UNITED STATES VIRGIN ISLANDS

MARINE RESOURCES AND FISHERIES

STRATEGIC AND COMPREHENSIVE

CONSERVATION PLAN

Division of Fish and Wildlife
Department of Planning and Natural Resources
U.S. Virgin Islands

December 2005

EXECUTIVE SUMMARY

The US Virgin Islands (USVI) is a territory of the United States. It lies in the northeast Caribbean and consists of four major islands, St. Thomas, St. John, St. Croix, and Water Island, and about 50 cays. The USVI is endowed with many natural resources and contains examples of tropical ecosystems such as coral reefs, seagrass meadows, salt ponds, and mangrove forests. These habitats provide food and shelter for a large variety of resident marine and terrestrial life. In addition, a variety of fish and wildlife migrate through the USVI annually. These natural resources are under pressure from a variety of user groups. The marine waters are heavily fished by both recreational and commercial fishermen. Annually, thousands of tourists visit the USVI to go snorkeling and diving. Pollution is also a primary impact on the marine resources. In addition, economic development such as home and hotel construction continues to infringe on coastal environments.

There have been numerous plans completed, at least to draft stage, relating to some aspect of the fisheries and marine resources in the U.S. Virgin Islands (Chapter 1). Plans have been written regarding management of specific areas, topics and issues, and species related to the fisheries and marine resources of the USVI. Some of these plans have been successfully implemented, or at least partially implemented.

To date, there has been no comprehensive plan for the management of fish and wildlife resources in the U.S. Virgin Islands. Therefore, there is a need to compile such a plan. This plan also provides a forum for public input regarding the priority issues affecting USVI marine resources and fisheries, which is critical to identifying the priority issues.

In July 2004, USFWS provided guidelines for writing this plan in the form of eight specific elements, and this plan was developed accordingly (Chapter II). These were the basis for the format and approach used to making this plan (Chapter II).

In the USVI there are many types of marine habitats such as coral reefs, seagrass beds, algal plains, mangroves, and salt ponds (Chapter III). These are discussed separately in this document, but they are not separate and independent entities. These distinctive habitats are linked and interact with each other in a variety of ways. In addition to nutrient flows, many marine species have specific habitat requirements for each portion of their life cycle. A detailed overview of many USVI marine species was recently completed by the Caribbean Fisheries Management Council in their 2004 draft “Sustainable Fisheries Act Amendment”. This species overview is attached as Appendix 1.

In addition to marine species and habitats, there are various sources of anthropogenic impacts to the marine environment. These include commercial fisheries, recreational fisheries, marine recreation, development, and pollution. An overview is provided for commercial and recreational fisheries as well as marine recreation (Chapter IV).

Priority issues were identified (Chapter V) based on various user group and public opinion surveys that were recently conducted by DFW. The common perceived problems with USVI marine resources and fisheries included: (1) pollution, (2) lack of enforcement, (3) gillnets, (4) overfishing, (5) traps, (6) longlines, (7) habitat degradation, and (8) lack of moorings. Species of concern were also identified (Chapter V). To focus on species with conservation concerns, species under Territorial, Federal, and National Park Service management were identified. Various external agencies such as IUCN, FishBase, NOAA Fisheries, and CFMC have also identified species of concern. These were added to the list for consideration.

Strategies for addressing priority issues and species of concern were then developed (Chapter VI). User group and public input, from various opinion surveys, were used to guide this process. Common user group and public suggestions for addressing USVI marine resource problems include (1) improve enforcement, (2) more education, (3) pollution control, (4) deploy more FADs, (5) develop more artificial reefs, and (6) develop/improve boat and public access. These suggestions were the basis for the development of strategies to address priority issues and species of concern.

Plans for implementing priority issue strategies and for addressing species of concern were developed (Chapter VII). The primary (lead) and cooperating (supporting) agencies for each strategy were identified. Detailed planning for implementing of each conservation strategy is left to the primary agency. In cases where DFW is the primary agency, more specific plans to implement conservation strategies are indicated. These implementation activities, especially those in which DFW is the primary agency, are subject to the availability of funds and resources. As funding opportunities for stated strategies come up, DFW will pursue funding to implement these conservation strategies.

Plans for monitoring implementation strategies were then developed (Chapter VIII). Detailed planning for monitoring the implementation of strategies is left to the primary agency. In cases where DFW is the primary agency, more detailed plans for monitoring of implementation of strategies is provided. These monitoring activities, especially those in which DFW is the primary agency, are subject to the availability of funds and resources. Coupled with monitoring, is the need for assessing results, new information, or changing environments so that appropriate adjustments can be made to the conservation strategy. These feedback loops are critical to ensure that the conservation strategies are appropriate or are adjusted as necessary to ensure that objectives are addressed. This is essential for adaptive management of conservation strategies.

Since development of this plan was a rather lengthy process (2 to 3 years), a decadal review and update of this plan is proposed (Chapter IX). Procedures for the decadal review of this plan are basically the same as for formulating this plan (see Chapter II). A review should also be conducted to determine the extent to which conservation strategies identified in this plan have been implemented or resolved, and have had the desired effect on the marine resources, in 10 years. Review and update of this plan in 10 years is contingent on the availability of funds and resources.

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This management plan originated from two separate planning efforts: (1) a strategic management plan for the USVI fisheries (USFWS FW16 grant), which focuses on species or species groups that are "harvested", and (2) a comprehensive management plan, (Grant T2 under SWG), which focuses on all species or species groups ("harvested" and "non-harvested") that make up the marine resources of the USVI. Both of these plans have been combined with this document into one plan. The following table (Table P-1) identifies which plan each chapter and section refers to.

