus paru* [2]

Pomacentridae -- Damselfishes
- Sergeant major, *Abudefduf saxatilis*
- Blue chromis, *Chromis cyanea* [2]
- Sunshinefish, *Chromis insolata* [1]
- Yellowtail damselfish, *Microspathodon chrysurus* [2]
- Dusky damselfish, *Pomacentrus fuscus* [1]
- Beaugregory, *Pomacentrus leucostictus* [1]
- Bicolor damselfish, *Pomacentrus partitus* [1]
- Threespot damselfish, *Pomacentrus planifrons* [1]

Priacanthidae -- Bigeyes
- Bigeye, *Priacanthus arenatus*
- Glasseye snapper, *Priacanthus cruentatus*

Scaridae -- Parrotfishes
- Midnight parrotfish, *Scarus coelestinus*
- Blue parrotfish, *Scarus coeruleus*
- Striped parrotfish, *Scarus croicensis*
- Rainbow parrotfish, *Scarus guacamaia*
- Princess parrotfish, *Scarus taeniopterus*
- Queen parrotfish, *Scarus vetula*
- Redband parrotfish, *Sparisoma aurofrenatum*
- Redtail parrotfish, *Sparisoma chrysopterum*
- Redfin parrotfish, *Sparisoma rubripinne*
- Stoplight parrotfish, *Sparisoma viride*

Sciaenidae -- Drums
- High-hat, *Equetus acuminatus* [1]
- Jackknife-fish, *Equetus lanceolatus* [1]
- Spotted drum, *Equetus punctatus* [1]

Scorpaenidae -- Scorpionfishes [1]

Serranidae -- Sea basses
- Rock hind, *Epinephelus adscensionis*
- Graysby, *Epinephelus cruentatus*
- Yellowedge grouper, *Epinephelus flavolimbatus*
- Coney, *Epinephelus fulvus*
- Red hind, *Epinephelus guttatus*
- Goliath grouper, *Epinephelus itajara*
- Red grouper, *Epinephelus morio*
- Misty grouper, *Epinephelus mystacinus*
- Nassau Grouper, *Epinephelus striatus*
- Butter hamlet, *Hypoplectrus unicolor* [1]
- Swissguard basslet, *Liopropoma rubre* [1]
- Yellowfin grouper, *Mycteroperca venenosa*
- Tiger grouper, *Mycteroperca tigris*

Serranidae -- Sea basses (cont.)
- Creole-fish, *Paranthias furcifer*
- Greater soapfish, *Rypticus saponaceus*
- Orangeback bass, *Serranus annularis*
- Lantern bass, *Serranus baldwini*
- Tobaccofish, *Serranus tabacarius*
- Harlequin bass, *Serranus tigrinus* [2]
- Chalk bass, *Serranus tortugarum*

Soleidae -- Soles
- Caribbean tonguefish, *Symphurus arawak* [1]

Sparidae -- Porgies
- Sea bream, *Archosargus rhomboidalis*
- Jolthead porgy, *Calamus bajonado*
- Sheepshead porgy, *Calamus penna*
- Pluma, *Calamus pennatula*

Syngnathidae -- Pipefishes
- Seahorses, *Hippocampus* spp. [1]
- Pipefishes, *Syngnathus* spp. [1]

Synodontidae -- Lizardfishes
- Sand diver, *Synodus intermedius*

Tetraodontidae -- Puffers
- Sharpnose puffer, *Canthigaster rostrata* [1]
- Porcupinefish, *Diodon hystrix* [1]

[1] **Species that would be deleted from the FMU proposed in Section 4.1.1.3.**

[2] **Species in addition to those noted with a [1] (i.e., *Genus sp.*[1]) that would be deleted from the FMU proposed in Section 4.1.1.4.**

Table 4. Species in the Caribbean Coral Reef Resource FMU.

Sponges – Phylum Porifera
Demosponges -- Class Demospongiae
Aphimedon compressa, Erect rope sponge
Chondrilla nucula, Chicken liver sponge
Cynachirella alloclada
Geodia neptuni, Potato sponge
Haliclona sp., Finger sponge
Myriastra sp.
Niphates digitalis, Pink vase sponge
N. erecta, Lavender rope sponge
Spinosella policifera
S. vaginalis
Tethya crypta

Coelenterates – Phylum Coelenterata
Hydrocorals -- Class Hydrozoa
Hydroids -- Order Athecatae
Family Milleporidae
Millepora spp., Fire corals
Family Stylasteridae
Stylaster roseus, Rose lace corals
Anthozoans -- Class Anthozoa
Soft corals -- Order Alcyonacea
Family Anthothelidae
Erythropodium caribaeorum, Encrusting gorgonian
Iciligorgia schrammi, Deepwater sea fan
Family Briaridae
Briareum asbestinum, Corky sea finger
Family Clavulariidae
Carijoa riisei
Telesto spp.
Gorgonian corals -- Order Gorgonacea
Family Ellisellidae
Ellisella spp., Sea whips
Family Gorgoniidae
Gorgonia flabellum, Venus sea fan
G. mariae, Wide-mesh sea fan
G. ventalina, Common sea fan
Pseudopterogorgia acerosa, Sea plume
P. albatrossae
P. americana, Slimy sea plume
P. bipinnata, Bipinnate plume
P. rigida

Coelenterates – Phylum Coelenterata (cont.)
Anthozoans -- Class Anthozoa (cont.)
Gorgonian corals -- Order Gorgonacea (cont.)
Family Gorgoniidae (cont.)
Pterogorgia anceps, Angular sea whip
P. citrina, Yellow sea whip
Family Plexauridae
Eunicea calyculata, Warty sea rod
E. clavigera
E. fusca, Doughnut sea rod
E. knighti
E. laciniata
E. laxispica
E. mammosa, Swollen-knob
E. succinea, Shelf-knob sea rod
E. touneforti
Muricea atlantica
M. elongata, Orange spiny rod
M. laxa, Delicate spiny rod
M. muricata, Spiny sea fan
M. pinnata, Long spine sea fan
Muriceopsis sp.
M. flavida, Rough sea plume
M. sulphurea
Plexaura flexuosa, Bent sea rod
P. homomalla, Black sea rod
Plexaurella dichotoma, Slit-pore sea rod
P. fusifera
P. grandiflora
P. grisea
P. nutans, Giant slit-pore
Pseudoplexaura crucis
P. flagellosa
P. porosa, Porous sea rod
P. wagenaari
Hard Corals -- Order Scleractinia
Family Acroporidae
Acropora cervicornis, Staghorn coral
A. palmata, Elkhorn coral
A. prolifera, Fused staghorn
Family Agaricidae
Agaricia agaricities, Lettuce leaf coral
A. fragilis, Fragile saucer
A. lamarcki, Lamarck's sheet
A. tenuifolia, Thin leaf lettuce
Leptoseris cucullata, Sunray lettuce

Coelenterates – Phylum Coelenterata (cont.)
Anthozoans -- Class Anthozoa (cont.)
Hard Corals -- Order Scleractinia (cont.)
Family Astrocoeniidae
Stephanocoenia michelinii, Blushing star
Family Caryophyllidae
Eusmilia fastigiata, Flower coral
Tubastrea aurea, Cup coral
Family Faviidae
Cladocora arbuscula, Tube coral
Colpophyllia natans, Boulder coral
Diploria clivosa, Knobby brain coral
D. labyrinthiformis, Grooved brain
D. strigosa, Symmetrical brain
Favia fragum, Golfball coral
Manicina areolata, Rose coral
M. mayori, Tortugas rose coral
Montastrea annularis, Boulder star coral
M. cavernosa, Great star coral
Solenastrea bournoni, Smooth star coral
Family Meandrinidae
Dendrogyra cylindrus, Pillar coral
Dichocoenia stellaris, Pancake star
D. stokesi, Elliptical star
Meandrina meandrites, Maze coral
Family Mussidae
Isophyllastrea rigida, Rough star coral
Isophyllia sinuosa, Sinuous cactus
Mussa angulosa, Large flower coral
Mycetophyllia aliciae, Thin fungus coral
M. danae, Fat fungus coral
M. ferox, Grooved fungus
M. lamarckiana, Fungus coral
Scolymia cubensis, Artichoke coral
S. lacera, Solitary disk
Family Oculinidae
Oculina diffusa, Ivory bush coral
Family Pocilloporidae
Madracis decactis, Ten-ray star coral
M. mirabilis, Yellow pencil
Family Poritidae
Porites astreoides, Mustard hill coral
P. branneri, Blue crust coral
P. divaricata, Small finger coral
P. porites, Finger coral
Family Rhizangiidae
Astrangia solitaria, Dwarf cup coral

Coelenterates – Phylum Coelenterata (cont.)
Anthozoans -- Class Anthozoa (cont.)
Hard Corals -- Order Scleractinia (cont.)
Family Rhizangiidae (cont.)
Phyllangia americana, Hidden cup coral
Family Siderastreidae
Siderastrea radians, Lesser starlet
S. siderea, Massive starlet
Black Corals -- Order Antipatharia
Antipathes spp., Bushy black coral
Stichopathes spp., Wire coral
Anemones -- Order Actiniaria
Aiptasia tagetes, Pale anemone [1]
Bartholomea annulata, Corkscrew anemone [1]
Condylactis gigantea, Giant pink-tipped anemone [1]
Hereractis lucida, Knobby anemone [1]
Lebrunia spp., Staghorn anemone [1]
Stichodactyla helianthus, Sun anemone [1]
Colonial Anemones -- Order Zoanthidea
Zoanthus spp., Sea mat [1]
False Corals -- Order Corallimorpharia
Discosoma spp. (formerly Rhodactis), False coral
Ricordia florida, Florida false coral

Annelid Worms – Phylum Annelida
Polychaetes -- Class Polychaeta
Family Sabellidae, Feather duster worms [1]
Sabellastarte spp., Tube worms [1]
S. magnifica, Magnificent duster
Family Serpulidae [1]
Spirobranchus giganteus, Christmas tree worm [1]

Mollusks – Phylum Mollusca
Gastropods -- Class Gastropoda
Family Elysiidae
Tridachia crispata, Lettuce sea slug [1]
Family Olividae
Oliva reticularis, Netted olive
Family Ovulidae
Cyphoma gibbosum, Flamingo tongue [1]
Family Ranellidae
Charonia tritonis, Atlantic triton trumpet [1]

Mollusks – Phylum Mollusca (cont.)
Gastropods -- Class Gastropoda (cont.)
Family Strombidae, Winged conchs
Strombus spp. (except *S. gigas*) [1]
Bivalves -- Class Bivalvia
Family Limidae
Lima spp., Fileclams [1]
L. scabra, Rough fileclam [1]
Family Spondylidae
Spondylus americanus, Atlantic thorny oyster [1]
Cephalopods -- Class Cephalopoda
Octopuses -- Order Octopoda
Family Octopodidae
Octopus spp. (except *O. vulgaris*) [1]

Arthropods – Phylum Arthropoda
Crustaceans -- Subphylum Crustacea
Decapods -- Order Decapoda
Family Alpheidae
Alpheaus armatus, Snapping shrimp
Family Diogenidae
Paguristes spp., Hermit crabs [1]
P. cadenati, Red reef hermit [1]
Family Grapsidae
Percnon gibbesi, Nimble spray crab [1]
Family Hippolytidae
Lysmata spp., Peppermint shrimp [1]
Thor ambionensis, Anemone shrimp
Family Majidae, Coral crabs
Mithrax spp., Clinging crabs [1]
M. cinctimanus, Banded clinging [1]
M. sculptus, Green clinging [1]
Stenorhynchus seticornis, Yellowline arrow [1]
Family Palaemonida
Periclimenes spp., Cleaner shrimp [1]
Family Squillidae, Mantis crabs
Gonodactylus spp. [1]
Lysiosquilla spp. [1]
Family Stenopodidae, Coral shrimp
Stenopus hispidus, Banded shrimp
S. scutellatus, Golden shrimp

Bryozoans -- Phylum Bryozoa

Echinoderms -- Phylum Echinodermata
Feather stars -- Class Crinoidea
Analcidometra armata, Swimming crinoid [1]
Davidaster spp., Crinoids [1]
Nemaster spp., Crinoids [1]
Sea stars -- Class Asteroidea
Astropecten spp., Sand stars [1]
Linckia guildingii, Common comet star [1]
Ophidiaster guildingii, Comet star [1]
Oreaster reticulatus, Cushion sea star
Brittle and basket stars -- Class Ophiuroidea
Astrophyton muricatum, Giant basket star [1]
Ophiocoma spp., Brittlestars [1]
Ophioderma spp., Brittlestars [1]
O. rubicundum, Ruby brittlestar [1]
Sea Urchins -- Class Echinoidea
Diadema antillarum, Long-spined urchin [1]
Echinometra spp., Purple urchin [1]
Eucidaris tribuloides, Pencil urchin [1]
Lytechinus spp., Pin cushion urchin [1]
Tripneustes ventricosus, Sea egg [1]
Sea Cucumbers -- Class Holothuroidea
Holothuria spp., Sea cucumbers [1]

Chordates – Phylum Chordata
Tunicates -- Subphylum Urochordata [1]

Green Algae -- Phylum Chlorophyta
Caulerpa spp., Green grape algae
Halimeda spp., Watercress algae
Penicillus spp., Neptune's brush
Udotea spp., Mermaid's fan
Ventricaria ventricosa, Sea pearls

Red Algae -- Phylum Rhodophyta

Sea grasses -- Phylum Angiospermae
Halodule wrightii, Shoal grass
Halophila spp., Sea vines
Ruppia maritima, Widgeon grass
Syringodium filiforme, Manatee grass
Thalassia testudium, Turtle grass

[1] **Species that would be deleted from the FMU proposed in Section 4.1.1.3.**

Table 5. Average commercial fishery landings in pounds for 20 finfish groups, spiny lobster, and conch for the U.S. Caribbean (Puerto Rico and the USVI). Yearly commercial landings are shown for Puerto Rico from 1997 - 2001. USVI average landings (1994-2002) are directly based on Valle-Esquivel and Diaz (2003) for all species sub-units except for the snapper, grouper, boxfish, and tilefish sub-units. USVI snapper and grouper are extrapolated using USVI landings, and then modifying it by the percentage that the various grouper and snapper sub-units appear in the Puerto Rican landings. For example, Snapper Unit 1 consists of 26.76% of all snapper landed in Puerto Rico on average from 1997-2001. USVI boxfish and tilefish complexes are extrapolated using the same proportion that the species appear in Puerto Rican landings (% of group) out of the total USVI landings (673,436 pounds; averaged over 1994-2002). The USVI landings are then combined with Puerto Rico landings as a best estimate of total U.S. Caribbean landings (last column).

STOCK	1997	1998	1999	2000	2001	Total	PR Avg	% of Grp	USVI	Landings
REEF FISH FMP										
SNAPPER										
Unit 1										
SNAPPER, BLACK		207	672	403	20	1,302	260			
SNAPPER, BLACKFIN	822	3,689	4,342	10,652	9,940	29,445	5,889			
SNAPPER, UNC										
SNAPPER, VERMILION	14,022	16,585	17,240	22,177	44,891	114,915	22,983			
SNAPPER, SILK	285,787	209,384	224,818	187,639	282,159	1,189,787	237,957	11.76%	34,345	301,434
Unit 2										
SNAPPER, QUEEN	38,778	46,073	66,695	82,828	107,671	342,045	68,409			
WENCHMAN	542	2,303	3,645	4,953	7,731	19,174	3,835	3.18%	9,290	81,533
Unit 3										
SNAPPER, GRAY		3	10	85	53	151	30			
SNAPPER, LANE	270,275	221,030	196,988	204,314	186,580	1,079,187	215,837			
SNAPPER, MUTTON	76,602	77,437	96,377	84,256	90,583	425,255	85,051			
SNAPPERS, UNC	66,957	55,989	62,110	48,934	58,468	292,458	58,492			
SNAPPER, DOG	10		78	75	1,537	1,700	340			
SNAPPER, SCHOOLMASTER	15	107	146	10	29	307	61			
SNAPPER, MAHOGANY	978	274	43	41	7	1,343	269	15.85%	46,302	406,382
Unit 4										
SNAPPER, YELLOWTAIL	273,088	252,087	279,467	360,624	328,961	1,494,227	298,845	13.16%	38,428	337,273
GROUPER										
Unit 1										
GROUPER, NASSAU	15,474	19,107	14,971	12,947	18,706	81,205	16,241	0.72%	4,073	20,314
Unit 2										
GROUPER, GOLIATH	85	142		27	50	304	61	0.00%	15	76
Unit 3										
HIND, RED	60,253	55,012	65,974	60,901	69,098	311,238	62,248			
CONEY	12,103	13,877	10,262	11,544	15,929	63,715	12,743			
HIND, ROCK		113		113		226	45			
GRAYSBY			25			25	5			
CREOLE FISH				43		43	9	3.30%	18,821	93,871
Unit 4										
GROUPER, RED	18		7		28	53	11			
GROUPER, MISTY	4,349	5,562	6,718	5,246	6,222	28,097	5,619			
GROUPER, TIGER						0	0			
GROUPER, YELLOWFIN	2,088	1,793	3,350	11,208	3,708	22,147	4,429			
GROUPER, YELLOWEDGE										
GROUPER, UNC	72,655	43,197	47,891	40,632	54,005	258,380	51,676	2.72%	15,482	77,218

Table 5. Continued.