Table P-1. Chapters and Sections Pertaining to Strategic Plan and/or Comprehensive Plan.

Chapter/Section		Strategic Plan (Harvested Species)	Comprehensive Plan (All Species)
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Table P-1. List of Chapters and Sections and Designation as to Strategic Plan or Comprehensive Plan (Continued)

	Chapter/Section	Strategic Plan (Harvested Species)	Comprehensive Plan (All Species)
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LIST OF ACRONYMS

ACRONYM	NAME OR PHRASE
ACOE	U.S. Army Corps of Engineers
APC	Areas of Particular Concern
APR	Areas for Preservation and Restoration
BIG	USFWS Boat Infrastructure Grant
BIRNM	Buck Islands Reef National Monument
BVI	British Virgin Islands
CL	Carapace Length
CFMC	Caribbean Fisheries Management Council
CG	U.S. Coast Guard
CMES	Center for Marine and Environmental Studies
CRRT	Caribbean Rapid Response Team
CWA	U.S. Clean Water Act
CZM	Coastal Zone Management
DCZM	U.S. Virgin Islands Division of Coastal Zone Management
DEE	U.S. Virgin Islands Division of Environmental Enforcement
DEP	U.S. Virgin Islands Division of Environmental Protection
DFW	U.S. Virgin Islands Division of Fish and Wildlife
DOI	U.S. Department of Interior
DOS	U.S. Department of State
DPNR	U.S. Virgin Islands Department of Planning and Natural Resources
DPW	Department of Public Works
ECC	Eastern Caribbean Center, University of the Virgin Islands
EEMP	East End Marine Park (St. Croix)
EEZ	United States Exclusive Economic Zone
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
EPIRB	Emergency Position Indicating Radio Beacon
ESA	U.S. Endangered Species Act
FAC	Fisheries Advisory Committee
FAD	Fish Aggregation Device
FMP	Fisheries Management Plan
HMS SAFE	Highly Migratory Species Stock Assessment and Fisheries Evaluation
ICE	Island Conservation Effort
IRF	Island Resources Foundation
IUCN	Internatl. Union for the Conservation of Nature-World Conserv. Union
IWC	International Whaling Commission
LAS	Local Action Strategy
MCD	Marine Conservation District
MMPA	U.S. Marine Mammal Protection Act
MPA	Marine Protected Areas
MMSC/UVI	MacLean Marine Science Center, University of the Virgin Islands

LIST OF ACRONYMS (continued)

ACRONYM	NAME OR PHRASE
MPRSA	U.S. Marine Protection, Research, and Sanctuaries Act
MSY	Maximum Sustainable Yield
NEPA	U.S. National Environmental Policy Act
NOAA Fisheries	National Oceanographic and Atmospheric Administration Fisheries
NOS	National Ocean Service
NPDES	National Pollutant Discharge Elimination System
NPS	U.S. National Park Service
OC	Ocean Conservancy
OSP	Optimum Sustainable Population
OY	Optimum Yield
PBR	Potential Biological Removal
REF	Reef Ecology Foundation
SEAMAP-C	Southeast Area Monitoring and Assessment Project - Caribbean
SFA	U.S. Sustainable Fisheries Act
SPR	Spawning Potential Ratio
SSBR	Spawning Stock Biomass Per Recruit
STFA	St. Thomas Fishermen’s Association
STJ	St. John
STP	Secondary Treatment Plant
STT	St. Thomas
STX	St. Croix
SWG	State Wildlife Grant
TBT	tributyltin
TL	Total Length
TNC	The Nature Conservancy
TOC	The Ocean Conservancy
UNESCO	United Nations Educational, Scientific, and Cultural Organization
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Service
USVI	United States Virgin Islands
UVI	University of the Virgin Islands
VIRR	Virgin Islands Rules and Regulations
VICRNM	Virgin Islands Coral Reef National Monument
VINP	Virgin Islands National Park
VIPD	Virgin Island Police Department
VIRMC	Virgin Islands Resource Management Cooperative
YONAH	Year of the North Atlantic Humpback

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CHAPTER I
INTRODUCTION AND PURPOSE

1. Setting

The US Virgin Islands (USVI) is a territory of the United States. It lies in the northeast Caribbean (Figure I-1), in the subtropics at 18˚ north and 65˚ west. It consists of four major islands, St. Thomas, St. John, St. Croix and Water Island, and about 50 cays (Figure I-2). St. Thomas and St. John, part of the northern Virgin Islands, lie on the Puerto Rico Bank that extends from western Puerto Rico to eastern Anegada in the British Virgin Islands. St. Croix, the largest of the US Virgin Islands, is 40 miles to the south and is separated from the Puerto Rico Bank by a deep trench. The USVI is politically and administratively separated into two districts, St. Thomas/St. John District and St. Croix District.