STOCK	1997	1998	1999	2000	2001	Total	PR Avg	% of Grp	USVI	Landings
REEFFISHES										
GRUNTS										
GRUNT, WHITE	164,401	112,694	117,124	114,982	155,878	665,079	133,016			
MARGATE	3,612	2,675	990	864	437	8,578	1,716			
GRUNT, BLUESTRIPED	101	28	109	12	5	255	51			
GRUNT, FRENCH	7					7	1			
GRUNT, TOMTATE						0	0			
PORKFISH						0	0			
GRUNTS, UNC	190	234		57	88	569	114	5.94%	38,062	172,960
GOATFISH										
GOATFISH, SPOTTED	14,106	11,532	22,340	16,065	16,149	80,192	16,038			
GOATFISH, YELLOW	4,697	3,478	3,866	4,266	6,251	22,558	4,512			
GOATFISHES, UNC	6			103	75	184	37	0.91%	2,165	22,752
PORGIES										
PORGIES, UNC	28,431	26,549	34,586	28,883	36,374	154,823	30,965			
PORGY, JOLTHEAD					619	619	124			
PORGY, SHEEPSHEAD										
SEA BREAM		6				6	1			
PORGY, PLUMA				30	31	61	12	1.37%	10,041	41,143
SQUIRRELFISH										
BIGEYE	73	59		49	1	182	36			
SQUIRRELFISHES, UNC	21,420	18,773	14,591	15,689	18,264	88,737	17,747			
SQUIRRELFISH	184	234	112	127	49	706	141			
SQUIRRELFISH, LONGSPINED										
SOLDIERFISH, BLACKBAR						0	0	0.79%	1,179	19,104
TILEFISH										
TILEFISH, UNC	131			10		141	28			
TILEFISH, BLACKLINE	9	156	996	209	105	1,475	295			
TILEFISH, SAND	463	464	12	18		957	191	0.02%	153	667
JACKS										
BLUE RUNNER	86	19	1			106	21			
HORSE-EYE JACK	1,878	6,126	5,109	7,568	6,607	27,288	5,458			
BLACK JACK						0	0			
ALMACO JACK			17		851	868	174			
BAR JACK	24,528	27,180	40,913	44,680	50,845	188,146	37,629			
GREATER AMBERJACK	802	270	151	7	8	1,238	248			
JACK, YELLOW	426	3,314	2,021	2,460	3,934	12,155	2,431			
JACKS, UNC	55,394	35,739	29,999	29,703	36,415	187,250	37,450	3.67%	33,816	117,226
PARROTFISHES										
PARROTFISH, MIDNIGHT										
PARROTFISH, STRIPED										
PARROTFISH, PRINCESS										
PARROTFISH, QUEEN										
PARROTFISH, REDBAND										
PARROTFISH, REDFIN										
PARROTFISH, BLUE	5	15	10		72	102	20			
PARROTFISH, RAINBOW			11			11	2			
PARROTFISH, REDTAIL			116			116	23			
PARROTFISH, STOPLIGHT	44	61	30	12	9	156	31			
PARROTFISH, UNC	110,944	97,503	80,547	72,865	99,174	461,033	92,207	4.06%	185,960	278,244

Table 5. Continued

STOCK	1997	1998	1999	2000	2001	Total	PR Avg	% of Grp	USVI	Landings
SURGEONFISH										
TANG, BLUE										
DOCTORFISH										
SURGEON, OCEAN			9			9	2			
SURGEONFISHES, UNC		4	4		20	28	6	0.00%	34,876	34,883
TRIGGERFISH AND FILEFISH										
FILEFISH										
FILEFISH, SCRAWLED										
FILEFISH, WHITESPOTTED										
TRIGGERFISHES, UNC	22	5	28	102	53	210	42			
TRIGGERFISH, OCEAN	82		293	5		380	76			
DURGON, BLACK	24			731		755	151			
TRIGGERFISH, SARGASSUM	6	15	92		18	131	26			
TRIGGERFISH, QUEEN	73,200	64,448	49,591	40,810	60,858	288,907	57,781	2.56%	51,973	110,050
BOXFISH										
COWFISH, HONEYCOMB						0	0			
COWFISH, SCRAWLED										
TRUNKFISH, SMOOTH										
TRUNKFISH, SPOTTED										
TRUNKFISH	898	224	175		505	1,802	360			
BOXFISH, UNC	80,995	90,713	83,758	83,580	77,309	416,355	83,271	3.68%	24,796	108,428
WRASSES										
HOGFISH, SPANISH	144	360	218	31	11	764	153			
PUDDINGWIFE					104	104	21			
WRASSES, UNC	23	37			12	72	14			
HOGFISH	68,577	49,570	46,390	58,230	68,716	291,483	58,297	2.57%	117	58,602
ANGELFISH										
ANGELFISH, QUEEN		8		4		12	2			
ANGELFISH, GRAY				343		343	69			
ANGELFISH, FRENCH								0.00%	6,320	6,391
					Finfish Total =	**8,661,682**	**1,732,336**		**556,214**	**2,288,550**
SPINY LOBSTER FMP										
LOBSTER, SPOTTED SPINY		3				3	1			
LOBSTER, SPINY	283,752	298,924	327,560	257,120	285,413	1,452,769	290,554	12.79%	80,302	370,856
QUEEN CONCH FMP										
CONCH	238,648	260,955	214,100	280,313	248,169	1,242,185	248,437	10.94%	38,927	287,364
OTHER							0		1,616	1,616
					GranTot =	**11,356,639**	**2,271,328**	**100.00%**	**677,059**	**2,948,387**

Table 6. Summary of recreational catch (landings) for 2000-2001 in pounds for 20 finfish groups, spiny lobster, and conch for the U.S. Caribbean (Puerto Rico and the USVI). Total recreational finfish catch for Puerto Rico was 43.77% of commercial finfish landings and the same proportion was assumed for the USVI. Thus, the total average USVI recreational finfish landings were estimated as 243,455 pounds. The percentage of each species (or group) from Puerto Rico's recreational landings were used to derive recreational landing for the USVI (column labeled USVI adj). USVI and Puerto Rico landings were totaled as a best estimate of total U.S. Caribbean landings (last column). For the USVI, the recreational catch for queen conch and spiny lobster was assumed to be 50% of the USVI commercial landings, approximating the same commercial:recreational relationship as for that in Puerto Rico.

STOCK	2000	2001	Total	PR Avg	% of Grp	USVI adj	RecLandings
REEF FISH FMP							
SNAPPER							
Unit 1							
SNAPPER, BLACK	2,148	571	2,719	1,360			
SNAPPER, BLACKFIN	4,429	2,493	6,922	3,461			
SNAPPER, VERMILION	4,041	34,799	38,840	19,420			
SNAPPER, SILK	208,479	41,790	250,269	125,135			
SNAPPER, UNC	6,953	842	7,795	3,898	20.21%	49,210	202,482
Unit 2							
SNAPPER, QUEEN	66,704	17,637	84,341	42,171			
WENCHMAN	30,046	6,836	36,882	18,441	7.99%	19,460	80,072
Unit 3							
SNAPPER, GRAY	653	484	1,137	569			
SNAPPER, LANE	86,842	28,546	115,388	57,694			
SNAPPER, MUTTON	29,446	23,920	53,366	26,683			
SNAPPER, UNC	2,713	1,599	4,312	2,156			
SNAPPER, DOG	3,895	32,852	36,747	18,374			
SNAPPER, SCHOOLMAS	6,551	14,874	21,425	10,713			
SNAPPER, MAHOGANY	2,312	409	2,721	1,361	15.50%	37,740	155,288
Unit 4							
SNAPPER, YELLOWTAIL	16,790	31,479	48,269	24,135	3.18%	7,749	31,883
GROUPER							
Unit 1							
GROUPER, NASSAU	7,499	44	7,543	3,772	0.50%	1,211	4,982
Unit 2							
GROUPER, GOLIATH	12,338		12,338	6,169	0.8136%	1,981	8,150
Unit 3							
HIND, RED	15,915	49,968	65,883	32,942			
CONEY	17,456	17,551	35,007	17,504			
HIND, ROCK	1,539	4,923	6,462	3,231			
GRAYSBY	2,198	939	3,137	1,569			
CREOLE FISH	43		43	22	7.3%	17,744	73,010
Unit 4							
GROUPER, RED							
GROUPER, MISTY							
GROUPER, TIGER							
GROUPER, YELLOWFIN		1,986	1,986	993			
GROUPER, YELLOWEDGE							
GROUPER, UNC	40,632		40,632	20,316	2.81%	6,842	28,151

Table 6. Continued.

STOCK	2000	2001	Total	PR Avg	% of Grp	USVI adj	RecLandings
REEFFISHES							
GRUNTS							
GRUNT, WHITE	3,668	7,627	11,295	5,648			
MARGATE	340		340	170			
GRUNT, BLUESTRIPED		1,918	1,918	959			
GRUNT, FRENCH	3,009		3,009	1,505			
GRUNT, TOMTATE							
PORKFISH	2,073		2,073	1,037			
GRUNTS, UNC	9,777	9,690	19,467	9,734	2.51%	6,117	25,168
GOATFISH				0			
GOATFISH, SPOTTED	340	683	1,023	512			
GOATFISH, YELLOW	288	1,339	1,627	814			
GOATFISHES, UNC	370		370	185	0.20%	485	1,995
PORGIES							
PORGIES, UNC	2,802	175	2,977	1,489			
PORGY, JOLTHEAD	1,566		1,566	783			
SEA BREAM	1,402		1,402	701			
PORGY, SHEEPSHEAD							
PORGY, PLUMA	30		30	15	0.39%	959	3,947
SQUIRRELFISH							
BIGEYE		315	315	158			
SQUIRRELFISH, LONGSPINED							
SQUIRRELFISHES, UNC		343	343	172			
SOLDIERFISH, BLACKBAR		133	133	67			
SQUIRRELFISH	7,074	5,321	12,395	6,198	0.87%	2,117	8,710
TILEFISH							
TILESFISH, UNC							
TILEFISH, BLACKLINE							
TILEFISH, SAND	147	3,382	3,529	1,765	0.233%	567	2,331
JACKS							
BLUE RUNNER	2,171	30,575	32,746	16,373			
HORSE-EYE JACK	11,076	15,239	26,315	13,158			
BLACK JACK	288	21,065	21,353	10,677			
ALMACO JACK		1,269	1,269	635			
BAR JACK	5,415	8,444	13,859	6,930			
GREATER AMBERJACK	28,065		28,065	14,033			
JACK, YELLOW	2,158	10,581	12,739	6,370			
JACK, UNC	42,373	155,561	197,934	98,967	22.04%	53,662	220,802
PARROTFISHES							
PARROTFISH, BLUE	2,486		2,486	1,243			
PARROTFISH, MIDNIGHT							
PARROTFISH, PRINCESS	978	614	1,592	796			
PARROTFISH, QUEEN	4,511	5,319	9,830	4,915			
PARROTFISH, RAINBOW							
PARROTFISH, REDFIN	1,938		1,938	969			
PARROTFISH, REDTAIL	1,701	604	2,305	1,153			
PARROTFISH, STOPLIGHT		31,019	31,019	15,510			
PARROTFISH, REDBAND		1,115		558			
PARROTFISH, STRIPED		102	102	51			
PARROTFISH, UNC	7,427	614	8,041	4,021	3.85%	9,379	38,593

Table 6. Continued.

STOCK	2000	2001	Total	PR Avg	% of Grp	USVI adj	RecLandings
SURGEONFISH							
TANG, BLUE		143	143	72			
SURGEON, OCEAN	303		303	152			
DOCTORFISH	672		672	336			
SURGEONFISH, UNC		143	143	72	0.08%	202	833
TRIGGERFISH AND FILEFISH							
FILEFISH							
TRIGGERFISH,SCRAWLED							
FILEFISH,WHITESPOTTED							
TRIGGERFISH, UNC							
TRIGGERFISH, OCEAN	39,996	620	40,616	20,308			
DURGON, BLACK	29,680	49,918	79,598	39,799			
TRIGGERFISH, SARGASSUM							
TRIGGERFISH, QUEEN	8,984	19,513	28,497	14,249	9.81%	23,873	98,228
BOXFISH							
COWFISH, HONEYCOMB		920	920	460			
COWFISH, SCRAWLED		386	386	193			
BOXFISH, UNC							
TRUNKFISH	3,892	2,747	6,639	3,320			
TRUNKFISH, SPOTTED		214	214	107			
TRUNKFISH, SMOOTH		356	356	178	0.56%	1,367	5,624
WRASSES							
WRASSES, UNC							
HOGFISH, SPANISH	1,019	2,390	3,409	1,705			
PUDDINGWIFE	2,081	4,257	6,338	3,169			
HOGFISH	518	4,569	5,087	2,544	0.98%	2,381	9,798
ANGELFISH							
ANGELFISH, QUEEN							
ANGELFISH, GRAY		1,827	1,827	914			
ANGELFISH, FRENCH		729	729	365	0.17%	410	1,688
		FinfishTot=	**1,515,446**	**758,281**	**100.0%**	**243,455**	**1,001,736**
SPINY LOBSTER FMP							
LOBSTER, SPOTTED SPINY							
LOBSTER, SPINY	128,560	142,707	271,267	135,633	N/A	40,151	175,784
QUEEN CONCH FMP							
CONCH	140,157	124,085	264,241	132,121	N/A	19,464	151,584
OTHER CONCH					N/A		
		GranTot =	**2,050,954**	**1,026,035**	**N/A**	**303,069**	**1,329,104**

Table 7. Recent combined landing averages in pounds for the U.S. Caribbean. Commercial landings (see Table 5) were averaged over 1997-2001 for Puerto Rico, and 1994-2002 for the USVI. Recreational landings (see Table 6) were averaged from MRFSS over 2000-2001 for Puerto Rico, and extrapolated for the USVI.

STOCK	ComLandings	RecLandings	Total	CommAllocation	RecAllocation
REEF FISH FMP					
SNAPPER					
Unit 1	301,434	202,482	503,916	60%	40%
SNAPPER, BLACK					
SNAPPER, BLACKFIN					
SNAPPER, SILK					
SNAPPER, VERMILION					
SNAPPER, UNC					
Unit 2	81,533	80,072	161,605	50%	50%
SNAPPER, QUEEN					
WENCHMAN					
Unit 3	406,382	155,288	561,670	72%	28%
SNAPPER, GRAY					
SNAPPER, LANE					
SNAPPER, MUTTON					
SNAPPER, UNC					
SNAPPER, DOG					
SNAPPER, SCHOOLMASTER					
SNAPPER, MAHOGANY					
Unit 4	337,273	31,883	369,156	91%	9%
SNAPPER, YELLOWTAIL					
GROUPER					
Unit 1	20,314	4,982	25,296	80%	20%
GROUPER, NASSAU					
Unit 2	76	8,150	8,226	1%	99%
GROUPER, GOLIATH					
Unit 3	93,871	73,010	166,881	56%	44%
HIND, RED					
CONEY					
HIND, ROCK					
GRAYSBY					
CROLE FISH					
Unit 4	77,218	28,151	105,369	73%	27%
GROUPER, RED					
GROUPER, MISTY					
GROUPER, TIGER					
GROUPER, YELLOWFIN					
GROUPER, YELLOWEDGE					
GROUPER, UNC					

Table 7. Continued.

REEFFISHES					
GRUNTS	172,960	25,168	198,128	87%	13%
GRUNT, WHITE					
PORKFISH					
MARGATE					
GRUNT, BLUESTRIPED					
GRUNT, FRENCH					
GRUNT, TOMTATE					
GRUNTS, UNC					
GOATFISH	22,752	1,995	24,747	92%	8%
GOATFISH, SPOTTED					
GOATFISH, YELLOW					
GOATFISHES, UNC					
PORGIES	41,143	3,947	45,090	91%	9%
PORGIES, UNC					
PORGY, JOLTHEAD					
SEA BREAM					
PORGY, SHEEPSHEAD					
PORGY, PLUMA					
SQUIRRELFISH	19,104	8,710	27,814	69%	31%
BIGEYE					
SQUIRRELFISH, LONGSPINED					
SQUIRRELFISHES, UNC					
SOLDIERFISH, BLACKBAR					
SQUIRRELFISH					
TILEFISH	667	2,331	2,998	22%	78%
TILEFISH, UNC					
TILEFISH, BLACKLINE					
TILEFISH, SAND					
JACKS	117,226	220,802	338,028	35%	65%
BLUE RUNNER					
HORSE-EYE JACK					
BLACK JACK					
ALMACO JACK					
BAR JACK					
GREATER AMBERJACK					
JACK, YELLOW					
JACKS, UNC					
PARROTFISHES	278,244	38,593	316,837	88%	12%
PARROTFISH, BLUE					
PARROTFISH, MIDNIGHT					
PARROTFISH, PRINCESS					
PARROTFISH, QUEEN					
PARROTFISH, RAINBOW					
PARROTFISH, REDFIN					
PARROTFISH, REDTAIL					
PARROTFISH, STOPLIGHT					
PARROTFISH, REDBAND					
PARROTFISH, STRIPED					
PARROTFISH, UNC					

Table 7. Continued.

SURGEONFISH	34,883	833	35,716	98%	2%
TANG, BLUE					
SURGEON, OCEAN					
DOCTORFISH					
SURGEONFISHES, UNC					
TRIGGERFISH	110,050	98,228	208,278	53%	47%
FILEFISH					
FILEFISH, SCRAWLED					
FILEFISH, WHITESPOTTED					
TRIGGERFISHES, UNC					
TRIGGERFISH, OCEAN					
DURGON, BLACK					
TRIGGERFISH, SARGASSUM					
TRIGGERFISH, QUEEN					
BOXFISH	108,428	5,624	114,052	95%	5%
BOXFISH, UNC					
COWFISH, HONEYCOMB					
COWFISH, SCRAWLED					
TRUNKFISH					
TRUNKFISH, SPOTTED					
TRUNKFISH, SMOOTH					
WRASSES	58,602	9,798	68,400	86%	14%
HOGFISH, SPANISH					
WRASSES, UNC					
PUDDINGWIFE					
HOGFISH					
ANGELFISH	6,391	1,688	8,079	79%	21%
ANGELFISH, QUEEN					
ANGELFISH, GRAY					
ANGELFISH, FRENCH					
Finfish Total =	**2,288,550**	**1,001,735**	**3,290,285**	**70%**	**30%**

SPINY LOBSTER FMP					
LOBSTER, SPOTTED SPINY					
LOBSTER, SPINY	370,856	175,784	546,640	68%	32%
QUEEN CONCH FMP					
CONCH	287,364	151,584	438,948	65%	35%
OTHER CONCH	1,616	0	1,616	100%	0%
GranTot =	**2,948,386**	**1,329,103**	**4,277,489**	**69%**	**31%**

Table 8. Preferred biological reference points and stock status determination criteria.

FMU/SUB-UNIT	STATUS	MSY (1,000 lbs)	OY (1000 lbs)	RECENT CATCH (1,000 lbs)	B_{MSY} (1,000 lbs)	B_{CURR} / B_{MSY}	MSST (1,000 lbs)	B_{CURR} / MSST	F_{MSY}	F_{CURR} / F_{MSY}	M
SPINY LOBSTER FMU											
LOBSTER,SPINY	unknown	547	410	547	2,217	1.00	1,463	1.52	0.34	1.00	0.34
CONCH FMU											
QUEEN CONCH	OVERFISHED	452	339	439	2,005	<<1	1,404	<1	0.30	>1	0.30
OTHER CONCH [1]	-	-	-	2	-	-	-	-	-	-	-
REEF FISH FMU											
SNAPPER											
UNIT 1	at risk	520	390	504	1,268	0.75	634	1.50	0.86	1.50	0.86
SNAPPER, SILK											
SNAPPER, UNC											
SNAPPER, BLACK											
SNAPPER, VERMILION											
SNAPPER, BLACKFIN											
UNIT 2	unknown (at risk)	162	122	162	554	1.00	310	1.79	0.44	1.00	0.44
SNAPPER, QUEEN											
WENCHMAN											
UNIT 3	unknown	562	422	562	2,491	1.00	1,744	1.43	0.30	1.00	0.30
SNAPPER, GRAY											
SNAPPER, LANE											
SNAPPER, MUTTON											
SNAPPER, UNC											
SNAPPER, DOG											
SNAPPER, SCHOOLMASTER											
SNAPPER, MAHOGANY											
UNIT 4	at risk	344	258	369	2,084	0.75	1,667	0.94	0.20	1.50	0.20
SNAPPER, YELLOWTAIL											
GROUPER											
UNIT 1	OVERFISHED	2-25	2-19 [2]	25	20-190	<<1	18-171	<<.9	0.18	~0	0.18
GROUPER, NASSAU											
UNIT 2	OVERFISHED	2-11	2-8 [2]	8	40-120	<<1	38-114	<<.95	0.13	~0	0.13
GROUPER, GOLIATH											
UNIT 3	unknown	167	125	167	1,105	1.00	906	1.22	0.18	1.00	0.18
HIND, RED											
CONEY											
HIND, ROCK											
GRAYSBY											
CREOLE FISH											
UNIT 4	at risk	97	73	105	644	0.75	528	0.91	0.18	1.50	0.18
GROUPER, RED											
GROUPER, YELLOWEDGE											
GROUPER, MISTY											
GROUPER, TIGER											
GROUPER, YELLOWFIN											
GROUPER, UNC											

Table 8. Preferred biological reference points and stock status determination criteria.

FMU/SUB-UNIT	STATUS	MSY (1,000 lbs)	OY (1000 lbs)	RECENT CATCH (1,000 lbs)	B_{MSY} (1,000 lbs)	B_{CURR} / B_{MSY}	MSST (1,000 lbs)	B_{CURR} / MSST	F_{MSY}	F_{CURR} / F_{MSY}	M
GRUNTS	unknown	198	149	198	751	1.00	469	1.60	0.38	1.00	0.38
GRUNT, WHITE											
MARGATE											
GRUNT, TOMTATE											
GRUNT, BLUESTRIPED											
GRUNT, FRENCH											
PORKFISH											
GRUNTS, UNC											
GOATFISHES	unknown	25	19	25	60	1.00	30	2.00	0.89	1.00	0.89
GOATFISH, SPOTTED											
GOATFISH, YELLOWTAIL											
GOATFISH, UNC											
PORGIES	unknown	45	34	45	118	1.00	59	2.00	0.72	1.00	0.72
PORGY, JOLTHEAD											
SEA BREAM											
PORGY, SHEEPSHEAD											
PORGY, PLUMA											
SQUIRRELFISHES	unknown	27	20	27	75	1.00	37	2.00	0.64	1.00	0.64
SOLDIERFISH, BLACKBAR											
BIGEYE											
SQUIRRELFISH, UNC											
SQUIRRELFISH, LONGSPINED											
SQUIRRELFISH											
TILEFISH	unknown	3	2	3	11	1.00	6	1.72	0.42	1.00	0.42
TILEFISH, UNC											
TILEFISH, BLACKLINE											
TILEFISH, SAND											
JACKS	unknown	338	254	338	1,399	1.00	937	1.49	0.33	1.00	0.33
BLUE RUNNER											
JACK, HORSE-EYE											
JACK, BLACK											
JACK, ALMACO											
JACK, BAR											
AMBERJACK, GREATER											
JACK, YELLOW											
JACK, UNC											
PARROTFISHES	at risk	308	231	317	1,069	0.75	610	1.32	0.43	1.50	0.43
PARROTFISH, BLUE											
PARROTFISH, MIDNIGHT											
PARROTFISH, PRINCESS											
PARROTFISH, QUEEN											
PARROTFISH, RAINBOW											
PARROTFISH, REDFIN											
PARROTFISH, REDTAIL											
PARROTFISH, STOPLIGHT											
PARROTFISH, REDBAND											
PARROTFISH, UNC											
PARROTFISH, STRIPED											

Table 8. Preferred biological reference points and stock status determination criteria.

FMU/SUB-UNIT	STATUS	MSY (1,000 lbs)	OY (1000 lbs)	RECENT CATCH (1,000 lbs)	B_{MSY} (1,000 lbs)	B_{CURR} / B_{MSY}	MSST (1,000 lbs)	B_{CURR} / MSST	F_{MSY}	F_{CURR} / F_{MSY}	M
SURGEONFISH	unknown	36	27	36	152	1.00	104	1.47	0.32	1.00	0.32
TANG, BLUE											
SURGEONFISH, OCEAN											
DOCTORFISH											
SURGEONFISH, UNC											
TRIGGERFISH AND FILEFISH	at risk	196	147	208	942	0.75	687	1.03	0.27	1.50	0.27
TRIGGERFISHES, UNC											
TRIGGERFISH, OCEAN											
TRIGGERFISH, QUEEN											
TRIGGERFISH, SARGASSUM											
FILEFISH, UNC											
FILEFISH, SCRAWLED											
FILEFISH, WHITESPOTTED											
DURGON, BLACK											
BOXFISH	at risk	111	83	114	380	0.75	213	1.34	0.44	1.50	0.44
BOXFISH, UNC											
COWFISH, HONEYCOMB											
COWFISH, SCRAWLED											
TRUNKFISH											
TRUNKFISH, SPOTTED											
TRUNKFISH, SMOOTH											
WRASSES	unknown	68	51	68	346	1.00	259	1.33	0.25	1.00	0.25
HOGFISH											
WRASSES, UNC											
PUDDINGWIFE											
HOGFISH, SPANISH											
ANGELFISH	unknown	8	6	8	28	1.00	16	1.72	0.42	1.00	0.42
ANGELFISH, QUEEN											
ANGELFISH, GRAY											
ANGELFSISH, FRENCH											
AQUARIUM TRADE [3]	unknown	-	-	29,469	-	-	-	-	-	-	-

ATLANTIC SPADEFISH	CHALK BASS	FOUREYE BUTTERFLYFISH	LANTERN BASS
BATFISH	CHAIN MORAY	FLYING GURNARD	LONGSNOUT BUTTERFLYFISH
BANDED BUTTERFLYFISH	CHERUBFISH	FROGFISH	MORAY UNC
BEAUGREGORY	CLOWN WRASSE	GLASSEYE SNAPPER	NEON GOBY
BICOLOR DAMSELFISH	CONCHFISH	GOLDENTAIL MORAY	ORANGEBACK BASS
BLENNIES UNC	CREOLE WRASSE	GOLDSPOTTED EEL	PEACOCK FLOUNDER
BLUE CHROMIS	DAMSELFISH UNC	GREEN MORAY	PIPEFISHES
BLUEHEAD WRASSE	DUSKY DAMSELFISH	HAMLETS	PEARLY RAZORFISH
BUTTERFLYFISH UNC	DUSKY JAWFISH	HARLEQUIN BASS	GREEN RAZORFISH
CARDINALFISH UNC	FLAMEFISH	HIGH-HAT	PORCUPINEFISH
CARIBBEAN TONGUEFISH	CARDNAL SOLDIERFISH	JACKKNIFE-FISH	GREATER SOAPFISH

Table 8. Preferred biological reference points and stock status determination criteria.

FMU/SUB-UNIT	STATUS	MSY (1,000 lbs)	OY (1000 lbs)	RECENT CATCH (1,000 lbs)	B_{MSY} (1,000 lbs)	B_{CURR} / B_{MSY}	MSST (1,000 lbs)	B_{CURR} / MSST	F_{MSY}	F_{CURR} / F_{MSY}	M
CORAL FMU											
PROHIBITED CORALS	N/A	0	0	0	-	-	-	-	-	-	-
MARINE PLANTS	N/A	0	0	0	-	-	-	-	-	-	-
AQUARIUM TRADE [4]	unknown	-	-	-	-	-	-	-	-	-	-

Aphimedon compressa , Erect rope sponge	*Lima* spp., Fileclams	*Astrophyton muricatum* , Giant basket star
Chondrilla nucula , Chicken liver sponge	*L. scabra* , Rough fileclam	*Ophiocoma* spp., Brittlestars
Cynachirella alloclada	*Spondylus americanus* , Atlantic thorny oyster	*Ophioderma* spp., Brittlestars
Geodia neptuni , Potato sponge	*Octopus* spp. (except the Common octopus, *O. vulgaris*)	*O. rubicundum* , Ruby brittlestar
Haliclona sp., Finger sponge	*Alpheaus armatus* , Snapping shrimp	*Diadema antillarum* , Long-spined urchin
Myriastra sp.	*Paguristes* spp., Hermit crabs	*Echinometra* spp., Purple urchin
Niphates digitalis , Pink vase sponge	*P. cadenati* , Red reef hermit	*Eucidaris tribuloides* , Pencil urchin
N. erecta , Lavender rope sponge	*Percnon gibbesi* , Nimble spray crab	*Lytechinus* spp., Pin cushion urchin
Spinosella policifera	*Lysmata* spp., Peppermint shrimp	*Tripneustes ventricosus* , Sea egg
S. vaginalis	*Thor amboinensis* , Anemone shrimp	*Holothuria* spp., Sea cucumbers
Tethya crypta	*Mithrax* spp., Clinging crabs	Tunicates--Subphylum Urochordata
Aiptasia tagetes , Pale anemone	*M. cinctimanus* , Banded clinging	
Bartholomea annulata , Corkscrew anemone	*M. sculptus* , Green clinging	
Condylactis gigantea , Giant pink-tipped anemone	*Stenorhynchus seticornis* , Yellowline arrow	
Hereractis lucida , Knobby anemone	*Periclimenes* spp., Cleaner shrimp	
Lebrunia spp., Staghorn anemone	*Gonodactylus* spp.	
Stichodactyla helianthus , Sun anemone	*Lysiosquilla* spp.	
Zoanthus spp., Sea mat	*Stenopus hispidus* , Banded shrimp	
Discosoma spp., False coral	*S. scutellatus* , Golden shrimp	
Ricordia florida , Florida false coral	*Analcidometra armata* , Swimming crinoid	
Sabellastarte spp., Tube worms	*Davidaster* spp., Crinoids	
S. magnifica , Magnificent duster	*Nemaster* spp., Crinoids	
Spirobranchus giganteus , Christmas tree worm	*Astropecten* spp., Sand stars	
Tridachia crispata , Lettuce sea slug	*Linckia guildingii* , Common comet star	
Oliva reticularis , Netted olive	*Ophidiaster guildingii* , Comet star	
Cyphoma gibbosum , Flamingo tongue	*Oreaster reticulatus* , Cushion sea star	

[1] Includes Atlantic triton's trumpet (*Charonia variegata*), cameo helmet (*Cassis madagascarensis*), green star shell (*Astrea tuber*), hawkwing conch (*Strombus raninus*), milk conch (*Strombus costatus*), roostertail conch (*Strombus gallus*), true tulip (*Fasciolaria tulipa*), and West Indian fighting conch (*Strombus pugilis*).

[2] OY represents a target for this stock upon recovery and has been estimated based on a stock capable of producing MSY.

[3] Values derived from average landings from Puerto Rico only for 1998-2000 (Ojeda-Serrano et al. 2001). Landings are in number of fish.

[4] Includes all stocks in the Coral FMP except stony corals, octocorals, live-rock, and seagrasses.

Table 9. Alternative definitions of F and B ratios, MSY, and OY considered in this amendment for Caribbean Council-managed species. Alternatives beyond MSY are based on the preferred stock status parameter alternatives.

FMU/SUB-UNITS	F AND B RATIO ALT 1		F AND B RATIO ALT 2		F AND B RATIO ALT 3		F AND B RATIO ALT 4		MSY (1,000 lbs)				OY (1,000 lbs)			
	F_{CURR}/F_{MSY}	B_{CURR}/B_{MSY}	F_{CURR}/F_{MSY}	B_{CURR}/B_{MSY}	F_{CURR}/F_{MSY}	B_{CURR}/B_{MSY}	F_{CURR}/F_{MSY}	B_{CURR}/B_{MSY}	ALT 1	ALT 2	ALT 3	ALT 4	ALT 1	ALT 2	ALT 3	ALT 4
SPINY LOBSTER FMU																
LOBSTER, SPINY	-	-	1.00	1.00	1.00	1.00	1.00	1.00	830	547	0	613	582-830	410	0	513
CONCH FMU																
QUEEN CONCH	-	-	>1	<<1	>1	<<1	2.00	0.20	738	452	0	567	[2]	339	0	424
OTHER CONCH [1]	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	-	-	-	-	-	-	-
REEF FISH FMU									7,700				7,700			
SNAPPER																
UNIT 1	-	-	1.50	0.75	1.50	0.50	1.33	0.50		520	0	756		390	0	488
SNAPPER, SILK																
SNAPPER, UNC																
SNAPPER, BLACK																
SNAPPER, VERMILION																
SNAPPER, BLACKFIN																
UNIT 2	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	162	0	163	-	122	0	152
SNAPPER, QUEEN																
WENCHMAN																
UNIT 3	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	562	0	643	-	422	0	527
SNAPPER, GRAY																
SNAPPER, LANE																
SNAPPER, MUTTON																
SNAPPER, UNC																
SNAPPER, DOG																
SNAPPER, SCHOOLMASTER																
SNAPPER, MAHOGANY																
UNIT 4	-	-	1.50	0.75	1.50	0.50	1.33	0.20	-	344	0	369	-	258	0	322
SNAPPER, YELLOWTAIL																
GROUPER																
UNIT 1	-	-	~0	<<1	~0	<<1	2.00	0.12	-	2-25	0	2-25	-	2-19*	0	0.50-6.25
GROUPER, NASSAU																
UNIT 2	-	-	~0	<<1	~0	<<1	2.00	0.09	-	2-11	0	2-11	-	2-8*	0	0.50-2.75
GROUPER, GOLIATH																
UNIT 3	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	167	0	175	-	125	0	157
HIND, RED																
CONEY																
HIND, ROCK																
GRAYSBY																
CREOLE FISH																
UNIT 4	-	-	1.50	0.75	1.50	0.50	1.33	0.18	-	97	0	248	-	73	0	91
GROUPER, RED																
GROUPER, YELLOWEDGE																
GROUPER, MISTY																
GROUPER, TIGER																
GROUPER, YELLOWFIN																
GROUPER, UNC																

Table 9. Alternative definitions of F and B ratios, MSY, and OY considered in this amendment for Caribbean Council-managed species. Alternatives beyond MSY are based on the preferred stock status parameter alternatives.

FMU/SUB-UNITS	F AND B RATIO ALT 1		F AND B RATIO ALT 2		F AND B RATIO ALT 3		F AND B RATIO ALT 4		MSY (1,000 lbs)				OY (1,000 lbs)			
	F_{CURR}/F_{MSY}	B_{CURR}/B_{MSY}	F_{CURR}/F_{MSY}	B_{CURR}/B_{MSY}	F_{CURR}/F_{MSY}	B_{CURR}/B_{MSY}	F_{CURR}/F_{MSY}	B_{CURR}/B_{MSY}	ALT 1	ALT 2	ALT 3	ALT 4	ALT 1	ALT 2	ALT 3	ALT 4
GRUNTS	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	198	0	322	-	149	0	186
GRUNT, WHITE																
MARGATE																
GRUNT, TOMTATE																
GRUNT, BLUESTRIPED																
GRUNT, FRENCH																
PORKFISH																
GRUNTS, UNC																
GOATFISHES	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	25	0	55	-	19	0	23
GOATFISH, SPOTTED																
GOATFISH, YELLOWTAIL																
GOATFISH, UNC																
PORGIES	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	45	0	48	-	34	0	42
PORGY, JOLTHEAD																
SEA BREAM																
PORGY, SHEEPSHEAD																
PORGY, PLUMA																
SQUIRRELFISHES	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	27	0	33	-	20	0	25
SOLDIERFISH, BLACKBAR																
BIGEYE																
SQUIRRELFISH, UNC																
SQUIRRELFISH, LONGSPINED																
SQUIRRELFISH																
TILEFISH	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	3	0	4	-	2	0	3
TILEFISH, UNC																
TILEFISH, BLACKLINE																
TILEFISH, SAND																
JACKS	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	338	0	394	-	254	0	317
BLUE RUNNER																
JACK, HORSE-EYE																
JACK, BLACK																
JACK, ALMACO																
JACK, BAR																
AMBERJACK, GREATER																
JACK, YELLOW																
JACK, UNC																
PARROTFISHES	-	-	1.50	0.75	1.50	0.50	1.33	0.43	-	308	0	233	-	231	0	289
PARROTFISH, BLUE																
PARROTFISH, MIDNIGHT																
PARROTFISH, PRINCESS																
PARROTFISH, QUEEN																
PARROTFISH, RAINBOW																
PARROTFISH, REDFIN																
PARROTFISH, REDTAIL																
PARROTFISH, STOPLIGHT																
PARROTFISH, REDBAND																
PARROTFISH, UNC																
PARROTFISH, STRIPED																

Table 9. Alternative definitions of F and B ratios, MSY, and OY considered in this amendment for Caribbean Council-managed species. Alternatives beyond MSY are based on the preferred stock status parameter alternatives.

FMU/SUB-UNITS	F AND B RATIO ALT 1		F AND B RATIO ALT 2		F AND B RATIO ALT 3		F AND B RATIO ALT 4		MSY (1,000 lbs)				OY (1,000 lbs)			
	F_{CURR}/F_{MSY}	B_{CURR}/B_{MSY}	F_{CURR}/F_{MSY}	B_{CURR}/B_{MSY}	F_{CURR}/F_{MSY}	B_{CURR}/B_{MSY}	F_{CURR}/F_{MSY}	B_{CURR}/B_{MSY}	ALT 1	ALT 2	ALT 3	ALT 4	ALT 1	ALT 2	ALT 3	ALT 4
SURGEONFISH	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	36	0	1	-	27	0	34
TANG, BLUE																
SURGEONFISH, OCEAN																
DOCTORFISH																
SURGEONFISH, UNC																
TRIGGERFISH AND FILEFISH	-	-	1.50	0.75	1.50	0.50	1.33	0.27	-	196	0	220	-	147	0	184
TRIGGERFISHES, UNC																
TRIGGERFISH, OCEAN																
TRIGGERFISH, QUEEN																
TRIGGERFISH, SARGASSUM																
FILEFISH																
FILEFISH, SCRAWLED																
FILEFISH, WHITESPOTTED																
DURGON, BLACK																
BOXFISH	-	-	1.50	0.75	1.50	0.50	1.33	0.44	-	111	0	104	-	83	0	104
BOXFISH, UNC																
COWFISH, HONEYCOMB																
COWFISH, SCRAWLED																
TRUNKFISH																
TRUNKFISH, SPOTTED																
TRUNKFISH, SMOOTH																
WRASSES	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	68	0	107	-	51	0	64
HOGFISH																
WRASSES, UNC																
PUDDINGWIFE																
HOGFISH, SPANISH																
ANGELFISH	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	8	0	2	-	6	0	8
ANGELFISH, QUEEN																
ANGELFISH, GREY																
ANGELFISH, FRENCH																
AQUARIUM TRADE [3]	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	29,469	0	-	[4]	22,102	0	27,627
CORAL FMU									-				-			
PROHIBITED CORALS	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	-	0	-	-	-	0	-
MARINE PLANTS	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	-	0	-	-	-	0	-
AQUARIUM TRADE [5]	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	-	0	-	-	-	0	-

[1] Includes Atlantic triton's trumpet (*Charonia variegata*), cameo helmet (*Cassis madagascarensis*), green star shell (*Astrea tuber*), hawkwing conch (*Strombus raninus*), milk conch (*Strombus costatus*), roostertail conch (*Strombus gallus*), true tulip (*Fasciolaria tulipa*), and West Indian fighting conch (*Strombus pugilis*).

[2] All queen conch commerically and recreationally harvested from the EEZ landed consistent with management measures set forth in the Queen Conch FMP under a goal of allowing 20% of the spawning stock biomass to remain intact.

[3] Values derived from average landings from Puerto Rico only for 1998-2000 (Ojeda-Serrano et al. 2001). Landings are in number of fish.

[4] Value cannot be defined due to lack of a long-time series of landings data.

[5] Includes all stocks in the Coral FMP except stony corals, octocorals, live-rock, and seagrasses.

Table 10. Alternative definitions of MSST, limit, and target catches considered in this amendment for Caribbean Council-managed species. Alternatives are based on the preferred stock status parameter alternatives (i.e., MSY, OY, etc.).

FMU/SUB-UNITS	MSST (1,000 lbs)				ABC/MFMT SPECIFIED BY LIMIT CONTROL RULE (1,000 lbs)							OY SPECIFIED BY TARGET CONTROL RULE (1,000 lbs)						
	ALT 1	ALT 2	ALT 3	ALT 4	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7
SPINY LOBSTER FMU																		
LOBSTER, SPINY	-	1,463	1,109	2,217	-	547	0	547	547	547	426	-	410	0	295	410	295	295
CONCH FMU																		
CONCH, QUEEN	-	1185-1309	847-935	1693-1871	-	-	0	-	-	-	-	-	-	-	-	-	-	-
CONCH, OTHER [1]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
REEF FISH FMU																		
SNAPPER																		
UNIT 1	-	634	634	1,268	-	347	0	260	349	390	230	-	260	0	153	260	230	125
SNAPPER, SILK																		
SNAPPER, UNC																		
SNAPPER, BLACK																		
SNAPPER, VERMILION																		
SNAPPER, BLACKFIN																		
UNIT 2	-	310	277	554	-	162	0	162	162	162	127	-	122	0	89	122	89	89
SNAPPER, QUEEN																		
WENCHMAN																		
UNIT 3	-	1,744	1,246	2,491	-	562	0	562	562	562	436	-	422	0	301	422	301	301
SNAPPER, GRAY																		
SNAPPER, LANE																		
SNAPPER, MUTTON																		
SNAPPER, UNC																		
SNAPPER, DOG																		
SNAPPER, SCHOOLMASTER																		
SNAPPER, MAHOGANY																		
UNIT 4	-	1,667	1,042	2,084	-	229	0	172	113	258	135	-	172	0	90	86	135	69
SNAPPER, YELLOWTAIL																		
GROUPER																		
UNIT 1	-	18-171	10-95	20-190	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GROUPER, NASSAU																		
UNIT 2	-	38-114	20-60	40-120	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GROUPER, GOLIATH																		
UNIT 3	-	906	552	1,105	-	167	0	167	167	167	128	-	125	0	87	125	87	87
HIND, RED																		
CONEY																		
HIND, ROCK																		
GRAYSBY																		
CREOLE FISH																		
UNIT 4	-	528	322	644	0	65	0	49	32	73	38	-	49	0	25	24	38	19
GROUPER, RED																		
GROUPER, YELLOWEDGE																		
GROUPER, MISTY																		
GROUPER, TIGER																		
GROUPER, YELLOWFIN																		
GROUPER, UNC																		

Table 10. Alternative definitions of MSST, limit, and target catches considered in this amendment for Caribbean Council-managed species. Alternatives are based on the preferred stock status parameter alternatives (i.e., MSY, OY, etc.).