Figure I-1. Map showing the location of the Virgin Islands in the Caribbean

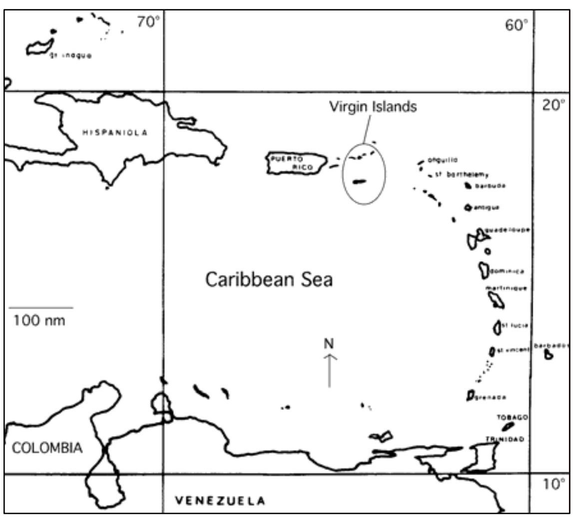
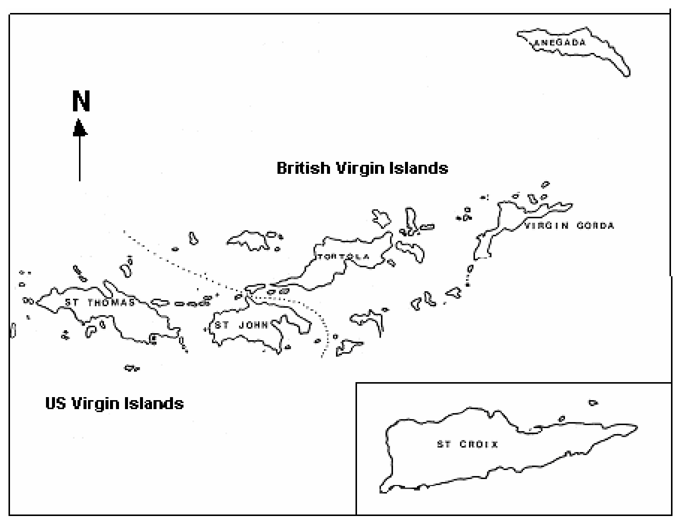


Figure I-2. Map of the Virgin Islands.



The U.S. Virgin Islands have many natural resources and contain examples of tropical ecosystems such as coral reefs, seagrass meadows, salt ponds, algal plains, and mangrove forests (Adey 1975; Adey et al. 1977; Aley et al. 1989; Smith et al. 1997; Garcia Sais 2004; Goenaga and Boulon 1992; IUCN 1988; IRF 2002; Ogden 1974; Olsen et al. 1981; Stengel 1998; Tetra Tech 1991a; U.S. Coral Reef Task Force 2002; and USGS 1994). These habitats provide food and shelter for a large variety of marine and terrestrial life (Adams and Ebersole 2002; AFS 2004; Boulon 1992; Dennis 1992; Gladfelter 1988; Hay 1984; Munro 1984; Ogden 1980; Ogden and Zieman 1977; Ogden and Lobel 1978; Philibosian and Yntema 1977; and UNESCO 1983). There are resident populations of fish and wildlife. In addition, a variety of fish and wildlife migrate through the USVI annually (Dixon 1994; Friedlander 1995; Norton undated; O'Connor 1991; and Oxenford and Hunte 1984).

These natural resources are under pressure from a variety of user groups (Allen 1992; Ellison and Farnsworth 1996; Rogers and Beets 2001; Short and Wyllie-Echeverria 1996; Tetra Tech 1992; Thayer et al. 1975; and Turgeon et al. 2002). The marine waters are heavily fished by both recreational and commercial fishermen (Beets 1987, 1990, 1996, 1997a, 1997b; Bohnsack 1992; Coblentz 1997; Ditton 1978; Ditton and Stoll 2000; Garrison et al. 1998; Holt and Uwate 2004; Olsen and Wood 1982; Roberts 1995; Sheridan et al. 2003; and USVI Govt. 1987). Annually, thousands of tourists visit the USVI to go snorkeling and/or diving (Garcia-Moliner et al. 2001; Hawkins et al. 1999; Marion and Rogers 1994; Rogers and Garrison 2001; Rogers and Needham 1991; Rogers et al. 1988a, 1988b; and Tilmant 1987). In addition, economic development such as home and hotel construction continues to infringe on coastal environments (Gilliard-Payne 1988; MacDonald et al. 1997; Mannoni 1999; and Nemeth and Sladek-Nowlis 2001).

These natural resources are also under pressure due to the high residential population densities that exist in the Virgin Islands, which are comparable to urban areas in the continental U.S. and are long standing (territorial populations in Danish colonial days were over 43,000). St. Thomas, with an area of 32 sq. miles, has a population of approximately 51,300 (July 2004 estimate). St. John, with an area of 19 sq. miles (2/3 of which is national park), has a population of approximately 3,600, St. Croix, with an area of 84 sq. miles, has a population of approximately 53,375, and Water Island has a population of less than 500. This is a total population of 108,775 with a density of approximately 800 people per square mile (CIA 2004).

Agencies of the Government of the United States Virgin Islands

Constitutional provisions of the U.S. Virgin Islands are established by the U.S. Congress. The current version of that law is termed the “1954 Revised Organic Act of the Virgin Islands”, amended in 1968-72 (CIA 2004). The Virgin Islands has a unicameral legislature of fifteen Senators; seven of whom are resident in St. Thomas or Water Island and are elected at large by voters resident in the district of St. Thomas/Water Island; seven of whom are resident in St. Croix and are elected at large by voters resident in the district of St. Croix; and one of whom is a resident of St. John, elected at large by voters from all islands.