FMU/SUB-UNITS	MSST (1,000 lbs)				ABC/MFMT SPECIFIED BY LIMIT CONTROL RULE (1,000 lbs)							OY SPECIFIED BY TARGET CONTROL RULE (1,000 lbs)						
	ALT 1	ALT 2	ALT 3	ALT 4	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7
GRUNTS	-	469	375	751	-	198	0	198	198	198	155	-	149	0	108	149	108	108
GRUNT, WHITE																		
MARGATE																		
GRUNT, TOMTATE																		
GRUNT, BLUESTRIPED																		
GRUNT, FRENCH																		
PORKFISH																		
GRUNTS, UNC																		
GOATFISHES	-	30	30	60	-	25	0	25	25	25	20	-	19	0	15	19	15	15
GOATFISH, SPOTTED																		
GOATFISH, YELLOWTAIL																		
GOATFISH, UNC																		
PORGIES	-	59	59	118	-	45	0	45	45	45	36	-	34	0	26	34	26	26
PORGY, JOLTHEAD																		
SEA BREAM																		
PORGY, SHEEPSHEAD																		
PORGY, PLUMA																		
SQUIRRELFISHES	-	37	37	75	-	27	0	27	27	27	22	-	20	0	15	20	15	15
SOLDIERFISH, BLACKBAR																		
BIGEYE																		
SQUIRRELFISH, UNC																		
SQUIRRELFISH, LONGSPINED																		
SQUIRRELFISH																		
TILEFISH	-	6	5	11	-	3	0	3	3	3	2	-	2	0	2	2	2	2
TILEFISH, UNC																		
TILEFISH, BLACKLINE																		
TILEFISH, SAND																		
JACKS	-	937	700	1,399	-	338	0	338	338	338	263	-	254	0	182	254	182	182
BLUE RUNNER																		
JACK, HORSE-EYE																		
JACK, BLACK																		
JACK, ALMACO																		
JACK, BAR																		
AMBERJACK, GREATER																		
JACK, YELLOW																		
JACK, UNC																		

Table 10. Alternative definitions of MSST, limit, and target catches considered in this amendment for Caribbean Council-managed species. Alternatives are based on the preferred stock status parameter alternatives (i.e., MSY, OY, etc.).

	MSST (1,000 lbs)				ABC/MFMT SPECIFIED BY LIMIT CONTROL RULE (1,000 lbs)							OY SPECIFIED BY TARGET CONTROL RULE (1,000 lbs)						
FMU/SUB-UNITS	ALT 1	ALT 2	ALT 3	ALT 4	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7
PARROTFISHES	-	610	535	1,069	-	206	0	154	207	231	127	-	154	0	85	154	127	67
PARROTFISH, BLUE																		
PARROTFISH, MIDNIGHT																		
PARROTFISH, PRINCESS																		
PARROTFISH, QUEEN																		
PARROTFISH, RAINBOW																		
PARROTFISH, REDFIN																		
PARROTFISH, REDTAIL																		
PARROTFISH, STOPLIGHT																		
PARROTFISH, REDBAND																		
PARROTFISH, UNC																		
PARROTFISH, STRIPED																		
SURGEONFISH	-	104	76	152	-	36	0	36	36	36	28	-	27	0	19	27	19	19
TANG, BLUE																		
SURGEONFISH, OCEAN																		
DOCTORFISH																		
SURGEONFISH, UNC																		
TRIGGERFISH AND FILEFISH	-	687	471	942	-	131	0	98	132	147	78	-	98	0	52	98	78	40
TRIGGERFISHES, UNC																		
TRIGGERFISH, OCEAN																		
TRIGGERFISH, QUEEN																		
TRIGGERFISH, SARGASSUM																		
FILEFISH																		
FILEFISH, SCRAWLED																		
FILEFISH, WHITESPOTTED																		
DURGON, BLACK																		
BOXFISH	-	213	190	380	-	74	0	56	74	83	46	-	56	0	31	56	46	24
BOXFISH, UNC																		
COWFISH, HONEYCOMB																		
COWFISH, SCRAWLED																		
TRUNKFISH																		
TRUNKFISH, SPOTTED																		
TRUNKFISH, SMOOTH																		
WRASSES	-	259	173	346	-	68	0	68	68	68	52	-	51	0	36	51	36	36
HOGFISH																		
WRASSES, UNC																		
PUDDINGWIFE																		
HOGFISH, SPANISH																		
ANGELFISH	-	16	14	28	-	8	0	8	8	8	6	-	6	0	4	6	4	4
ANGELFISH, QUEEN																		
ANGELFISH, GRAY																		
ANGELFSISH, FRENCH																		

Table 10. Alternative definitions of MSST, limit, and target catches considered in this amendment for Caribbean Council-managed species. Alternatives are based on the preferred stock status parameter alternatives (i.e., MSY, OY, etc.).

FMU/SUB-UNITS	MSST (1,000 lbs)				ABC/MFMT SPECIFIED BY LIMIT CONTROL RULE (1,000 lbs)							OY SPECIFIED BY TARGET CONTROL RULE (1,000 lbs)						
	ALT 1	ALT 2	ALT 3	ALT 4	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7
AQUARIUM TRADE [2]	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-

CHAIN MORAY	FOUREYE BUTTERFLYFISH	JACKKNIFE-FISH	REDLIP BLENNY	SPOTTED DRUM
CHERUBFISH	FLYING GURNARD	LANTERN BASS	SPOTFIN BUTTERFLYFISH	SUNSHINEFISH
CLOWN WRASSE	FROGFISH	LONGSNOUT BUTTERFLYFISH	ROCK BEAUTY	SWISSGUARD BASSLET
CONCHFISH	GLASSEYE SNAPPER	MORAY UNC	ROYAL GRAMMA	TOBACCOFISH
CREOLE WRASSE	GOLDENTAIL MORAY	NEON GOBY	RUSTY GOBY	TRUMPETFISH
DAMSELFISH UNC	GOLDSPOTTED EEL	ORANGEBACK BASS	SAND DIVER	YELLOWHEAD JAWFISH
DUSKY DAMSELFISH	GREEN MORAY	PEACOCK FLOUNDER	SCORPIONFISH	YELLOWHEAD WRASSE
DUSKY JAWFISH	HAMLETS	PIPEFISHES	SEAHORSES	YELLOWTAIL DAMSELFISH
FLAMEFISH	HARLEQUIN BASS	PEARLY RAZORFISH	SERGEANT MAJOR	YELLOWCHEEK WRASSE
CARDNAL SOLDIERFISH	HIGH-HAT	GREEN RAZORFISH	SHARPNOSE PUFFER	REDSPOTTED HAWKFISH
CHALK BASS	GREATER SOAPFISH	PORCUPINEFISH	THREESPOTTED DAMSELFISH	

FMU/SUB-UNITS	MSST ALT 1	MSST ALT 2	MSST ALT 3	MSST ALT 4	ABC ALT 1	ABC ALT 2	ABC ALT 3	ABC ALT 4	ABC ALT 5	ABC ALT 6	ABC ALT 7	OY ALT 1	OY ALT 2	OY ALT 3	OY ALT 4	OY ALT 5	OY ALT 6	OY ALT 7
CORAL FMU																		
PROHIBITED CORALS	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-
MARINE PLANTS	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-
AQUARIUM TRADE [3]	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-

Astrophyton muricatum , Giant basket star	*Linckia guildingii* , Common comet star	*P. cadenati* , Red reef hermit
Ophiocoma spp., Brittlestars	*Ophidiaster guildingii* , Comet star	*Percnon gibbesi* , Nimble spray crab
Ophioderma spp., Brittlestars	*Oreaster reticulatus* , Cushion sea star	*Lysmata* spp., Peppermint shrimp
O. rubicundum , Ruby brittlestar	*Nemaster* spp., Crinoids	*Thor amboinensis* , Anemone shrimp
Diadema antillarum , Long-spined urchin	*Astropecten* spp., Sand stars	*Mithrax* spp., Clinging crabs
Echinometra spp., Purple urchin	*Davidaster* spp., Crinoids	*M. cinctimanus* , Banded clinging
Eucidaris tribuloides , Pencil urchin	*Spirobranchus giganteus* , Christmas tree worm	*M. sculptus* , Green clinging
Lytechinus spp., Pin cushion urchin	*Lima* spp., Fileclams	*Stenorhynchus seticornis* , Yellowline arrow
Tripneustes ventricosus , Sea egg	*L. scabra* , Rough fileclam	*Periclimenes* spp., Cleaner shrimp
Holothuria spp., Sea cucumbers	*Spondylus americanus* , Atlantic thorny oyster	*Gonodactylus* spp.
Tunicates--Subphylum Urochordata	*Octopus* spp. (except the Common octopus, *O. vulgaris*)	*Lysiosquilla* spp.
Tridachia crispata , Lettuce sea slug	*Alpheaus armatus* , Snapping shrimp	*Stenopus hispidus* , Banded shrimp
Oliva reticularis , Netted olive	*Paguristes* spp., Hermit crabs	*S. scutellatus* , Golden shrimp
Cyphoma gibbosum , Flamingo tongue		*Analcidometra armata* , Swimming crinoid

[1] Includes Atlantic triton's trumpet (*Charonia variegata*), cameo helmet (*Cassis madagascarensis*), green star shell (*Astrea tuber*), hawkwing conch (*Strombus raninus*), milk conch (*Strombus costatus*), roostertail conch (*Strombus gallus*), true tulip (*Fasciolaria tulipa*), and West Indian fighting conch (*Strombus pugilis*).
[2] Values derived from average landings from Puerto Rico only for 1998-2000 (Ojeda-Serrano et al. 2001). Landings are in number of fish.
[3] Includes all stocks in the Coral FMP except stony corals, octocorals, live-rock, and seagrasses.

Table 11. Percent reduction in catches associated with alternative limit (ABC) and target (OY) control rules. Reductions were calculated based on recent catch. Alternatives are based on the preferred stock status parameter alternatives (e.g., MSY, OY, etc.).

FMU/SUB-UNITS	ABC/MFMT SPECIFIED BY LIMIT CONTROL RULE							OY SPECIFIED BY TARGET CONTROL RULE (1,000 lbs)						
	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7
SPINY LOBSTER FMU														
LOBSTER, SPINY	-	0%	100%	0%	0%	0%	22%	-	25%	100%	46%	25%	46%	46%
CONCH FMU														
CONCH, QUEEN	-	-	0%	-	-	-	-	-	-	-	-	-	-	-
CONCH, OTHER [1]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
REEF FISH FMU														
SNAPPER														
UNIT 1	-	31%	100%	48%	31%	23%	54%	-	48%	100%	70%	48%	54%	75%
SNAPPER, SILK														
SNAPPER, UNC														
SNAPPER, BLACK														
SNAPPER, VERMILION														
SNAPPER, BLACKFIN														
UNIT 2	-	0%	100%	0%	0%	0%	21%	-	25%	100%	45%	25%	45%	45%
SNAPPER, QUEEN														
WENCHMAN														
UNIT 3	-	0%	100%	0%	0%	0%	22%	-	25%	100%	46%	25%	46%	46%
SNAPPER, GRAY														
SNAPPER, LANE														
SNAPPER, MUTTON														
SNAPPER, UNC														
SNAPPER, DOG														
SNAPPER, SCHOOLMASTER														
SNAPPER, MAHOGANY														
UNIT 4	-	38%	100%	53%	69%	30%	63%	-	53%	100%	76%	77%	63%	81%
SNAPPER, YELLOWTAIL														
GROUPER														
UNIT 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GROUPER, NASSAU														
UNIT 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GROUPER, GOLIATH														
UNIT 3	-	0%	100%	0%	0%	0%	23%	-	25%	100%	48%	25%	48%	48%
HIND, RED														
CONEY														
HIND, ROCK														
GRAYSBY														
CREOLE FISH														
UNIT 4	-	38%	100%	54%	69%	30%	64%	-	54%	100%	76%	77%	64%	81%
GROUPER, RED														
GROUPER, YELLOWEDGE														
GROUPER, MISTY														
GROUPER, TIGER														
GROUPER, YELLOWFIN														
GROUPER, UNC														

Table 11. Percent reduction in catches associated with alternative limit (ABC) and target (OY) control rules. Reductions were calculated based on recent catch. Alternatives are based on the preferred stock status parameter alternatives (e.g., MSY, OY, etc.).

FMU/SUB-UNITS	ABC/MFMT SPECIFIED BY LIMIT CONTROL RULE							OY SPECIFIED BY TARGET CONTROL RULE (1,000 lbs)						
	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7
GRUNTS	-	0%	100%	0%	0%	0%	22%	-	25%	100%	46%	25%	46%	46%
GRUNT, WHITE														
MARGATE														
GRUNT, TOMTATE														
GRUNT, BLUESTRIPED														
GRUNT, FRENCH														
PORKFISH														
GRUNTS, UNC														
GOATFISHES	-	0%	100%	0%	0%	0%	19%	-	25%	100%	41%	25%	41%	41%
GOATFISH, SPOTTED														
GOATFISH, YELLOWTAIL														
GOATFISH, UNC														
PORGIES	-	0%	100%	0%	0%	0%	20%	-	25%	100%	42%	25%	42%	42%
PORGY, JOLTHEAD														
SEA BREAM														
PORGY, SHEEPSHEAD														
PORGY, PLUMA														
SQUIRRELFISHES	-	0%	100%	0%	0%	0%	20%	-	25%	100%	43%	25%	43%	43%
SOLDIERFISH, BLACKBAR														
BIGEYE														
SQUIRRELFISH, UNC														
SQUIRRELFISH, LONGSPINED														
SQUIRRELFISH														
TILEFISH	-	0%	100%	0%	0%	0%	21%	-	25%	100%	45%	25%	45%	45%
TILEFISH, UNC														
TILEFISH, BLACKLINE														
TILEFISH, SAND														
JACKS	-	0%	100%	0%	0%	0%	22%	-	25%	100%	46%	25%	46%	46%
BLUE RUNNER														
JACK, HORSE-EYE														
JACK, BLACK														
JACK, ALMACO														
JACK, BAR														
AMBERJACK, GREATER														
JACK, YELLOW														
JACK, UNC														

Table 11. Percent reduction in catches associated with alternative limit (ABC) and target (OY) control rules. Reductions were calculated based on recent catch. Alternatives are based on the preferred stock status parameter alternatives (e.g., MSY, OY, etc.).

FMU/SUB-UNITS	ABC/MFMT SPECIFIED BY LIMIT CONTROL RULE							OY SPECIFIED BY TARGET CONTROL RULE (1,000 lbs)						
	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7
PARROTFISHES	-	35%	100%	51%	35%	27%	60%	-	51%	100%	73%	51%	60%	79%
PARROTFISH, BLUE														
PARROTFISH, MIDNIGHT														
PARROTFISH, PRINCESS														
PARROTFISH, QUEEN														
PARROTFISH, RAINBOW														
PARROTFISH, REDFIN														
PARROTFISH, REDTAIL														
PARROTFISH, STOPLIGHT														
PARROTFISH, REDBAND														
PARROTFISH, UNC														
PARROTFISH, STRIPED														
SURGEONFISH	-	0%	100%	0%	0%	0%	22%	-	25%	100%	46%	25%	46%	46%
TANG, BLUE														
SURGEONFISH, OCEAN														
DOCTORFISH														
SURGEONFISH, UNC														
TRIGGERFISH AND FILEFISH	-	37%	100%	53%	37%	29%	62%	-	53%	100%	75%	53%	62%	81%
TRIGGERFISHES, UNC														
TRIGGERFISH, OCEAN														
TRIGGERFISH, QUEEN														
TRIGGERFISH, SARGASSUM														
FILEFISH														
FILEFISH, SCRAWLED														
FILEFISH, WHITESPOTTED														
DURGON, BLACK														
BOXFISH	-	35%	100%	51%	35%	27%	60%	-	51%	100%	73%	51%	60%	79%
BOXFISH, UNC														
COWFISH, HONEYCOMB														
COWFISH, SCRAWLED														
TRUNKFISH														
TRUNKFISH, SPOTTED														
TRUNKFISH, SMOOTH														
WRASSES	-	0%	100%	0%	0%	0%	23%	-	25%	100%	47%	25%	47%	47%
HOGFISH														
WRASSES, UNC														
PUDDINGWIFE														
HOGFISH, SPANISH														
ANGELFISH	-	0%	100%	0%	0%	0%	21%	-	25%	100%	45%	25%	45%	45%
ANGELFISH, QUEEN														
ANGELFISH, GRAY														
ANGELFSISH, FRENCH														

Table 11. Percent reduction in catches associated with alternative limit (ABC) and target (OY) control rules. Reductions were calculated based on recent catch. Alternatives are based on the preferred stock status parameter alternatives (e.g., MSY, OY, etc.).

FMU/SUB-UNITS	ABC/MFMT SPECIFIED BY LIMIT CONTROL RULE							OY SPECIFIED BY TARGET CONTROL RULE (1,000 lbs)						
	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7
AQUARIUM TRADE [2]	-	-	-	-	-	-	-	-	-	-	-	-	-	-

CHAIN MORAY	FOUREYE BUTTERFLYFISH	JACKKNIFE-FISH	REDLIP BLENNY	SPOTTED DRUM
CHERUBFISH	FLYING GURNARD	LANTERN BASS	SPOTFIN BUTTERFLYFISH	SUNSHINEFISH
CLOWN WRASSE	FROGFISH	LONGSNOUT BUTTERFLYFISH	ROCK BEAUTY	SWISSGUARD BASSLET
CONCHFISH	GLASSEYE SNAPPER	MORAY UNC	ROYAL GRAMMA	TOBACCOFISH
CREOLE WRASSE	GOLDENTAIL MORAY	NEON GOBY	RUSTY GOBY	TRUMPETFISH
DAMSELFISH UNC	GOLDSPOTTED EEL	ORANGEBACK BASS	SAND DIVER	YELLOWHEAD JAWFISH
DUSKY DAMSELFISH	GREEN MORAY	PEACOCK FLOUNDER	SCORPIONFISH	YELLOWHEAD WRASSE
DUSKY JAWFISH	HAMLETS	PIPEFISHES	SEAHORSES	YELLOWTAIL DAMSELFISH
FLAMEFISH	HARLEQUIN BASS	PEARLY RAZORFISH	SERGEANT MAJOR	YELLOWCHEEK WRASSE
CARDNAL SOLDIERFISH	HIGH-HAT	GREEN RAZORFISH	SHARPNOSE PUFFER	REDSPOTTED HAWKFISH
CHALK BASS	GREATER SOAPFISH	PORCUPINEFISH	THREESPOTTED DAMSELFISH	

FMU/SUB-UNITS	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7
CORAL FMU														
PROHIBITED CORALS	-	-	0%	-	-	-	-	-	-	0%	-	-	-	-
MARINE PLANTS	-	-	0%	-	-	-	-	-	-	0%	-	-	-	-
AQUARIUM TRADE [3]	-	-	0%	-	-	-	-	-	-	0%	-	-	-	-

Astrophyton muricatum , Giant basket star	*Linckia guildingii* , Common comet star	*P. cadenati* , Red reef hermit
Ophiocoma spp., Brittlestars	*Ophidiaster guildingii* , Comet star	*Percnon gibbesi* , Nimble spray crab
Ophioderma spp., Brittlestars	*Oreaster reticulatus* , Cushion sea star	*Lysmata* spp., Peppermint shrimp
O. rubicundum , Ruby brittlestar	*Nemaster* spp., Crinoids	*Thor amboinensis* , Anemone shrimp
Diadema antillarum , Long-spined urchin	*Astropecten* spp., Sand stars	*Mithrax* spp., Clinging crabs
Echinometra spp., Purple urchin	*Davidaster* spp., Crinoids	*M. cinctimanus* , Banded clinging
Eucidaris tribuloides , Pencil urchin	*Spirobranchus giganteus* , Christmas tree worm	*M. sculptus* , Green clinging
Lytechinus spp., Pin cushion urchin	*Lima* spp., Fileclams	*Stenorhynchus seticornis* , Yellowline arrow
Tripneustes ventricosus , Sea egg	*L. scabra* , Rough fileclam	*Periclimenes* spp., Cleaner shrimp
Holothuria spp., Sea cucumbers	*Spondylus americanus* , Atlantic thorny oyster	*Gonodactylus* spp.
Tunicates--Subphylum Urochordata	*Octopus* spp. (except the Common octopus, *O. vulgaris*)	*Lysiosquilla* spp.
Tridachia crispata , Lettuce sea slug	*Alpheaus armatus* , Snapping shrimp	*Stenopus hispidus* , Banded shrimp
Oliva reticularis , Netted olive	*Paguristes* spp., Hermit crabs	*S. scutellatus* , Golden shrimp
Cyphoma gibbosum , Flamingo tongue		*Analcidometra armata* , Swimming crinoid

[1] Includes Atlantic triton's trumpet (*Charonia variegata*), cameo helmet (*Cassis madagascarensis*), green star shell (*Astrea tuber*), hawkwing conch (*Strombus raninus*), milk conch (*Strombus costatus*), roostertail conch (*Strombus gallus*), true tulip (*Fasciolaria tulipa*), and West Indian fighting conch (*Strombus pugilis*).

[2] Values derived from average landings from Puerto Rico only for 1998-2000 (Ojeda-Serrano et al. 2001). Landings are in number of fish.

[3] Includes all stocks in the Coral FMP except stony corals, octocorals, live-rock, and seagrasses.

Table 12. Spawning Seasonality (By Month) for Species in the Caribbean Reef Fish FMU. "X" lindicates Months when Spawning Has Been Reported and Shaded Area Time of Peak Spawning.

SPECIES COMPLEX	January	February	March	April	May	June	July	August	September	October	November	December
REEF FISH FMP												
SNAPPER												
UNIT 1												
SNAPPER, SILK	X	X	X	X	X	X	X	X	X	X	X	X
SNAPPER, UNC												
SNAPPER, BLACK	X	X	X	X	X			X	X	X	X	X
SNAPPER, VERMILION	X	X	X	X	X	X	X	X	X	X	X	X
SNAPPER, BLACKFIN	X	X	X	X	X	X	X	X	X	X	X	X
UNIT 2												
SNAPPER, QUEEN				X	X							
WENCHMAN												
UNIT 3												
SNAPPER, GRAY					X	X	X	X	X	X		
SNAPPER, LANE	X	X	X	X	X	X	X	X	X	X	X	X
SNAPPER, MUTTON		X	X	X	X	X						
SNAPPER, UNC												
SNAPPER, DOG	X	X	X	X	X	X	X	X	X	X	X	X
SNAPPER, SCHOOLMASTER		X	X	X	X	X		X	X	X	X	
SNAPPER, MAHOGANY								X				
UNIT 4												
SNAPPER, YELLOWTAIL		X	X	X	X	X	X	X	X	X		
GROUPER												
UNIT 1												
GROUPER, NASSAU	X	X	X	X								X
UNIT 2												
GROUPER, GOLIATH						X	X	X	X	X	X	X
UNIT 3												
HIND, RED	X	X	X	X								X
CONEY	X	X	X								X	X
HIND, ROCK	X	X	X									
GRAYSBY			X		X	X	X	X	X	X		
CREOLE FISH												
UNIT 4												
GROUPER, RED		X	X	X	X							
GROUPER, YELLOWEDGE				X	X	X	X	X	X	X		
GROUPER, MISTY	X			X				X			X	
GROUPER, TIGER	X	X	X	X								
GROUPER, YELLOWFIN		X	X	X								
GROUPER, UNC												

Table 12. Spawning Seasonality (By Month) for Species in the Caribbean Reef Fish FMU. "X" lindicates Months when Spawning Has Been Reported and Shaded Area Time of Peak Spawning.

SPECIES COMPLEX	January	February	March	April	May	June	July	August	September	October	November	December
GRUNTS												
GRUNT, WHITE	X	X	X	X					X	X	X	
MARGATE	X	X	X	X	X	X	X	X	X	X	X	X
GRUNT, TOMTATE	X	X	X	X	X		X	X				
GRUNT, BLUESTRIPED	X	X	X	X					X	X	X	X
GRUNT, FRENCH	X	X	X	X	X	X	X	X	X	X	X	X
PORKFISH	X	X	X	X			X			X		X
GRUNTS, UNC												
GOATFISHES												
GOATFISH, SPOTTED	X	X	X	X						X		
GOATFISH, YELLOW		X	X	X	X				X	X		
GOATFISH, UNC												
PORGIES												
PORGY, JOLTHEAD	X	X	X	X	X	X				X	X	X
SEA BREAM	X	X	X								X	X
PORGY, SHEEPSHEAD												
PORGY, PLUMA		X	X									
SQUIRRELFISHES												
SOLDIERFISH, BLACKBAR			X									
BIGEYE												
SQUIRRELFISH, UNC												
SQUIRRELFISH, LONGSPINED	X	X	X	X	X	X		X	X	X	X	X
SQUIRRELFISH												
TILEFISH												
TILEFISH, UNC												
TILEFISH, BLACKLINE												
TILEFISH, SAND												
JACKS												
BLUE RUNNER		X	X	X	X	X	X	X	X			
JACK, HORSE-EYE		X	X	X		X	X	X	X	X		
JACK, BLACK	X	X	X	X	X	X	X	X	X	X	X	X
JACK, ALMACO												
JACK, BAR	X	X	X	X	X	X	X	X	X	X	X	X
AMBERJACK, GREATER	X	X	X	X	X	X		X			X	
JACK, YELLOW		X	X	X	X	X	X	X	X	X	X	
JACK, UNC												

Table 12. Spawning Seasonality (By Month) for Species in the Caribbean Reef Fish FMU. "X" lindicates Months when Spawning Has Been Reported and Shaded Area Time of Peak Spawning.

SPECIES COMPLEX	January	February	March	April	May	June	July	August	September	October	November	December
PARROTFISHES												
PARROTFISH, BLUE	X	X	X	X	X							
PARROTFISH, MIDNIGHT	X	X	X	X	X							
PARROTFISH, PRINCESS	X	X	X	X	X	X	X	X	X	X	X	X
PARROTFISH, QUEEN	X	X			X	X		X				
PARROTFISH, RAINBOW	X	X	X	X	X	X	X					
PARROTFISH, REDFIN	X	X	X	X	X	X	X	X	X	X	X	X
PARROTFISH, REDTAIL	X	X	X	X	X	X	X	X	X	X	X	X
PARROTFISH, STOPLIGHT	X	X	X	X	X	X	X	X	X	X	X	X
PARROTFISH, REDBAND		X	X	X		X		X				X
PARROTFISH, UNC												
PARROTFISH, STRIPED		X	X	X		X		X				
SURGEONFISH												
TANG, BLUE	X	X	X	X	X	X	X	X	X	X	X	X
SURGEONFISH, OCEAN	X	X	X	X	X	X	X	X	X	X	X	X
DOCTORFISH	X	X	X	X	X	X			X	X	X	
SURGEONFISH, UNC												
TRIGGERFISH AND FILEFISH												
TRIGGERFISHES, UNC												
TRIGGERFISH, OCEAN	X			X	X			X	X			X
TRIGGERFISH, QUEEN	X	X	X	X	X	X		X	X	X		
TRIGGERFISH, SARGASSUM			X								X	
FILEFISH, UNC												
FILEFISH, SCRAWLED												
FILEFISH, WHITESPOTTED												
DURGON, BLACK			X	X				X	X	X	X	
BOXFISH												
BOXFISH, UNC												
COWFISH, HONEYCOMB												
COWFISH, SCRAWLED	X	X				X	X	X	X			
TRUNKFISH												
TRUNKFISH, SPOTTED												
TRUNKFISH, SMOOTH												
WRASSES												
HOGFISH	X	X	X	X	X	X	X					X
WRASSES, UNC												X
PUDDINGWIFE			X	X								
HOGFISH, SPANISH		X										
ANGELFISH												
ANGELFISH, QUEEN	X		X	X				X				
ANGELFISH, GRAY		X	X		X	X						
ANGELFSISH, FRENCH			X		X							

Table 13. Alternatives considered to reduce fishing mortality of managed species in the U.S. Caribbean, and their subsequent reductions in mortality.

Fishable habitat consists of waters from 0-100 fathoms, of which there is a total of 2,467 nm^2 in the U.S. Caribbean. The EEZ includes 355 nm^2 or 14.39% of the total fishable habitat. There are 116 nm^2 or 32.6% of the total fishable habitat in the EEZ off Puerto Rico, and 240 nm^2 or 67.4% of the total fishable habitat in the EEZ off the USVI. There are 510 nm^2 of fishable habitat off St. Thomas/St. Johns, with 43% (218 nm^2) of that habitat in the EEZ. There are 120 nm^2 of fishable habitat off St. Croix, with 18% (21 nm^2) of that habitat in the EEZ.

The first two columns are the percent reductions in fishing mortality from each alternative, as it pertains to a particular complex (i.e., FMU sub-unit) or for all managed species. For example, alternatives 2a - 2e pertain to a specific complex, thus the reduction in fishing mortality would only be applied to that complex. The next two columns refer to where the percent reduction in fishing mortality occurs (i.e., EEZ waters off Puerto Rico or USVI), which is primarily included to assist the analysis of Alternative 3. The last column lists the potential economic impact (in dollars) resulting from each alternative. Due to a lack of discrete economic data, the economic impact estimates do not include the potential impact to the recreational sector. However, based on input from the Caribbean Council Advisory Panels, these alternatives are not likely to have a significant impact to recreational fishers in the EEZ since the majority of recreational activity in the EEZ is focused on species that are not under Council management (e.g., HMS, dolphin, wahoo).

[1] Actions which have already been implemented, but have only been implemented recently; their contribution to the reduction of overall fishing mortality is therefore included.

[2] Annual average values are based on Puerto Rico data, 1995-2002. Species-specific economic data is not available for USVI. More information on economic impacts can be found in Section 6.3.1 (Tables 6.3.1.2a-f).

[3] Values were determined using commercial landings in Table 5, and multiplied by $1.99351/pound, as utilized from Puerto Rico trip ticket data for reef fish species, 1995-2002; $2.285/pound, as utilized from Matos-Caraballo (2002) for Puerto Rican queen conch, 1998-2001; and $5.265/pound, as utilized from Matos-Caraballo (2002), for Puerto Rican spiny lobster, 1998-2001. The impact resulting from the prohibition of fish traps and nets is based on the expected reduction in fishing mortality (i.e., bounded by 22% for total Puerto Rico commercial landings and 67% for the USVI reef fish fishery, based on Scharer *et al.* (2002) and Valle-Esquivel and Diaz (2003), respectively; and by 10% for total Puerto Rico commercial reef fish landings and 6.34% for the USVI reef fish fishery, based on 2002 Puerto Rico trip ticket data and Valle-Esquivel and Diaz (2003), respectively) from total commercial reef fish landings in Table 5, as modified by the amount of fishable habitat in the EEZ (i.e., 14%).

[4] Values for the Puerto Rico closed areas in Alternative 3a were derived by first averaging the annual dockside value for west coast Puerto Rico landings for the 1998-2001 (i.e., four years) and then using an expansion factor of 1.28 to estimate total west coast landings. Based upon estimated fishable area in the EEZ relative to total fishable area on the west coast, the estimate of total landings was then multiplied by 0.20 (i.e., 20% of the total fishable area on the west coast is in the EEZ). Finally, this number was adjusted based on the size of each proposed closure relative to total fishable area in the EEZ off the west coast of Puerto Rico.

[5] Please see footnote 6 below for a discussion pertaining to estimating the economic impact north of St. Thomas (where TNW is the relevant grid). To determine the economic impact northeast of Puerto Rico, the estimate of economic impact of north of St. Thomas was reduced based upon the estimated size of the proposed closure northeast of Puerto Rico in relation to the estimated size of the proposed closure north of St. Thomas.

[6] Economic impacts associated with east of St. Croix on Lang Bank and south of St. John were estimated by first determining average annual reported catch in the associated grid for each of these two regions (e.g. C4 for east of St. Croix) in Federal waters. St. Croix area landings were modified by 0.40 (i.e., 40% of the total fishable area on the east coast is in the closed area). St. John area landings were modified by 0.50 (i.e., 50% of the total fishable area south of St. John is in the closed area). St. Thomas landings were modified by 0.65 (i.e., 65% of the total fishable area north of St. Thomas is in the closed area). This was conducted for the four-year fishing period during 1998-2001. Since price per pound is not reported, corresponding prices for Puerto Rico, by primary species (e.g., lobster, conch, grouper, snapper, and other) were used to estimate dockside value (note: since fishers in the USVI often sell their catch directly, prices for Puerto Rico may underestimate the price received by fishers in the USVI). This step provides an estimate of total dockside value of landings from Federal waters from the respective grid (the estimate is given in the "all catch" column). Finally, these estimates were adjusted to account for (a) under-reporting, which is relatively minor, and (b) estimated fishable area in the proposed closed area relative to fishable area in grid.

[7] Since this proposed closed area alternative is only seasonal, the reduction in fishing mortality would be reduced due to the periodic nature of the closure (i.e., the potential reduction in fishing mortality is multiplied by 0.25, since the closed area is only in effect four months out of the year.

Actions that are shaded relate to actions applicable only in State waters.

MANAGEMENT ACTION			PERCENT REDUCTION				IMPACT ($)
	TOTAL SIZE (NM^2)	FISHABLE HABITAT (NM^2)	COMPLEX	ALL SPECIES	PR	USVI	
Alternative 1: No action. Do not adopt additional management measures at this time.			-	-	-	-	-
Alternative 2: Establish seasonal closures.							
Alternative 2a. Close the U.S. EEZ to all fishing for species in Grouper Unit 4 (including the red, misty, black, tiger, yellowfin, and yellowedge grouper) from February 1 through April 30.	-	-	25		-	-	1,307 [2]
Alternative 2b. Close the U.S. EEZ to all fishing for red hind from December 1 through February 28.	-	-	25		-	-	6,577 [2]
Alternative 2c. Close the U.S. EEZ to all fishing for species in Snapper Unit 1 (including the black, blackfin, vermilion, and silk snapper) from January 1 through September 30.	-	-	75		-	-	97,736 [2]
Alternative 2d. Close the U.S. EEZ to all fishing for yellowtail snapper from April 1 through June 30.	-	-	25		-	-	25,699 [2]
Alternative 2e. Close the U.S. EEZ to all fishing for mutton snapper and lane snapper from April 1 through July 31.	-	-	33		-	-	36,507 [2]
Alternative 2f. Close the U.S. EEZ to all fishing for all Caribbean Council-managed species each year from January 1 to March 31 (3-month closure).	-	-		25	-	-	147,912 [2]
Alternative 2g. Close the U.S. EEZ to all fishing for all Caribbean Council-managed species each year from January 1 to March 31 and from July 1 to September 30 (6-month closure).	-	-		50	-	-	275,284 [2]
Alternative 2h. Close the U.S. EEZ to all fishing for all Caribbean Council-managed species all year round (total closure).	-	-		100	-	-	1,004,001 [3]
Alternative 3: Establish area closures.							
Hind Bank MCD (south of St. Thomas)[1]	13	11		3		100	
Grammanik Bank preferred alternative (February 1 - May 31)[7]	7	3		<1 (0.19)		100	
Buck Island Reef National Monument (St. Croix)[1]	28	9		<1 (0.44)		100	
Virgin Islands Coral Reef National Monument (St. John)[1]	20	20		1 (0.95)		100	
St. Croix East End Marine Park[1]	5	5		<1 (0.24)		100	

Luis Peña Channel Marine Natural Reserve[1]	2	2		<1 (0.10)	100		
Desecheo Marine Reserve[1]	2	2		<1 (0.11)	100		
Alternative 3a(1). West of Puerto Rico (PRW)	51	32		9	100		196,161[4]
Alternative 3a(6). West of Puerto Rico #2 (PRW2)	16	11		3	100		65,019 [4]
Alternative 3a(7). West of Puerto Rico #3 (PRW3)	33	28		8	100		174,202 [4]
Alternative 3a(2). Northeast of Puerto Rico (PRN)	23	20		4	70	30	54,470 [5]
Alternative 3a(8). Combined Northeast of Puerto Rico and North of St. Thomas (CARIB)	40	38		11	36	64	102,305 [5]
Alternative 3a(3). East of St. Croix on Lang Bank (CRX)	12	7		2		100	53,089 [6]
Alternative 3a(4). South of St. John (JOS)	15	13		4		100	73,144 [6]
Alternative 3a(5). North of St. Thomas (THN)	66	55		17		100	147,706 [6]
Alternative 3b. Close the EEZ off Puerto Rico, and establish a closed area off the USVI.	-	171		50	66	34	511,414 [2]
Alternative 4: Eliminate the use of fish traps in the U.S. EEZ.	-	-		22 - 67	-	-	140,517 - 427,939 [3]
Alternative 5: Eliminate the use of gill and trammel nets in the U.S. EEZ.	-	-		6 - 10	-	-	38,323 - 63,872 [3]
Alternative 6: Request that the Secretary of Commerce/NOAA Fisheries develop a memorandum of understanding (MOU) with the State governments of Puerto Rico and the U.S. Virgin Islands to develop compatible regulations to achieve the management objectives set forth in all Caribbean Council fishery management plans in State and	-	-	-	-	-	-	-

11.1 Appendix B - Scoping information

The Caribbean Council held seven public hearings to solicit input on the scope of this amendment prior to the distribution of this Public Hearing Draft/DSEIS. The following three hearings were held during the development of the original draft amendment, titled the Comprehensive Sustainable Fisheries Act Amendment to the Spiny Lobster, Queen Conch, Reef Fish, and Coral Fishery Management Plans (Comprehensive SFA Amendment):

Best Western Pierre Hotel
San Juan, PR
6 November 1998, 7:00 PM
Notice published 4 November 1998 (63 FR 59545)

Caravelle Hotel
St. Croix, USVI
10 November 1998, 7:00 PM
Notice published 4 November 1998 (63 FR 59545)

Divi Carina Bay Resort and Casino
St. Croix, USVI
14 August 2001, 1:30 PM
Notice published 27 July 2001 (66 FR 39146)

The notice of availability of the Comprehensive SFA Amendment, which included an Environmental Assessment, was published in the *Federal Register* on 25 January 2002 (67 FR 3679). A federal review determined that the amendment did not fully meet the requirements of the MSFCMA and of NEPA. The lack of an adequate range of alternatives for defining biological reference points, rebuilding schedules, and bycatch reporting standards was the primary deficiency cited in the notice of agency action to disapprove the document. That notice was published in the *Federal Register* on 1 May 2002 (67 FR 21598), along with a summary of comments provided by the public in response to the *Federal Register* notice of 25 January 2002.