The institution responsible for the management of marine resources in the U.S. Virgin Islands is the Department of Planning and Natural Resources (DPNR). Within territorial waters (less than 3 miles from shore), rules and regulations are codified in the Virgin Islands Rules and Regulations (VIRR), primarily within Title 12. Rules and regulations are enacted only by the executive branch. Laws are enacted by both the legislative branch and executive branch.

Fisheries and marine resource management suggestions can come from a variety of sources including local government agencies, the public, commercial fishermen, university scientists, the local Fisheries Advisory Committees (FAC), and the St. Croix Fishermen’s Co-op. In recent years, most suggestions for the management of marine resources and fisheries have been initiated by the local Fisheries Advisory Committees, which are composed of representatives from government, marine scientists, commercial and recreational fishers, charterboat fishers, and dive operators. For example, the recent initiative to limit issuance of new fishing licenses was a St. Croix FAC initiative. The DPNR Commissioner typically requests a public hearing on a recommendation. This allows the public to provide input into the management suggestions. Based on the results of public hearings, the advice of local government agencies (especially the Division of Fish and Wildlife, and the Division of Environmental Enforcement), and the range of authority of the DPNR Commissioner, the DPNR Commissioner may either issue a regulation or may suggest amendments or adjustments to the VIRR.

The role of the Division of Fish and Wildlife is quite varied and includes the following functions:

1) advise and support the local Fisheries Advisory Committees,

2) conduct appropriate research to assess the fisheries and marine resources,

3) review scientific literature and provide guidance based on the best available information, and

4) advise the DPNR Commissioner on fisheries and marine resource issues and management options.

Division of Fish and Wildlife (DFW) research continues in the USVI on a variety of natural resource issues relating to fish and wildlife (DFW 2003). It receives little local funding support. Funding is almost exclusively from two main sources: 1) Division of Federal Aid, U.S. Fish and Wildlife Service (USFWS), Department of the Interior, and 2) the National Oceanic and Atmospheric Administration Fisheries (NOAA Fisheries), Department of Commerce. As such, funded research projects are primarily ad hoc, and based on the priorities of each federal agency or grant program. These federal priorities may or may not be related to key resource priorities in the US Virgin Islands.

Within DPNR, there are other divisions that have responsibilities relating to the marine environment. The Division of Coastal Zone Management (CZM) requires a permit for any land or water disturbance that could impact territorial waters (within the first tier of the coastal zone, as designated by the CZM Act). The Division of Environmental Protection regulates discharge into territorial waters and issues earth change permits in the second tier of the coastal zone. The Division of Environmental Enforcement is responsible for enforcing regulations within USVI waters (Uwate 2002).

There are numerous other organizations conducting marine and fisheries related research in the USVI, including the University of the Virgin Islands (UVI), the Division of Coastal Zone Management (CZM), the Division of Environmental Protection (DEP), Island Resources Foundation (IRF), private consulting companies, the National Park Service (NPS), the United States Geological Survey (USGS), The Nature Conservancy (TNC), the Ocean Conservancy, NOAA Fisheries, the Caribbean Fisheries Management Council (CFMC), and individual researchers from universities outside of the USVI. Each organization has its own research priority and research interests.

2. NEED FOR CONSERVATION AND STRATEGIC PLANS

To date, there has been no comprehensive or strategic plan for the management of fish and wildlife resources in the U.S. Virgin Islands. Therefore, there is a need to compile such a plan.

As part of the Department of the Interior and Related Agencies Appropriations Act of 2002 (115 Stat. 414 Public Law 107-63–Appendix A), a State Wildlife Grants program was initiated "for the development and implementation of programs for the benefit of wildlife and their habitat, including species that are not hunted or fished". A stipulation of the act was that "no State, territory, or other jurisdiction shall receive a grant unless it has developed or committed to develop by October 1, 2005, a comprehensive wildlife conservation plan". Thus, to be eligible for future funding from congress under this Act, DFW must submit a comprehensive wildlife conservation plan that is approved by the USFWS, and which contains eight required elements outlined or listed in the Act, described in Chapter 2, section 1. Since the Division of Fish and Wildlife is nearly 100% federally funded, this is the main funding source that allows the Division to research and manage species that are not hunted or fished.

The final plan, to be submitted in 2005, is to incorporate both fish and wildlife (plants are subsumed within wildlife habitats). To achieve this goal, DFW decided to develop the plan in three phases: 1) a wildlife plan to be prepared by the Bureau of Wildlife and the Bureau of Environmental Education during the first year; 2) a fisheries and marine resources plan to be prepared by the Bureau of Fisheries and the Bureau of Environmental Education during the following 2 years; and 3) a comprehensive fish and wildlife plan to be integrated by 2005. However, due to the differences in funding sources, conservation requirements, overall priorities, and organizational constraints, DFW has since committed to producing two stand-alone documents: (1) a terrestrial wildlife comprehensive conservation plan, and (2) a fisheries and marine resources strategic and comprehensive marine wildlife conservation plan.

3. PREVIOUS USVI FISHERIES AND MARINE RESOURCES RELATED PLANS

Territorial Plans

Numerous plans have been written or drafted relating to management of fisheries and marine resources in the US Virgin Islands. These plans have focused on management of particular areas, issues, habitats, and species in the USVI.