On May 31, 2002, the Caribbean Council published in the *Federal Register* a notice of intent to prepare a DSEIS that would provide the framework for fully evaluating a broader range of alternatives to achieve MSFCMA requirements in U.S. Caribbean fisheries in a revised, integrated FMP amendment (67 FR 38060). That *Federal Register* notice also notified the public of the following four public hearings on the scope of the DSEIS:

Torres de la Parguera Hotel
La Parguera, Lajas, PR
4 June 2002, 2 PM

Best Western Pierre Hotel
Santurce, PR
6 June 2002, 2 PM

Caravelle Hotel
St. Christiansted, St. Croix, USVI
10 June 2002, 7 PM

Windward Passage Holiday Inn
Charlotte Amalie, St. Thomas, USVI
12 June 2002, 1 PM

In addition to comments provided by the public through these public hearings and through written comment letters, the Council received advice and guidance from the SFA Working Group, which was appointed by the Caribbean Council for this purpose. The SFA Working Group included representatives from NOAA Fisheries, the Caribbean Council, state agencies, and interested stakeholder groups, all of which are identified by name in Section 11.3.2. The group met twice during the development of this amendment. The first meeting took place at NOAA Fisheries' Southeast Regional Science Center in Miami, FL, on 6-7 August 2002. Notice of that meeting was published in the *Federal Register* on 30 July 2002 (67 FR 49284). The second meeting took place at The Embassy Suites Hotel in Carolina, PR, on 23-24 October 2002. Notice of that meeting was published in the *Federal Register* on 15 October 2002 (67 FR 63622).

Comments and suggestions provided to the Caribbean Council during the development of this amendment by the public and by the SFA Working Group were used to develop the suite of management alternatives presented in Section 4.0 of this amendment. Alternatives considered by the Council, but eliminated from more detailed study in this amendment, are described in Section 11.2.

Interested readers may request copies of comment letters submitted to the Caribbean Council, as well as the summaries of public hearings, and the minutes of SFA Working Group meetings, by contacting Miguel Rolon, Executive Director, Caribbean Fishery Management Council, at the address below.

The availability of the DSEIS for this integrated FMP amendment was announced in the *Federal Register* on March 18, 2005, (70 FR 13189. The 45-day comment period on the DSEIS ended May 2, 2005.

Written comments on the FSEIS should be mailed to Mr. Miguel Rolón or Dr. Roy Crabtree at the following addresses:

Miguel A. Rolón, Executive Director
Caribbean Fishery Management Council
268 Muñoz Rivera Avenue, Suite 1108
San Juan, PR 00918-2577

Dr. Roy Crabtree, Regional Administrator
National Marine Fisheries Service
Southeast Regional Office
9721 Executive Center Drive North
St. Petersburg, FL 33702

11.2 Alternatives considered during the scoping process, but eliminated from more detailed study in the amendment

This section describes alternatives that were considered by the Council in developing this document, but that are no longer being pursued. Many of these alternatives were proposed by stakeholders through the scoping process described above. The description of each alternative is followed by a summary statement of why it was eliminated from more detailed study.

11.2.1 Fishery management units and sub-units

11.2.1.1 Defining fishery management units and sub-units

11.2.1.1.1 Rejected Alternative 1. Redefine the fishery management units and sub-units in Caribbean Council fishery management plans to be consistent with those specified in Table 4 of the Draft Options Paper (CFMC 2002d).

Rationale for elimination: Table 4 of the Draft Options Paper (CFMC 2002d) reflected a revision of the FMUs and sub-units presented in the Caribbean Council's previous draft Comprehensive SFA Amendment. These revised FMUs and sub-units were delineated by staff of the Caribbean Council, the NOAA Fisheries SERO and SEFSC, the USVI and Puerto Rico fisheries management agencies, and several environmental non-governmental organizations represented on the Council's SFA Working Group. The Council rejected Table 4 at the 110th Council meeting in favor of a new table that reflects minor adjustments to eliminate the problem of identifying some species as food fish and also as aquarium trade species. Permitting the use of food fish in the aquarium trade could result in the take of juveniles that have not yet had the chance to reproduce. The Council's revised table described in the preferred FMU Alternative 2 (Section 4.1.1.2) categorizes species either as food fish or as aquarium trade species, depending on their primary use.

11.2.2 Biological reference points and stock status determination criteria

11.2.2.1 Maximum sustainable yield (MSY)

11.2.2.1.1 Rejected Alternative 2. Use the average current catch as a proxy for MSY, based on commercial landings data for the years 1997-2001, and recreational landings for the years 2000-2001.

Rationale for Elimination: This alternative would assume that both the biomass and the fishing mortality rate associated with the specified catch period were consistent with that able to produce MSY. We eliminated this alternative in response to public comments indicating that assumption did not allow for the possibility that recent catches were affected by a declining trend in stock biomass. MSY Alternative 2 (Section 4.2.1.2) modifies this alternative to address this concern by incorporating into the proxy estimates of B_{MSY}/B_{CURR} and F_{MSY}/F_{CURR} to enable us to consider alternative definitions of MSY that reflect situations where biomass and/or fishing mortality rates were above, equal to, or below the level needed to produce MSY during the defined catch period.

11.2.2.1.2 Rejected Alternative 3. Use the average current catch as a proxy for MSY, based on commercial landings data for the years 1997-2001, and recreational landings for 2000-2001, as modified by a reporting/correction factor.

Rationale for Elimination: This alternative differs from Rejected Alternative 2 only in that it would modify the catch data derived from trip ticket reports using reporting/correction factors. It has the same deficiencies as Rejected Alternative 2. Additionally, no scientific methodology has been documented for estimating reporting/correction factors for U.S. Caribbean fisheries. Those factors applied by state agencies have varied from year to year.

11.2.2.1.3 Rejected Alternative 4. Set MSY equal to 75% of current catch.

Rationale for Elimination: This alternative would assume that current catches reflect biomass levels that are below those which would produce MSY and/or fishing mortality rates that are above those which would produce MSY. Incorporating information on stock status into the definition of MSY proxies that are based on catch data allows fishery managers to consider that stocks may not have been at equilibrium during the defined catch period. Such considerations are appropriate. But estimates of stock status should be defined on a stock-specific basis using the best available scientific information. This is accomplished in MSY Alternative 2 (Section 4.2.1.2).

11.2.2.1.4 Rejected Alternative 5. Determine MSY by considering mortality factors: (a) set F = 0.75M; or (b) substitute $F_{0.1}$ for F.

Rationale for Elimination: The formulas in Rejected Alternatives 8(a) and 8(b) would define the fishing mortality rates, rather than the yields associated with MSY. Consequently, they would be more appropriately applied to the definition of MFMT proxies, or limit control rules. The range of MFMT proxies, or limit control rules, considered in Section 4.2.5 incorporates similar alternatives that would reduce the MFMT proxy of stocks believed to be at risk. Thus, Rejected Alternatives 8(a) and 8(b) were not studied in more detail. Additionally, alternative 8(b) would require data on growth and age-specific fishing mortality. These data are not available.

11.2.2.1.5 Rejected Alternative 6. Determine MSY by considering current catch levels: (a) use C_{CURR}/C_{XYEARS} as a proxy for F_{MSY}/F_{CURR}; (b) set MSY = 0.75C; (c) set C = 1.1MSST; or (d) set current catch by factoring landing declines over time. Assume F and B ratios equal to 1, but derive MSY based on C calculated as the average of yearly catches for the most recent eight years and four years, to factor in the obvious decline in landings that should be indicative of a decline in B.

Rationale for Elimination: The goal of each of the sub-alternatives listed in Rejected Alternative 6 is to incorporate into the calculation of MSY proxies information that would reduce those proxies below values that would be equal to average catches over a defined time period. Incorporating information on stock status into the definition of MSY proxies that are based on catch data allows fishery managers to consider that stocks may not have been at equilibrium during the defined catch period. Such considerations are appropriate. But estimates of stock status should be defined on a stock-specific basis using the best available scientific information. This is accomplished in MSY Alternative 2 (Section 4.2.1.2). The Council is examining in MSY

Alternative 4 (Section 4.2.1.4) the appropriateness of calculating MSY based on a longer time series of catch data.

11.2.2.1.6 Rejected Alternative 7. As a proxy, set MSY to the equilibrium yield corresponding to a 30% SPR for all managed stocks with the exception of Nassau grouper, Goliath grouper, red hind, and other hermaphroditic groupers, all of which have MSY set to the equilibrium yield corresponding to a 45% SPR.

Rationale for Elimination: This alternative would require age-specific information on growth, fishing mortality, and reproductive potential. These data are not available.

11.2.2.1.7 Rejected Alternative 8. Determine MSY by considering CPUE: (a) use CPUE trend ratios as proxies for F_{MSY}/B_{CURR}; or (b) use CPUE trend line to estimate B_{MSY}.

Rationale for Elimination: Catch-per-unit-effort data on U.S. Caribbean fisheries are not sufficiently reliable to be used in this capacity. The Council could consider CPUE trends in making future determinations about the biomass ratio of select stocks.

11.2.2.1.8 Rejected Alternative 9. Determine MSY by considering life history characteristics: (a) adjust F and B ratios for any stock with a steady declining catch history; or (b) adjust F and B ratios for species with "high risk" spawning strategies.

Rationale for Elimination: MSY Alternative 2 (Section 4.2.1.2), and B and F Ratio Alternatives 2-4 (Sections 4.2.2.2-4.2.2.4), incorporate this suggestion that MSY proxies should be adjusted to be more precautionary for stocks that are believed to be at risk or to be particularly vulnerable to overfishing.

11.2.2.1.9 Rejected Alternative 10. Incorporate precaution into MSY estimates for select species at risk based on extrapolated information. Species at risk could be defined as (a) the ten species that have been designated by the American Fisheries Society to be at risk of extinction. These species include black grouper, gag grouper, Goliath grouper, marbled grouper, Nassau grouper, snowy grouper, speckled hind, Warsaw grouper, yellowedge grouper, and yellowmouth grouper; or (b) species that are presently designated to be overfished or undergoing overfishing under the Gulf of Mexico Reef Fish FMP or the South Atlantic Snapper-Grouper FMP.

Rationale for Elimination: This alternative also would adjust MSY proxies to be more precautionary for stocks that are believed to be at risk. This approach is used in MSY Alternative 2 (Section 4.2.1.2). The SFA Working Group defined species at risk based on anecdotal information, trends in catch, and other available information, including the AFS publication referenced in Rejected Alternative 10. Most of the species referenced in this alternative are not represented in the Caribbean reef fish FMU. Those that are represented in the FMU have been classified as at risk.

11.2.2.1.10 Rejected Alternative 11. Specifically for spiny lobster and queen conch, MSY is defined as the equilibrium yield that corresponds to a 20% SPR.

Rationale for Elimination: This alternative would require age-specific information on growth, fishing mortality, and reproductive potential. These data, where available, are not sufficiently reliable to use in this capacity.

11.2.2.2 Optimum yield (OY)

11.2.2.2.1 Rejected Alternative 12. Set OY equal to MSY.

Rationale for Elimination: This alternative would result in OY definitions that are less precautionary than the default definition proposed in NOAA Fisheries' technical guidance. That definition would define OY as a yield that approximates about 94% of the MSY (Restrepo et al. 1998). Additionally, the OY definitions that would result from the implementation of this alternative would be problematic if the overfishing threshold (MFMT) proxies the Council is evaluating in Section 4.2.5 are adopted. Those proxies could result in the definition of an overfishing threshold that is equal to or less than the fishing mortality rate that would be associated with this definition of OY.

11.2.2.2.2 Rejected Alternative 13. Specifically for spiny lobster, OY will be derived from recent catch as: $OY = (MSY)(F_{OY}/F_{CURR})$, where F_{OY} is equal to 75% of F_{MSY}.

Rationale for Elimination: This alternative would incorporate information on stock status into the definition of OY. The Council has accomplished this by using in its preferred definition of OY an MSY proxy (MSY Alternative 2 (Section 4.2.1.2)) that incorporates information on stock status.

11.2.2.2.3 Rejected Alternative 14. As a proxy, set OY to the equilibrium yield corresponding to a 40% SPR for reef fish species, with the exception of Nassau grouper, Goliath grouper, red hind, and other hermaphroditic groupers, all of which have OY set to the equilibrium yield corresponding to a 55% SPR.

Rationale for Elimination: This alternative would require age-specific information on growth, fishing mortality, and reproductive potential. These data are not available.

11.2.2.2.4 Rejected Alternative 15. As a proxy, set OY to the equilibrium yield corresponding to a 30% SPR for queen conch and spiny lobster.

Rationale for Elimination: This alternative would require age-specific information on growth, fishing mortality, and reproductive potential. These data, where available, are not sufficiently reliable to use in this capacity.

11.2.2.2.5 Rejected Alternative 16. Based on the best available science, OY will be evaluated such that: a) For stocks that are not believed to be at risk based on the best available information, OY is set at 75% of MSY; b) For stocks for which no positive or negative determination can be made on the status of their condition, the default OY is set between 50% - 75% of MSY, based on life history and other relevant OY factors; c) For stocks that are believed to be at risk based on the best available information, OY will be set between 25% - 50% of MSY, based on life history and other relevant OY factors; and d) For each stock that is formally classified as overfished, OY will be determined in an appropriate rebuilding plan.

Rationale for Elimination: This approach to defining OY is being evaluated in OY Alternative 4 (Section 4.2.3.4), which would define OY as 75% of MSY, 50% of MSY, or 25% of MSY, based on determinations about the status, or risk level, of stocks.

11.2.2.2.6 Rejected Alternative 17. OY will be adjusted downward from 75% of MSY based on relevant factors considered by the SFA workgroup (e.g., vulnerable life history, especially high uncertainty, a need for stable economic return, ecological importance).

Rationale for Elimination: This approach to defining OY is being evaluated in OY Alternative 4 (Section 4.2.3.4), which would define OY as 75% of MSY, 50% of MSY, or 25% of MSY, based on determinations about the status, or risk level, of stocks.

11.2.2.2.7 Rejected Alternative 18. $OY = C \times (F_{OY}/F_{CURR})$, where $F_{OY} = 0.75(F_{MSY})$.

Rationale for Elimination: This alternative would define OY to equal some percentage of average catch. The specific percentage would be defined based on the status of the stock. The Council has accomplished this by using in its preferred definition of OY (Section 4.2.3.2) an MSY proxy (MSY Alternative 2 (Section 4.2.1.2)) that incorporates information on stock status.

11.2.2.3 Minimum stock size threshold (MSST)

11.2.2.3.1 Rejected Alternative 19. Since there is no biomass estimate at this time for groupers, no MSST can be set. When biomass data are available, MSST will be set equal to the lesser of 0.5 or (1-M) times the equilibrium biomass

resulting from a fishing mortality rate that generates a 45% SPR. Furthermore, since there is no biomass estimate at this time for other reef fish or spiny lobster, no MSST can be set. When biomass data are available, MSST will be set equal to the lesser of 0.5 or (1-M) times the equilibrium biomass resulting from a fishing mortality rate that generates a 30% SPR for reef fish or 20% SPR.

Rationale for elimination: MSST proxies must be biomass-based to be consistent with the MSFCMA and the National Standard Guidelines. A range of biomass-based MSST proxies are evaluated in Section 4.2.4. Additionally, we do not have data to estimate the yield associated with a specific SPR level.

11.2.2.3.2 Rejected Alternative 20. MSST is set at a transitional SPR of 15% (that is 50% of the SPR set for the MSY) for reef fish, with the exception of red hind, Nassau grouper, Goliath grouper, and other hermaphroditic groupers, which are set at a transitional SPR of 22.5% (that is 50% of the SPR set for the MSY).

Rationale for elimination: MSST proxies must be biomass-based to be consistent with the MSFCMA and the National Standard Guidelines. A range of biomass-based MSST proxies are evaluated in Section 4.2.4. Additionally, we do not have data to estimate the yield associated with a specific SPR level.

11.2.2.3.3 Rejected Alternative 21. Specifically for spiny lobster, a spiny lobster stock is overfished when any one of the following are observed: (a) the SPR is less than 20%; (b) when total landings have declined to a level below 75% of the five-year running mean; or (c) when total landings have declined for three consecutive years.

Rationale for elimination: With respect to Rejected Alternatives 21(a) and 21(c), MSST proxies must be biomass-based to be consistent with the MSFCMA and the National Standard Guidelines. And, again, we do not have data to estimate the yield associated with a specific SPR level. With respect to Rejected Alternatives 21(b) and 21(c), periodic declines in spiny lobster landings are not an unusual event and would not necessarily reflect an overfished condition.

11.2.2.4 Maximum fishing mortality threshold (MFMT) and limit and target control rules

11.2.2.4.1 Rejected Alternative 22. Overfishing for queen conch occurs when the fishing rate results in the static SPR being reduced below 30% SPR.

Rationale for elimination: This alternative would require age-specific information on growth, fishing mortality, and reproductive potential. These data, where available, are not sufficiently reliable to use in this capacity.

11.2.2.4.2 Rejected Alternative 23. Overfishing for spiny lobster occurs when the fishing rate results in the static SPR being reduced below 20% SPR.

Rationale for elimination: This alternative would require age-specific information on growth, fishing mortality, and reproductive potential. These data, where available, are not sufficiently reliable to use in this capacity.

11.2.2.4.3 Rejected Alternative 24. Specifically for spiny lobster, queen conch, and corals, MFMT is the fishing mortality rate corresponding to a 30% transitional SPR.

Rationale for elimination: This alternative would require age-specific information on growth, fishing mortality, and reproductive potential. These data, where available, are not sufficiently reliable to use in this capacity.

11.2.2.4.4 Rejected Alternative 25. Specifically for spiny lobster, queen conch, and corals, MFMT is the fishing mortality rate corresponding to a 40% transitional SPR.

Rationale for elimination: This alternative would require age-specific information on growth, fishing mortality, and reproductive potential. These data, where available, are not sufficiently reliable to use in this capacity.

11.2.2.4.5 Rejected Alternative 26. Set MFMT equal to F_{MSY}. If F_{MSY} cannot be estimated directly, set MFMT equal to 80% of the natural mortality rate (M).

Rationale for elimination: The approach suggested in this alternative is similar to that utilized in MFMT Alternative 7 (Section 4.2.5.7). MFMT Alternative 7 also would set MFMT equal to F_{MSY}. When F_{MSY} cannot be estimated directly, that alternative would define MFMT for stocks of unknown status or that are determined to be at risk to equal 0.75(M) and 0.50(M), respectively.

11.2.2.4.6 Rejected Alternative 27. When a stock is above B_{MSY} or no positive or negative determination can be made, then limit catch to 100% of MSY. When a stock is below B_{MSY} or believed to be at risk based on the best available information, limit catch to 75% of MSY.

Rationale for elimination: This alternative was originally proposed as a limit control rule. It would allow catches to equal the MSY from a fishery for stocks that are not determined to be at risk. While this characteristic is desirable, it also is included in MFMT/Limit Control Rule Alternatives 2 and 5 (Sections 4.2.5.2; 4.2.5.5). Unlike those rules, this rule would allow catches to equal up to 75% of MSY for stocks that are determined to be at risk. This policy would allow the fraction of a population captured to increase as the population declines. In contrast, MFMT/Limit Control Rule Alternative 2 would scale back fishing effort in proportion to any decline below the abundance associated with MSY. MFMT/Limit Control Rule Alternative 5 also would allow catches to increase as populations decline. However, that alternative would reduce fishing mortality rates once stock biomass decreased below the MSST.

11.2.2.4.7 Rejected Alternative 28. When a stock is above B_{MSY} or no positive or negative determination can be made, then limit catch to 75% of MSY. When a stock is below B_{MSY} or believed to be at risk based on the best available information, limit catch to 50% of MSY.