For St. Thomas, site specific marine resource management plans exist for the St. Thomas mangrove lagoon area (Anon. 1980), Cas Cay Wildlife Sanctuary (Anon. 1983), Red Hook marine terminal (deJongh & Associates 1993), Magens Bay Area of Particular Concern (APC) (IRF 1992a), Vessup Bay APC (IRF 1992b), Botany Bay APC (IRF 1993a), Mangrove Lagoon/Benner Bay APC (IRF 1993b), Mandahl Bay APC (IRF 1993c), St. Thomas Harbor and Waterfront APC (IRF 1993d), Crown Bay (W.F. McComb et al. 1984), and St. Thomas National Marine Sanctuary (OCZM 1981).

For St. John, site specific marine resource management plans have been written for Enighed Pond/Cruz Bay APC (IRF 1992c), Chocolate Hole/Great Cruz Bay APC (IRF 1993e), Coral Bay APC (IRF 1993f), and Fish Bay (Watershed Planning Committee, no date).

For St. Croix, site specific marine resource management plans have been written for the east end of St. Croix APC (IRF 1992d), Great Pond Bay APC (Bacle 1992, IRF 1992e), Christiansted Waterfront APC (1993g), Frederiksted Waterfront APC (IRF 1993h), Salt River/Sugar Bay APC (IRF 1993i), Sandy Point APC (IRF 1993j), Southgate Pond/Cheney Bay APC (IRF 1993k), Southshore Industrial Area APC (IRF 1993l), St. Croix's coral reef system APC (IRF 1993m; Teyaud 1980), and management of the St. Croix East End Marine Park (The Nature Conservancy 2002). See Figures I-3 and I-4 for the locations of these APCs (areas of particular concern). The V.I. Government established its first marine park, the St. Croix East End Marine Park (EEMP), in January 2003. The EEMP is being developed as part of the National Action Plan to Conserve Coral Reefs. To ensure the long-term success of this newly established park, the Virgin Islands has decided to continue the bottom-up approach for developing conservation activities within the boundaries of the EEMP (USVI Govt. 2004). The V.I. Government has also decided that the EEMP will be the focal point around which development of the Local Action Strategies (LAS) will occur for the first 3-year period. The overall goal is to implement and expand the existing EEMP Management Plan, which is the result of 2 years of workshops that relied heavily on community input and expertise (USVI Govt. 2004).

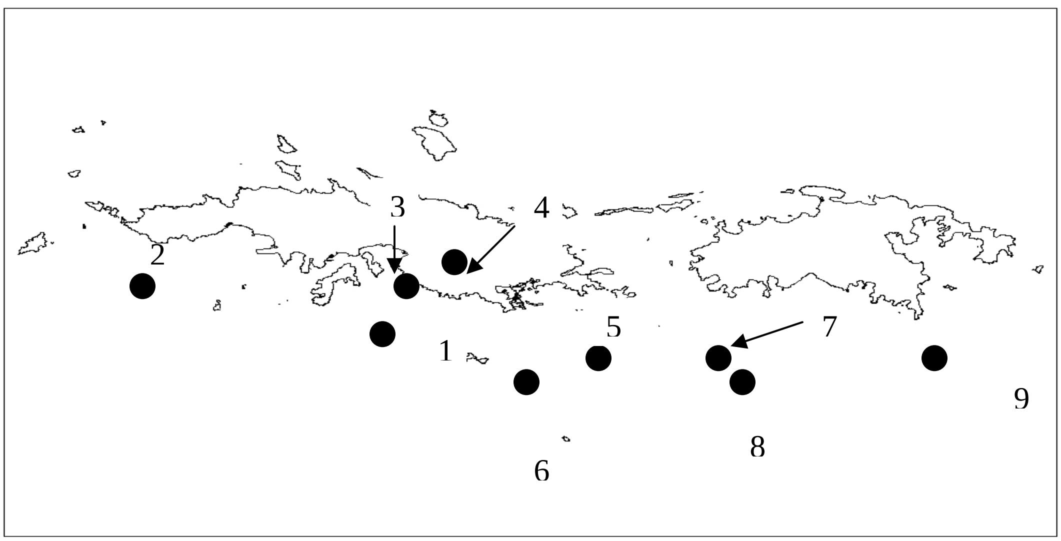


Figure I-3. Regional APC Map for St. Thomas and St. John. Adapted from OCZM 1988, and Island Resources Foundation 1993a.

St. Thomas:
1.) St. Thomas Harbor and Waterfront
2.) Botany Bay
3.) Magens Bay and Watershed
4.) Mandahl Bay
5.) Vessup Bay—East End
6.) Mangrove Lagoon—Benner Bay

St. John:
7.) Enighed Pond—Cruz Bay
8.) Chocolate Hole—Great Cruz Bay
9.) Lagoon Point—Coral Harbor

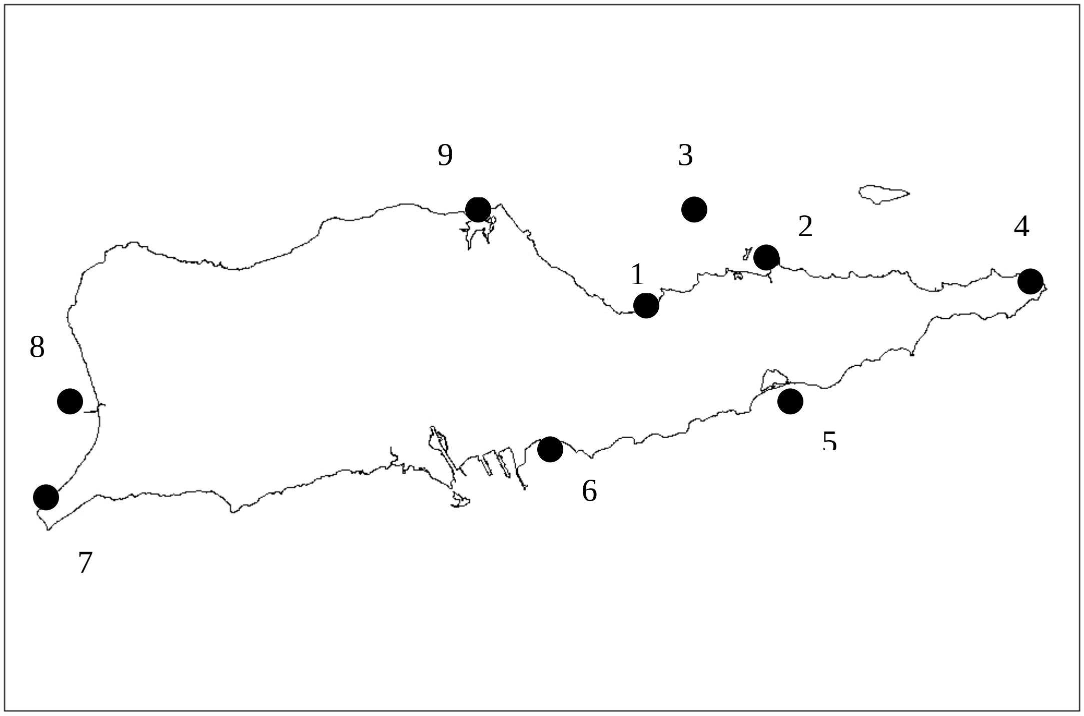


Figure I-4. Regional APC Map for St. Croix. Adapted from OCZM 1988, and Island Resources Foundation, 1993a.

St. Croix:

1.) Christiansted Waterfront
2.) Southgate Pond—Cheney Bay
3.) St. Croix Coral Reef System
4.) East End
5.) Great Salt Pond Bay
6.) Southshore Industrial Area
7.) Sandy Point
8.) Frederiksted Waterfront
9.) Salt River—Sugar Bay

USVI marine resource management plans that deal with more general issues include: wetlands (Department of Housing, Parks, and Recreation 1988); sediment control and monitoring (Island Resources Foundation 1996); saltwater wetlands protection (Knowles 1997); the Territorial park system (Policy and Planning Unit 1980); vessel waste control (Wernicke and Towle 1983); recreation including marine recreation (USVI Govt. 1985); management of coral diseases (Davis et al. no date); aquaculture development and management (Anon. 1995); coral reef management (ReefKeeper 1993); recovery of marine turtle populations (Anon. 1993; Boulon et al. 1992; NMFS 1992); monitoring habitat destruction from hurricanes (Aubrey et al. 1991); artificial reef development (Beets 1992); land and water use (USVI Govt. 2000); implementing environmental protection laws including marine environment issues (DCCZP 1994; OCZM 1988; and UVI Cooperative Extension Service 2002); general fish and wildlife management (Bureau of Sport Fisheries and Wildlife 1972).

One of the more recent management plans, prepared by the Division of Fish and Wildlife at the request of the USFWS, was written in 2001 (Division of Fish and Wildlife 2001). This five year management plan included strategies for the conservation, enhancement, and restoration of USVI marine and wildlife resources. By so doing, DFW qualified for additional funding through the USFWS Strategic Wildlife Grant (SWG) Program.

Federal Plans

In addition to territorial efforts, there have been many federal plans written or drafted for management of marine habitats and species within federal waters, from 3 to 200 miles from the coastline. These waters are under the jurisdiction of the Caribbean Fisheries Management Council (CFMC) (NOAA Fisheries 2004). CFMC has been involved in developing fisheries management plans for the following species: spiny lobsters (CFMC/NMFS 1981); queen conch (Anon. no date a; and CFMC 1988, 1989, and 1999a); coral and reef associated plants and invertebrates (Anon. no date b, Anon. 1982, CFMC 1993a, 1993b, 1994a, 1994b, 1998c, and 1999b; and U.S. Govt. 1999).

CFMC also completed work on management plans for the following: regulatory requirements for management of coastal migratory pelagic resources including dolphin and wahoo (CFMC 1982), and the general fisheries resources within the US Exclusive Economic Zone around Puerto Rico and the USVI (CFMC 1983a, 1983b); the shallow-water reef fish fishery of Puerto Rico and the Virgin Islands (CFMC 1984, 1985, 1990, 1991, 1992, 1995, and 1996; and NMFS 1990); and essential fish habitats in the U.S. Caribbean (Anon. 2001; CFMC 1998b; and NMFS no date). CFMC has also completed work on amending relevant Caribbean fisheries management plans (CFMC 1998a, and 2001). Public response, and commercial fishermen's response in particular, to CFMC's management plans has been critical due to the perception that fisheries data from Puerto Rico are driving the push for more strict management measures in the U.S. Virgin Islands.

There are marine resource and fisheries management plans that deal with species in both territorial and federal waters around the USVI. These are for the highly migratory species such as Atlantic tunas, swordfish, sharks, and billfish (Anon. 1998; Highly Migratory Species Management Division 1998, and 2004; and NMFS 1999; for sharks see NMFS 1991; for billfish see NMFS 1998; for swordfish see NMFS 2000 and South Atlantic Fisheries Management Council 1990).