Rationale for elimination: This alternative was originally proposed as a target control rule. At high abundance, this rule would define target catch levels to equal 75% of the MSY from a fishery. While this characteristic is desirable, it also is included in Target Control Rule Alternatives 2 and 5 (Sections 4.2.5.2; 4.2.5.5). Unlike those rules, this rule would define target catch levels for stocks at risk to equal 50% of MSY. That policy would allow the fraction of a population captured to increase as the population declines. In contrast, Target Control Rule Alternative 2 would scale back fishing effort in proportion to any decline below the abundance associated with MSY. Target Control Rule Alternative 5 also would allow catches to increase as populations decline. However, that alternative would reduce fishing mortality rates once stock biomass decreased below the MSST.

11.2.2.4.8 Rejected Alternative 29. Set catch levels equal to fishing mortality (F_{MSY})(B)(OY/MSY) or, when the data needed to determine F_{MSY} are not available, use a proxy for F_{MSY} calculated as a fraction of the natural mortality rate (M) as follows: a) Use 1.00(M) as a proxy for F_{MSY} for species that are not believed to be at risk based on the best available information; b) Use 0.75(M) as a proxy for F_{MSY} for species for which no positive or negative determination can be made on the status of their condition; and c) Use 0.50(M) as a proxy for F_{MSY} for species that are believed to be at risk based on the best available information.

Rationale for elimination: This alternative was originally proposed as a target control rule. It has been retained as an alternative target control rule, but has been modified to be consistent with MFMT/Limit Control Rule Alternative 7 (Section 4.2.5.7). It is considered in that section.

11.2.2.4.9 Rejected Alternative 30. Set catch levels based on when a particular stock is: a) Above B_{MSY}, then limit catch equal to MSY; b) Above MSST but below B_{MSY} (i.e., approaching an overfished condition), then limit catch equal to 67% of MSY; and c) Below MSST (i.e., overfished), limit catch equal to 33% of MSY. Define MSY as the current 5-year average catch.

Rationale for elimination: This alternative was originally proposed as a target control rule. It has been retained as an alternative target control rule, but has been modified to be consistent with MFMT/Limit Control Rule Alternative 5 (Section 4.2.5.5). It is considered in that section.

11.2.3 Regulating Fishing Mortality

11.2.3.1 Rejected Alternative 31. Reduce the total number of gear units fishing in the U.S. EEZ through a buyback program, or through an ITQ or TURF program.

Rationale for elimination: Existing data on participation in the fisheries are not adequate to successfully implement these types of programs at this time. This alternative could be revisited in a later amendment if the Council adopts Bycatch Reporting Alternative 2 or 4 in Section 4.6.1. The Council is considering two gear prohibitions in Section 4.3 as alternatives to a capacity reduction program.

11.2.3.2 Rejected Alternative 32. Establish recreational possession limits.

Rationale for elimination: Existing data are inadequate to support the development of bag limits that could be trusted to reduce catches below current levels. Thus, this alternative is not a viable option at this time.

11.2.3.3 Rejected Alternative 33. Establish trip limits.

Rationale for elimination: Existing data are inadequate to support the development of trip limits that could be trusted to reduce catches below current levels. Thus, this alternative is not a viable option at this time.

11.2.3.4 Rejected Alternative 34. Establish or increase minimum size limits.

Rationale for elimination: This alternative would be particularly resource intensive to implement and enforce. It would require educating fishermen about species and size limits and, unless the states implemented consistent size limits, it would not be enforceable unless law enforcement officials boarded boats in federal waters. Thus, this alternative was rejected as not viable at this time.

11.2.3.5 Rejected Alternative 35. Prohibit the harvest of vulnerable or rare species.

Rationale for elimination: The Caribbean Council has prohibited the catch of Nassau grouper and goliath grouper, and is considering in this amendment an alternative that would prohibit the catch of queen conch (Section 4.4.3.2.2). The alternative management measures the Council is considering in Section 4.3 to reduce fishing mortality on the remaining species managed in Council FMPs are believed to be sufficiently restrictive to reduce fishing pressure in federal waters. Additionally, those measures do not have the same potential as species-specific prohibitions to increase bycatch.

11.2.3.6 Rejected Alternative 36. Develop management measures for aquarium trade species that are consistent with those of Puerto Rico.

Rationale for elimination: The Council's preferred Alternative 2 (Section 4.1.2.2) would move aquarium trade species from a management to a monitoring-only category within their respective FMUs. Rejected Alternative 36 could be re-examined if aquarium trade species require management in the future.

11.2.3.7 Rejected Alternative 37. Implement a total allowable catch management regime. Stop the harvest of stocks/complexes when catch projections indicate that incidental and directed catches will exceed these defined targets.

Rationale for elimination: This alternative would establish an enforced quota for stocks/complexes based on the control rules adopted in Section 4.2.5. Data deficiencies and administrative realities in the U.S. Caribbean would make the effective implementation of this alternative extremely difficult. The seasonal and areal closure alternatives evaluated in Sections 4.3.2 and 4.3.3, respectively, are designed to achieve the same objective. Those regulations would be easier to monitor and enforce, and also would allow fishermen to better plan for closures. For these reasons, this alternative was determined to be impractical and is no longer being considered.

11.2.3.8 Rejected Alternative 38. Preempt state management authority.

Rationale for elimination: Preemption would require a factual finding that "The fishing in a fishery that is covered by an FMP implemented under the Magnuson-Stevens Act is engaged in predominately within the EEZ and beyond such zone" (50 CFR §600.610). Existing data do not support such a finding.

11.2.3.9 Rejected Alternative 39. Delegate management of fisheries to the state governments, with the requirement that the states implement laws and regulations that are consistent with those in the federal fishery management plans.

Rationale for elimination: This alternative is not believed to be feasible at this time. Some regulations in state waters are not consistent with those in Council FMPs despite previous recommendations from the Council to state agencies. Delegating management of federal fisheries to the states could be reconsidered at a future date if the memorandum of understanding proposed in Alternative 6 (Section 4.3.6) is successfully implemented.

11.2.3.10 Rejected Alternative 40. Define the process for developing a limited entry/capacity reduction program that would be implemented in 2006, and

would be capable of achieving the harvest controls established through this amendment.

11.2.3.11 Rejected Alternative 41. Establish a marine protected area (MPA) network.

Rationale for elimination: The two alternatives above can't be implemented without further development, which is not practical at this time. A limited entry/capacity reduction program would require specific details as to how it would be implemented, including criteria for participation and/or capacity reduction, which would be extremely complicated in the absence of a federal permit. Further, the establishment of a MPA network would require additional information. Beyond the establishment of stand-alone closed areas, as in Section 4.3.3, a network implies that numerous closed areas would have some type of relationship or rationale for creation (e.g., spawning aggregations). Therefore, it is not possible to adopt an alternative that can't be implemented due to lack of development.

11.2.4 Rebuilding Overfished Fisheries

11.2.4.1 Nassau grouper

11.2.4.1.1 Rebuilding schedule

11.2.4.1.1.1 Rejected Alternative 42. Rebuild Nassau grouper to B_{MSY} in 20 years, using the formula (T_{MIN} (10 years) + one generation (10 years)).

11.2.4.1.1.2 Rejected Alternative 43. Rebuild Nassau grouper to B_{MSY} in 40 years, using the formula (T_{MIN} (10 years) + one generation (30 years)).

11.2.4.1.1.3 Rejected Alternative 44. Rebuild Nassau grouper to 45% SPR in 20 years, using the formula (T_{MIN} (10 years) + one generation (10 years)).

11.2.4.1.1.4 Rejected Alternative 45. Rebuild Nassau grouper to B_{MSY} within T_{MIN} (10 years).

Rationale for elimination: Rejected Alternatives 42-45 were considered in the first draft of the Comprehensive SFA Amendment based on an estimated generation time published by Legault and Eklund (1998) that ranged from 10 to 30 years for Nassau grouper (CFMC 2001a). The current best available scientific information indicates that the generation time for Nassau grouper ranges from 15 to 70 years (Porch and Scott 2001). The new Rebuilding Schedule Alternatives 2-4 (Sections 4.4.1.1.2-4.4.1.1.4) are based on the low, intermediate, and high values of this new range of estimated generation times. Additionally, Rejected Alternative 44 would not be consistent with the National Standard Guidelines, which advise that rebuilding goal be defined as B_{MSY}.

11.2.4.1.2 Rebuilding strategy

11.2.4.1.2.1 Rejected Alternative 46. Gear restrictions/prohibitions.

11.2.4.1.2.1.1 Alternative 46a. Prohibit deployment of traps on top of reefs.

11.2.4.1.2.1.2 Alternative 46b. Prohibit deployment of traps on top of reefs and in 100-ft buffer zones around reefs.

11.2.4.1.2.1.3 Alternative 46c. Limit trap strings to two traps.

11.2.4.1.2.1.4 Alternative 46d. Prohibit the use of other allowable gear(s) in and around coral reefs or other specified habitats.

Rationale for elimination: A preliminary evaluation of Rejected Alternatives 46a-d indicated that none would likely benefit the recovery of Nassau grouper as much as the rebuilding strategy alternatives considered in the document (Section 4.4.1.2). The usefulness of gear restrictions and prohibitions in the context of regulating fishing mortality on all Council-managed species is considered in Section 4.3.

11.2.4.1.2.2 Rejected Alternative 47. Increase the minimum allowable mesh size for fish traps.

Rationale for elimination: A preliminary evaluation of Rejected Alternative 47 indicated that the adverse socioeconomic impacts of this alternative would more likely be justifiable in the context of reducing bycatch and bycatch mortality. This alternative is considered in that context in Section 4.6.2 (Alternative 2).

11.2.4.1.2.3 Rejected Alternative 48. Establish a marine protected area to protect habitat and/or reduce incidental catches.

Rationale for elimination: A preliminary evaluation of Rejected Alternative 48 indicated that the adverse socioeconomic impacts of this alternative would more likely be justifiable in the context of constraining total catches to levels consistent with the control rules considered in Section 4.2.5 of this document.

11.2.4.1.2.4 Rejected Alternative 49. Reduce the total number of traps fishing in the federal waters of the Caribbean.

Rationale for elimination: A preliminary evaluation of Rejected Alternative 49 indicated that the adverse socioeconomic impacts of this alternative would more likely be justifiable in the context of constraining total catches to levels consistent with the control rules considered in Section 4.2.5 of this document. This alternative could be considered in that context should the Council elect to adopt a capacity reduction alternative. The Council is considering a total prohibition on the use of fish traps in Section 4.3 as an alternative to a capacity reduction program.

11.2.4.1.2.5 Rejected Alternative 50. Define the process for a limited entry program, which may or may not be coupled with a required reduction in fishing capacity by a set percentage, that will be developed for implementation in 2004. Establish through this amendment the control date that will be used to determine participation in the program.

Rationale for elimination: A preliminary evaluation of Rejected Alternative 50 indicated that the adverse socioeconomic impacts and administrative burdens associated with this alternative would more likely be justifiable in the context of constraining total catches to levels consistent with the control rules considered in Section 4.2.5 of this document.

11.2.4.1.2.6 Rejected Alternative 51. Reduce the total number of gear units fishing in the U.S. EEZ through a buyback program, or through an ITQ or TURF program.

Rationale for elimination: A preliminary evaluation of Rejected Alternative 51 indicated that the adverse socioeconomic impacts of this alternative would more likely be justifiable in the context of constraining total catches to levels consistent with the control rules considered in Section 4.2.5 of this document.

11.2.4.1.2.7 Rejected Alternative 52. Develop a program to phase out the use of fish traps in the U.S. Caribbean.

Rationale for elimination: A preliminary evaluation of Rejected Alternative 52 indicated that the adverse socioeconomic impacts associated with this management alternative would likely greatly outweigh any benefit to the rebuilding of Nassau grouper. Bottom line gear was responsible for the majority of Nassau grouper landings in 1997 and 1998 (71% and 75%, respectively), followed by fish traps (16% and 19%, respectively), and gillnets (1.3% and 1.1%, respectively) (CFMC 2001b). This alternative would more likely be justifiable in the context of constraining total catches to levels consistent with the control rules considered in Section 4.2.5 of this document. It is considered in that context in Section 4.3.

11.2.4.1.2.8 Rejected Alternative 53. Establish a trap certificate program.

Rationale for elimination: A federal permit program is evaluated in Section 4.6.1 of this document as an alternative bycatch reporting program. That program would accomplish the same objective as this alternative.

11.2.4.1.2.9 Rejected Alternative 54. Improve outreach and education (e.g., recreational fishing guides).

Rationale for elimination: It is unclear to what extent Nassau grouper would benefit from this alternative. The Council and NOAA Fisheries believe it is important to focus scarce fiscal resources on more direct rebuilding measures.

11.2.4.1.2.10 Rejected Alternative 55. Institute incidental catch quotas to reduce commercial bycatch and recreational release mortality.

Rationale for elimination: The administrative environment is not adequately structured to effectively implement such an intensive monitoring program.

11.2.4.1.2.11 Rejected Alternative 56. Delegate management of Nassau grouper to state governments, with the requirement that the states implement laws and regulations that are consistent with those in the federal FMP.

Rationale for elimination: Some regulations in state waters are not consistent with those in Council FMPs despite previous recommendations from the Council to state agencies. Delegating management of species taken in federal waters to the states could be reconsidered at a future date if the memorandum of understanding proposed in Alternative 4a (Section 4.4.1.2.4.1) is successfully implemented.

11.2.4.2 Goliath grouper

11.2.4.2.1 Rebuilding schedule

11.2.4.2.1.1 Rejected Alternative 57. Rebuild Goliath grouper to B_{MSY} in 25 years, using the formula (T_{MIN} (10 years) + one generation (15 years)).

11.2.4.2.1.2 Rejected Alternative 58. Rebuild Goliath grouper to B_{MSY} in 40 years, using the formula (T_{MIN} (10 years) + one generation (30 years)).

11.2.4.2.1.3 Rejected Alternative 59. Rebuild Goliath grouper to 45% SPR in 20 years, using the formula (T_{MIN} (10 years) + one generation (10 years)).

11.2.4.2.1.4 Rejected Alternative 60. Rebuild Goliath grouper to B_{MSY} within T_{MIN} (10 years).

Rationale for elimination: Rejected Alternatives 57-59 were considered in the first draft of the Comprehensive SFA Amendment based on an estimated generation time published by Legault and Eklund (1998) that ranged from 15 to 40 years for goliath grouper (CFMC 2001a). The current best available scientific information indicates that the generation time for goliath grouper ranges from 20 to 95 years (Porch and Scott 2001). The new Rebuilding Schedule Alternatives 2-4 (Sections 4.4.2.1.2-4.4.2.1.4) are based on the low, intermediate, and high values of this new range of estimated generation times. Additionally, Rejected Alternative 59 would not be consistent with the National Standard Guidelines, which advise that rebuilding goal be defined as B_{MSY}.

11.2.4.2.2 Rebuilding strategy

11.2.4.2.2.1 Rejected Alternative 61. Gear restrictions/prohibitions.

11.2.4.2.2.1.1 Rejected Alternative 61a. Prohibit deployment of traps on top of reefs.

11.2.4.2.2.1.2 Rejected Alternative 61b. Prohibit deployment of traps on top of reefs and in 100-ft buffer zones around reefs.

11.2.4.2.2.1.3 Rejected Alternative 61c. Limit trap strings to two traps.

11.2.4.2.2.1.4 Rejected Alternative 61d. Prohibit the use of other allowable gear(s) in and around coral reefs or other specified habitats.

Rationale for elimination: None of Rejected Alternatives 61a-d would likely benefit the recovery of goliath grouper as much as the rebuilding strategy alternatives considered in the document (Section 4.4.2.2). The usefulness of gear restrictions and prohibitions in the context of regulating fishing mortality on all Council-managed species is considered in Section 4.3.

11.2.4.2.2.2 Rejected Alternative 62. Increase the minimum allowable mesh size for fish traps.

Rationale for elimination: The adverse socioeconomic impacts of this alternative would more likely be justifiable in the context of reducing bycatch and bycatch mortality. This alternative is considered in that context in Section 4.6.2.

11.2.4.2.2.3 Rejected Alternative 63. Establish a marine protected area to protect habitat and/or reduce incidental catches.

Rationale for elimination: The adverse socioeconomic impacts of this alternative would more likely be justifiable in the context of constraining total catches to levels consistent with the control rules considered in Section 4.2.5 of this document.

11.2.4.2.2.4 Rejected Alternative 64. Reduce the total number of traps fishing in the federal waters of the Caribbean.

Rationale for elimination: The adverse socioeconomic impacts of this alternative would more likely be justifiable in the context of constraining total catches to levels consistent with the control rules considered in Section 4.2.5 of this document. The Council is considering a total prohibition on the use of fish traps in Section 4.3 as an alternative to a capacity reduction program.

11.2.4.2.2.5 Rejected Alternative 65. Define the process for a limited entry program, which may or may not be coupled with a required reduction in fishing capacity by a set percentage, that will be developed for implementation in 2004. Establish through this amendment the control date that will be used to determine participation in the program.

Rationale for elimination: The adverse socioeconomic impacts and administrative burdens associated with this alternative would more likely be justifiable in the context of constraining total catches to levels consistent with the control rules considered in Section 4.2.5 of this document.

11.2.4.2.2.6 Rejected Alternative 66. Reduce the total number of gear units fishing in the U.S. EEZ through a buyback program, or through an ITQ or TURF program.

Rationale for elimination: The adverse socioeconomic impacts of this alternative would more likely be justifiable in the context of constraining total catches to levels consistent with the control rules considered in Section 4.2.5 of this document.

11.2.4.2.2.7 Rejected Alternative 67. Develop a program to phase out the use of fish traps in the U.S. Caribbean.

Rationale for elimination: The adverse socioeconomic impacts associated with this management alternative would likely greatly outweigh any benefit to the rebuilding of goliath grouper. This alternative would more likely be justifiable in the context of constraining total catches to levels consistent with the control rules considered in Section 4.2.5 of this document. It is considered in that context in Section 4.3.

11.2.4.2.2.8 Rejected Alternative 68. Establish a trap certificate program.

Rationale for elimination: A federal permit program is evaluated in Section 4.6.1 of this document as an alternative bycatch reporting program. That program would accomplish the same objective as this alternative.

11.2.4.2.2.9 Rejected Alternative 69. Improve outreach and education (e.g., recreational fishing guides).

Rationale for elimination: It is unclear to what extent Goliath grouper would benefit from this alternative. The Council and NOAA Fisheries believe it is important to focus scarce fiscal resources on more direct rebuilding measures.

11.2.4.2.2.10 Rejected Alternative 70. Institute incidental catch quotas to reduce commercial bycatch and recreational release mortality.

Rationale for elimination: The administrative environment is not adequately structured to effectively implement such an intensive monitoring program.

11.2.4.2.2.11 Rejected Alternative 71. Delegate management of Goliath grouper to state governments, with the requirement that the states implement laws and regulations that are consistent with those in the federal FMP.

Rationale for elimination: Some regulations in state waters are not consistent with those in Council FMPs despite previous recommendations from the Council to state agencies. Delegating management of species taken in federal waters to the states could be reconsidered at a future date if the memorandum of understanding proposed in Alternative 4a (Section 4.4.2.2.4.1) is successfully implemented.

11.2.4.2.2.12 Alternative 72 (Preferred). Develop a memorandum of understanding (MOU) between NOAA Fisheries and the state governments to develop compatible regulations to achieve the objectives for Goliath grouper set forth in the Caribbean Fishery Management Council's Reef Fish Fishery Management Plan in state and federal waters of the U.S. Caribbean.

Rationale for elimination: Puerto Rico established regulations to prohibit the harvest, possession, and/or sale of Goliath grouper in state waters, establishing consistent regulations with those in the EEZ. Furthermore, the harvest, possession, or sale of this species is already prohibited in USVI waters. Thus, this alternative is no longer pertinent.