The National Park Service is initiating a major planning effort that will guide the future management of the Virgin Islands National Park, the Virgin Islands Coral Reef National Monument, and the Buck Island Reef National Monument. Virgin Islands National Park (VINP) comprises slightly more than half of the island of St. John and almost nine square miles of the waters surrounding St. John (VINP 2004). The new Virgin Islands Coral Reef National Monument (VICRNM) (12,708 acres) was established in January 2001 to expand protection of marine resources located near the Virgin Islands National Park in St. John. There was a V.I. Senate resolution opposing this action and the failure to follow NEPA-required processes. Also in 2001, the Buck Island Reef National Monument (BIRNM) in St. Croix was expanded more than twenty times in size (880 acres to over 19,000 acres) and provided full protection from extractive uses (NPS 2004). Both VICRNM and the expanded BIRNM were created by

Presidential Proclamations, calling for both areas to be administered as no-take marine reserves. The new VICRNM was established, and existing BIRNM expanded, largely to restore fish populations and protect reef ecosystems (NPS 2004). Each area is entirely no-take except for fishing for bait fish at Hurricane Hole, St. John, and rod and line fishing for blue runner via permit at VICRNM. Anchoring is not permitted. Regulations to implement the new Monuments took effect in April 2003.

In addition to the above planning efforts, various agencies have written marine resource management plans or guidelines that include or are related to the USVI (NOAA 2004; NOAA Fisheries 1996, 2003; NOS 1998; and UNEP 1996).

Success of Previous Plans

As presented above, there has been much written regarding plans. Some of these plans have been successfully implemented or at least partially implemented. However, many plans have been left by the wayside. Without adequate support, in terms of funding, resources, and political will, no plan can be successful.

The distinction between this plan and other plans, such as the CFMC plans, also needs to be made. This plan is a product of the territorial Virgin Islands government and predominately deals with management issues in territorial waters, from 0 to 3 miles offshore. Federal plans, such as the CFMC plans, deal with management issues in Federal waters, from 3 to 200 miles offshore. As such, area closures are primarily a Federal management issue.

4. BENEFITS OF A USVI STRATEGIC AND COMPREHENSIVE MARINE RESOURCES AND FISHERIES PLAN

The strategic and comprehensive marine resources and fisheries plan will consolidate and document all research and project work related to the status of USVI marine resources and fisheries. Based on the consolidation and review of these previous studies, an assessment can be made regarding these resources. Critical research and data deficiencies and needs can then be identified.

This plan also provides an opportunity to clearly state the objectives of marine resource and fisheries management in the USVI. These objectives should be compiled in consultation with government as well as private sector input.

This plan also provides a forum for public input regarding the priority issues of the USVI’s marine resources and fisheries. Public input is critical to identifying priority issues. Finally, the plan will serves as a blueprint or nautical chart for addressing and resolving the priority issues concerning USVI marine resources and fisheries.

5. OBJECTIVE

The overall objective of this plan is to manage the fisheries and marine resources in a sustainable manner for the continued benefit of the people of the U.S. Virgin Islands.

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CHAPTER II
APPROACH

1. USFWS EIGHT ESSENTIAL ELEMENTS

In April 2003, DFW staff attended a USFWS workshop on the comprehensive plan. In that meeting, problems and difficulties were shared between the states regarding creation of the comprehensive plan. At that time, USFWS did not provide guidance on required format for this plan.

The following year, July 2004, DFW staff attended another workshop on the comprehensive plan, where the USFWS did provide plan guidelines and required elements (see Anon. 2004). During this meeting, eight required elements for the plan were specified. They are as follows:

1) Information on the distribution and abundance of species of wildlife, including low and declining populations as the state fish and wildlife agency deems appropriate, that are indicative of the diversity and health of the state's wildlife.

2) Description of locations and relative condition of key habitats and community types essential to conservation of species identified in the 1st element.

3) Description of problems which may adversely affect species identified in the 1st element or their habitats, and priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and habitats.

4) Description of conservation actions determined to be necessary to conserve the identified species and habitats and priorities for implementing such actions.

5) Description of the proposed plans for monitoring species identified in the 1st element and their habitats, for monitoring the effectiveness of the conservation actions proposed in the 4th element, and for adapting these conservation actions to respond appropriately to new information or changing conditions.

6) Description of procedures to review the plan at intervals not to exceed ten years.

7) Description of the plans for coordinating, to the extent feasible, the development, implementation, review, and revision of the plan/strategies with Federal, state, and local agencies and Indian tribes that manage significant land and water areas within the state or administer programs that significantly affect the conservation of identified species and habitats.

8) Description of the necessary public participation in the development, revision, and implementation of the plan.

These USFWS eight essential elements are addressed in various chapters and sections in this plan. Table II-1 identifies specific chapters and sections in which these elements are discussed or addressed.

2. APPROACH TO MAKING THIS PLAN

The basic approach used to formulate this plan is as follows:

1) Solicit public and user group input to identify major fisheries and marine resource issues.

2) Contact local governmental and private sector agencies within the USVI and solicit relevant scientific and technical reports and documents relating to USVI marine resources and fisheries.

3) Develop a library with copies of all relevant USVI marine resources and fisheries reports.

4) Create a searchable database for these reports.

5) Review USVI marine resources and fisheries related reports and incorporate information into relevant sections of this plan.

6) Identify priorities and major problems.

7) Propose solutions or specific actions to address priorities and resolve major problems.

8) Propose programs to monitor resolution of priorities and major problems.