11.2.4.3 Queen conch

11.2.4.3.1 Rebuilding schedule

11.2.4.3.1.1 Rejected Alternative 73. Rebuild queen conch to B_{MSY} in 10 years.

11.2.4.3.1.2 Rejected Alternative 74. Rebuild queen conch to 30% SPR in 10 years.

11.2.4.3.1.3 Rejected Alternative 75. Rebuild queen conch to 20% SPR in 10 years.

Rationale for elimination: Rejected Alternatives 73-75 were considered in the first draft of the Comprehensive SFA Amendment based on an estimated natural mortality rate of 0.85 derived from Appeldoorn (1992). This rate represents the high mortality experienced by the juvenile life stage of this species, rather than the mortality rate of the entire population of queen conch. The current best available scientific information based on all size/age classes indicates that the natural mortality rate is closer to 0.30 (Appeldoorn, personal communication). Thus, it probably is not possible to rebuild queen conch within ten years. Additionally, Rejected Alternatives 74 and 75 would not be consistent with the National Standard Guidelines, which advise that the rebuilding goal be defined as B_{MSY}.

11.2.4.3.2 Rebuilding strategy

11.2.4.3.2.1 Rejected Alternative 76. Prohibit the use of SCUBA gear in commercial and recreational queen conch fisheries operating in federal waters of the U.S. Caribbean.

Rationale for elimination: This alternative is similar to Rebuilding Strategy Alternative 2 (Section 4.4.3.2.2) because the deep depths of federal waters generally require the use of SCUBA to harvest queen conch. This alternative would result in a greater enforcement burden because law enforcement officials would have to determine whether queen conch observed on boats in federal waters were harvested with or without SCUBA gear.

11.2.4.3.2.2 Rejected Alternative 77. Extend the seasonal closure to protect queen conch spawning stock.

Rationale for elimination: The current closed season extends from July 1 through September 30. Peak spawning reportedly occurs from April through August (Rhine 2000). Modifying the seasonal closure to encompass the entire peak spawning season would provide some additional protection to the spawning stock. However, this action, in itself, would not likely be sufficient to reduce overfishing and rebuild queen conch within the alternative time frames considered in Section 4.4.3.1. Additionally, if fishermen were to increase fishing pressure in the open season, most of the benefits of a longer spawning season closures would be negated.

11.2.4.3.2.3 Rejected Alternative 78. Prohibit the use of allowable gear(s) in and around coral reefs or other specified habitats.

Rationale for elimination: Prohibiting the use of certain fishing gear(s) in habitats that the queen conch depends upon for its growth and survival could benefit the recovery of this species. But these habitats, such as seagrass beds, generally occur in territorial waters.

11.2.4.3.2.4 Rejected Alternative 79. Define the process for a limited entry program, which may or may not be coupled with a required reduction in fishing capacity by a set percentage, that will be developed for implementation in 2004. Establish through this Amendment the control date that will be used to determine participation in the program.

Rationale for elimination: The adverse socioeconomic impacts and administrative burdens associated with this alternative would more likely be justifiable in the context of constraining total catches to levels consistent with the control rules considered in Section 4.2.5 of this document.

11.2.4.3.2.5 Rejected Alternative 80. Establish an MPA to protect spawning aggregations of queen conch.

Rationale for elimination: An MPA may be effective in protecting spawning stock and would also provide a controlled area for assessing fishing impacts. But the protections afforded by this type of rebuilding strategy appear to be insufficient to reduce overfishing and to rebuild queen conch within the alternative time frames considered in Section 4.4.3.1.

11.2.4.3.2.6 Rejected Alternative 81. Preempt state management authority.

Rationale for elimination: The queen conch fishery is conducted primarily in state waters, with only a minimal amount of activity occurring in the U.S. EEZ off southwest Puerto Rico (Valle-Esquivel 2002). The authority to preempt requires a factual finding that "The fishing in a fishery that is covered by an FMP implemented under the Magnuson-Stevens Act is engaged in predominately within the EEZ and beyond such zone" (50 CFR §600.610).

11.2.4.3.2.7 Rejected Alternative 82. Prohibit recreational catch and possession of queen conch in the U.S. EEZ.

Rationale for elimination: Total recreational landings of queen conch are estimated to equal about 50% of commercial landings of this species (Valle-Esquivel, personal communication). And most recreational catches of this species are believed to come from state waters, which are easier to access. Consequently, a harvest prohibition that does not apply to commercial fisheries cannot be expected to be sufficient to rebuild queen conch within the alternative time frames considered in Section 4.4.3.1.

11.2.4.3.2.8 Rejected Alternative 83. Prohibit deployment of traps on top of reefs, and/or in a 100-ft buffer zones around reefs, and/or limit trap strings to two traps.

Rationale for elimination: Neither of these alternatives could be expected to contribute substantially to rebuilding queen conch. Queen conch generally are found on seagrass beds and sandy bottom habitat, and they are captured predominantly by hand.

11.2.4.3.2.9 Rejected Alternative 84. Reduce the total number of gear units fishing in the U.S. EEZ through a buyback program, or through an ITQ or TURF program.

Rationale for elimination: The adverse socioeconomic impacts of this alternative would more likely be justifiable in the context of constraining total catches to levels consistent with the control rules considered in Section 4.2.5 of this document.

11.2.4.3.2.10 Rejected Alternative 85. Establish a queen conch permit for commercial fishers and dealers.

Rationale for elimination: A federal permit program is considered in Section 4.6.1 as a means to meet the MSFCMA bycatch reporting mandate.

11.2.4.3.2.11 Rejected Alternative 86. Establish commercial catch limits equal to 100 pounds of queen conch meat per vessel per trip and a total of 300 pounds per week per vessel. Eliminate the requirement to land queen conch in the shell.

Rationale for elimination: The Regulatory Impact Review associated with the 1996 Queen Conch FMP indicates that 80% and 88% of queen conch trips off Puerto Rico and the USVI, respectively, yielded catches of less than 100 pounds (CFMC 2002a). Thus this alternative would do little to reduce fishing pressure on this stock. In addition, it would do nothing to address the illegal take of undersized conch.

11.2.4.3.2.12 Rejected Alternative 87. Establish a commercial trip limit of 150 queen conch per person per trip. Eliminate the requirement to land queen conch in the shell.

Rationale for elimination: This alternative would maintain the present level of fishing mortality, but eliminate the requirement to land queen conch in the shell. Thus, it would be less restrictive than current management measures. The Council believes that additional restrictions must be implemented to rebuild this overfished stock.

11.2.4.3.2.13 Rejected Alternative 88. Improve outreach and education.

Rationale for elimination: It is unclear to what extent queen conch would benefit from this alternative. The Council and NOAA Fisheries believe it is important to focus scarce fiscal resources on more direct rebuilding measures.

11.2.4.3.2.14 Rejected Alternative 89. Develop a mariculture and restocking program.

Rationale for elimination: There are several successful queen conch mariculture operations in existence. The Caicos Conch Farm, Ltd., estimates production will surpass 1.5 million conch per year. While these conchs are raised for the market, conch mariculture holds promise for stock rebuilding as well. Cultured conch can be reared to a size that greatly reduces natural juvenile mortality. Despite the promising potential of mariculture, it is not yet considered to be a cost-effective way to rebuild overfished stocks. The Florida Marine Research Laboratory conducted a series of field and laboratory experiments in Marathon, Florida, to evaluate the effectiveness of using hatchery-raised young conchs to supplement the wild spawning stock. They discovered that a 4-inch conch released in the fall surviving to 6 inches costs about $9 per individual (Deluca 2002).

11.2.4.3.2.15 Rejected Alternative 90. Delegate management of queen conch to state governments, with the requirement that the states implement laws and regulations that are consistent with those in the federal FMP.

Rationale for elimination: Some regulations in state waters are not consistent with those in Council FMPs despite previous recommendations from the Council to state agencies. Delegating management of species taken in federal waters to the states could be reconsidered at a future date if the memorandum of understanding proposed in Alternative 4 (Section 4.4.3.2.4) is successfully implemented.

11.2.5 Conserving and Protecting Yellowfin Grouper

11.2.5.1 Rejected Alternative 91. Close the Grammanik Bank to all fishing from February 1 to May 31 of each year. The proposed boundaries for the Grammanik Bank closed area are: 18º 12.40' N, 64º 59.00' W; 18º 10.00' N, 64º 59.00' W; 18º 10.00' N, 64º 56.10' W; and 18º 12.40' N, 64º 56.10' W.

Rationale for elimination: The best available information indicates that the spawning period for yellowfin grouper only extends through April 30. Therefore, this alternative, while being more conservative than an alternative consisting of a shorter duration, would not reflect the best available information.

11.2.6 Achieving the MSFCMA Bycatch Mandates

11.2.6.1 Bycatch reporting

11.2.6.1.1 Rejected Alternative 92. Require commercial and charter boat participants in federal fisheries to record catch and discard data in a logbook.

Rationale for elimination: This alternative is similar to the preferred Bycatch Reporting Alternative 2 (Section 4.6.1.2). In comparison, this alternative would present less direct costs to fishermen because they would not be required to purchase permits. However, it would not tie the mandatory catch reporting requirement to permit renewals. Consequently, bycatch and other data derived from this reporting system would probably be fewer and less reliable.

11.2.6.1.2 Rejected Alternative 93. Request that NOAA Fisheries establish a program to achieve standardized bycatch reporting in the commercial fisheries included in the Council's FMPs.

Rationale for elimination: Requesting that NOAA Fisheries establish a bycatch reporting program falls short of meeting the MSFCMA requirement to "establish a standardized bycatch reporting methodology to assess the amount and type of bycatch occurring in the fishery." Thus, Rejected Alternative 93 is not a viable option.

11.2.6.1.3 Rejected Alternative 94. Request that the governments of Puerto Rico and the USVI implement a program to establish standardized bycatch reporting in Caribbean fisheries.

Rationale for elimination: Requesting that the state governments establish a bycatch reporting program falls short of meeting the MSFCMA requirement to "establish a standardized bycatch reporting methodology to assess the amount and type of bycatch occurring in the fishery." Thus, Rejected Alternative 94 is not a viable option.

11.2.6.1.4 Rejected Alternative 95. Include in the fishery-dependent biological sampling program the collection of bycatch data from commercial fishers.

Rationale for elimination: Collecting bycatch data through the sampling program would probably present less of a burden to fishermen than would requiring them to submit a separate data report for catches taken in federal waters. But several deficiencies make this program insufficient to meet the MSFCMA mandate. First, the program samples landed catch, so port agents would need to rely on the memory of the fisherman being interviewed. Second, the program covers only a small percentage of total fishery participants. And, third, participation is voluntary.

11.2.6.1.5 Rejected Alternative 96. Establish gear permits for all fisheries, including recreational angling, with attached mandatory reporting requirements (focus on fish traps, reef nets).

Rationale for elimination: A federal permit program that would apply to all gear types is considered in Section 4.6.1.2. That program would not apply to recreational anglers. Permitting that sector is not feasible at this time. Preferred bycatch reporting Alternative 3 (Section 4.6.1.3) would utilize data from the Marine Recreational Fisheries Statistical Survey to provide bycatch information on the recreational and subsistence sectors. The Council and NOAA Fisheries could reconsider the feasibility of instituting a permit requirement in federal recreational fisheries at a future date if the commercial permitting program is successfully implemented.

11.2.6.1.6 Rejected Alternative 97. Require vessel monitoring systems for vessels fishing in the U.S. EEZ and obligatory reporting of bycatch.

Rationale for elimination: Requiring that participants in federal fisheries utilize vessel monitoring systems (VMS) would improve the timeliness of data collection. Such a requirement would also assist with enforcement and improve safety at sea. But a preliminary analysis of this alternative indicated that the costs of VMS would not likely be warranted at this time, particularly when considered relative to the value of catches in this region, the economic profitability of commercial fishing operations, and the large number of fishermen that fish on a part-time basis (Fred Kyle, NMFS, presentation to the Council, 107th Council Meeting, March 26-27, 2002).

11.2.6.1.7 Rejected Alternative 98. Provide incentives to report bycatch.

Rationale for elimination: This action would fall short of meeting the MSFCMA mandate, which requires that participants report bycatch in U.S. EEZ fisheries. Should the Council elect to adopt a bycatch program that relies on fishery-dependent data, various incentive programs could be considered in combination with the Council's preferred Alternatives 2 and 3 (Sections 4.6.1.2; 4.6.1.3) to reward fishers for the added reporting burden. For example, the Council/NOAA Fisheries could provide incentives to participate in a tag and release program to provide data on bycatch mortality.

11.2.6.1.8 Rejected Alternative 99. Develop and establish an observer program to include bycatch data collection requirements.

Rationale for elimination: An observer program would most likely provide the best, most reliable information on bycatch and bycatch mortality. Such a program could also improve the social interaction between fishery participants and managers. But the small-scale nature of fisheries in the U.S. Caribbean makes an observer program an impractical alternative. The majority of boats participating in commercial and recreational fisheries in this region are small in size. Matos-Caraballo (1997) reported that 86% of vessels reported in Puerto Rico's commercial fishery during 1995-96 were under 21 feet in length. Boats in USVI fisheries commonly range from 17-19 feet in length (Impact Assessment, Inc. 1997). Most of these boats generally accommodate one to three people, in addition to fishing gear, coolers, gasoline tanks, and other equipment. They are not generally equipped to accommodate observer safety mandates. As an alternative, observers could trail fishermen in separate boats or conduct random at-sea interventions. But funding is not sufficient to develop these types of programs to the extent that would be needed to provide reliable bycatch data on the fishery. Even were funding available, such a program would not likely be cost-effective considering the current and potential value of landings in the U.S. Caribbean region.

11.2.6.1.9 Rejected Alternative 100. Establish a bycatch reporting logbook in federal waters that would require a subset of commercial fishermen to report bycatch.

Rationale for elimination: This alternative is similar to the preferred Bycatch Reporting Alternative 2 (Section 4.6.1.2). In comparison, this alternative would present less direct costs to fishermen because they would not be required to purchase permits. However, it would not tie the mandatory catch reporting requirement to permit renewals. Consequently, bycatch and other data derived from this reporting system would probably be fewer and less reliable. Additionally, this alternative probably would not provide coverage that is sufficient to meet the MSFCMA mandate. More comprehensive commercial reporting programs are considered in Bycatch Reporting Alternatives 2 and 4 (Sections 4.6.1.2; 4.6.1.4).

11.2.6.2 Minimizing bycatch and bycatch mortality to the extent practicable

11.2.6.2.1 Rejected Alternative 101. Establish seasonal or permanent marine protected areas.

Rationale for elimination: In the absence of a more detailed description of the proposed area or seasonal closure, it is difficult to ascertain at this time whether this alternative would likely pass a practicability analysis for the purposes of minimizing bycatch and bycatch mortality. Restricting fishing activity in identified nursery grounds could effectively reduce the regulatory bycatch of yellowtail snapper, which is managed with a minimum size limit. But, because juveniles are generally more prevalent in nearshore environments, closing areas of high juvenile abundance would likely require the cooperation of the governments of Puerto Rico and the USVI. MPAs also could be used to reduce the bycatch of prohibited species, such as Nassau grouper, that have been observed to aggregate in the same place year after year. This alternative is considered in that context in Section 4.4. The utility of areal and seasonal closures in reducing fishing mortality on multiple species is considered in Sections 4.3.

11.2.6.2.2 Rejected Alternative 102. Establish incidental catch quotas to curb incidental catches of prohibited species.

Rationale for elimination: The administrative environment is not adequately structured to effectively implement such an intensive monitoring program.

11.2.6.2.3 Rejected Alternative 103. Prohibit the use of fish traps.

Rationale for elimination: This alternative would not likely be practicable in the context of reducing bycatch, as economic and regulatory discards are believed to be minimal in this region (see Section 4.6.2). A prohibition on the use of fish traps is considered in Section 4.3 as a means to reduce overall fishing mortality in U.S. Caribbean fisheries.

11.2.6.2.4 Rejected Alternative 104. Prohibit the use of allowable gear(s) in particular habitats.

Rationale for elimination: Gear prohibitions would not likely be practicable in the context of reducing bycatch, as economic and regulatory discards are believed to be minimal in this region (see Section 4.6.2). The Council could reconsider this alternative in a future amendment if bycatch data collected under one of the new reporting programs evaluated in Section 4.6.1 identify a problem with the use of one or more specific gear types in specific areas. Prohibitions on the use of fish traps and nets are considered in Section 4.3 as a means to reduce overall fishing mortality in U.S. Caribbean fisheries.

11.2.6.2.5 Rejected Alternative 105. Prohibit the use of fish traps and nets on coral reefs.

Rationale for elimination: Most fishermen, scientists, and managers acknowledge that fishermen do not knowingly set traps on coral reef habitat. Thus, the impact of this alternative on bycatch would most likely be minimal. Additionally, such a prohibition would be difficult to enforce and to interpret, as coral reef and live bottom habitats are still being delineated.

11.2.6.2.6 Rejected Alternative 106. Restrict the size of the hooks used by vertical line/longline fishermen.

Rationale for elimination: The enforcement burden presented by this alternative makes it impractical. NOAA Fisheries ultimately abandoned a similar alternative in the highly migratory species fishery due to this and other problems associated with implementation.

11.2.6.2.7 Rejected Alternative 107. Implement a trap reduction program.

Rationale for elimination: The adverse socioeconomic impacts of this alternative would more likely be justifiable in the context of constraining total catches to levels consistent with the control rules considered in Section 4.2.5 of this document. The Council is considering a total prohibition on the use of fish traps in Section 4.3 as an alternative to a capacity reduction program.

11.2.7 Establishing/modifying framework procedures

11.2.7.1 Rejected Alternative 108. No action. Do not modify current framework procedures.

11.2.7.2 Rejected Alternative 109. Expand the existing framework procedures for the Coral and Reef Fish FMPs to the other Caribbean FMPs (Spiny Lobster and Queen Conch), but do not broaden the scope of the framework procedures.

11.2.7.3 Rejected Alternative 110. Expand the framework procedures for the Coral and Reef Fish FMPs (50 CFR § 622.48 (a, b)), or establish similar framework procedures for all Caribbean FMPs. Broaden the scope of the framework procedures to include the revision of MSY, MFMT, MSST, and OY definitions when improved information becomes available. Additionally, establish criteria to determine when a species or species complex should be elevated from monitored (e.g., aquarium trade species) to managed status.

Rationale for elimination: The intent of framework procedures is to enable the Secretary of Commerce to respond quickly to changing conditions by implementing one or more pre-defined management measures without developing a comprehensive FMP amendment. Framework measures are still subject to the multiple analytical requirements of the of the MSFCMA, NEPA, and other laws. But these requirements are fulfilled at the time measures are added to the Council's list of framework actions, rather than at the time the measures are applied to a fishery.

The large number of actions that must be considered in this amendment has precluded the Council from analyzing an additional suite of proposed framework actions at this time. The Council will revisit Rejected Alternatives 108-110 in a future amendment.

11.3 List of preparers

The following individuals contributed to the preparation of this integrated amendment:

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Many other individuals and organizations were instrumental in developing the scope and content of this amendment through their participation in the public scoping process and on the SFA Working Group. Composed of representatives from NOAA Fisheries, the Caribbean Council, state agencies, and environmental non-governmental organizations, the SFA Working Group met twice during the development of this amendment. Participants in the two Working Group meetings are listed below.

SFA Working Group Meeting, Miami, FL
6-7 August 2002

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SFA Working Group Meeting. San Juan, PR
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11.4 List of agencies, organizations, and persons to whom copies of this document were sent

The availability of the DSEIS was published in the *Federal Register* for public review and comment on March 18, 2005 (70 FR 13189). Additionally, copies of this document were distributed to:

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Appendix C

CARIBBEAN FISHING VESSEL PERMIT APPLICATION FOR FISHING IN THE EXCLUSIVE ECONOMIC ZONE (EEZ)

VESSEL INFORMATION (please print legibly or type)

NAME OF VESSEL	CG DOC. OR STATE REG. NO. (OFFICIAL NUMBER)
OWNER(S) NAME	
MAILING ADDRESS	CITY
STATE	ZIP CODE

NAME (PRINT OR TYPE) ____________________

SIGNATURE ____________________