9) Solicit public and professional comments on this plan.

The distinction between this plan and other plans, such as the CFMC plans, also needs to be made. This plan is a product of the territorial Virgin Islands government and predominately deals with management issues in territorial waters, from 0 to 3 miles offshore. Federal plans, such as the CFMC plans, deal with management issues in Federal waters, from 3 to 200 miles offshore. As such, area closures are primarily a Federal management issue.

Table II-1. Chapters and Sections of this Plan that Address the USFWS Eight Essential Elements (page numbers indicated in table)

Chapter/Section		USFWS Eight Essential Elements							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
		species info	**habitat info**	**problems**	**proposed actions**	**monitor plans**	**plan review**	**plan coord**	**public input**
I	**INTRODUCTION AND PURPOSE**								
	1. Setting	1	1	2					
	2. Need for Conservation and Strategic Plans			4					
	3. Previous USVI Fisheries and Marine Resources Related Plans	4-8	4-8	4-8					
	4. Benefits of a Strategic and Comprehensive Marine Resources and Fisheries Plan								
	5. Objective								
II	**APPROACH**								
	1. USFWS Eight Essential Elements	22	22	22	22	22	22	22	22
	2. Approach to Making this Plan			23, 28-30	23, 30	23, 30	31	23, 30-31	23, 31
III	**OVERVIEW OF HABITATS, ECOSYSTEMS, AND SPECIES**								
	1. Physical Setting		33-34						
	2. Coral Reefs	34-71	34-71	54-61		62-64			
	3. Mangroves	71-87	71-87	78-82		82-84			
	4. Seagrass Beds	88-95	88-95	93		93			
	5. Salt Ponds	96-100	96-100	99					
	6. Algal Plains	100-102	100-102	102					
	7. Marine Species	103							

Table II-1 (continued). Chapters and Sections of this Plan that Address the USFWS Eight Essential Elements (page numbers indicated in table)

Chapter/Section		USFWS Eight Essential Elements							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
		species info	**habitat info**	**problems**	**proposed actions**	**monitor plans**	**plan review**	**plan coord**	**public input**
IV	**OVERVIEW OF FISHERIES AND MARINE RECREATION**								
	1. Commercial Fisheries	132-134		135-139, 142-144		144-146		144-146	143-144
	2. Recreational Fisheries	147-152		152	152-153				
	3. Marine Recreation			157-162	164-165				
V	**IDENTIFICATION OF PRIORITY ISSUES AND SPECIES OF CONCERN**								
	1. Identification of Priority Issues			174-178					174-178
	2. Identification of Species of Conservation Concern	178-189							
VI	**CONSERVATION STRATEGIES**								
	1. Strategies for Addressing Priority Issues			191-211	191-211			194-211	191-211
	2. Strategies for Addressing Species of Greatest Conservation Concerns				211-217			211-217	
VII	**PLAN IMPLEMENTATION**								
	1. Implementation of Priority Issue Conservation Strategies			225-238	225-238			225-238	
	2. Implementation of Species of Concern Conservation Strategies				225, 239-243	225, 239-243		225, 239-243	

Table II-1 (continued). Chapters and Sections of this Plan that Address the USFWS Eight Essential Elements (page numbers indicated in table)

Chapter/Section		USFWS Eight Essential Elements							
		1	2	3	4	5	6	7	8
		species info	habitat info	problems	proposed actions	monitor plans	plan review	plan coord	public input
VIII	**PLANS TO MONITOR IMPLEMENTATION OF CONSERVATION STRATEGIES**								
	1. Plans to Monitor Priority Issue Strategies			244-256	244-256	244-256		244-256	
	2. Plans to Monitor Species of Concern Strategies				244, 257-261	244, 257-261		244, 257-261	
	3. Adjusting and Adapting Conservation Strategies Based on Feedback from Monitoring					262-264			
IX	**DECADAL REVIEW AND UPDATE OF THIS PLAN**								
	1. Review Period						266		
	2. Decadal Review Procedures						266-267	266-267	266-267
	3. Review the Success in Implementation of this Plan						267	267	
	4. Resources for Conducting the Review						267		
APPENDICES									
1.	**MARINE SPECIES OVERVIEW**								
	A. Reef Fish	268-372		268-372					
	B. Invertebrates	273-385		273-385					
	C. C. Other Species	386-418		386-418					

Table II-1 (continued). Chapters and Sections of this Plan that Address the USFWS Eight Essential Elements (page numbers indicated in Table)

Chapter/Section		USFWS Eight Essential Elements							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
		species info	**habitat info**	**problems**	**proposed actions**	**monitor plans**	**plan review**	**plan coord**	**public input**
APPENDICES									
2.	**U.S. VIRGIN ISLANDS MARINE HABITAT MAPS**								
	A. Marine Habitat Maps of St. Thomas/St. John		443-468						
	B. Marine Habitat Maps of St. Croix		469-499						
3.	**SUMMARY OF MARINE RESOURCES AND FISHERIES REGULATIONS**								
	A. Territorial Regulations	500-502	502-505						
	B. B. Federal Regulations	505-509	509-512						
4.	**DRAFT PLAN REVIEW COMMENTS**						513-539		513-539
5.	**PUBLIC ANNOUNCEMENTS AND PUBLIC MEETINGS**								540-555

(1) Solicit Public and User Group Input

Input from the public and resource user groups are essential to make any management approach successful. Various public forums, including opinion surveys, focus groups, and workshops, were used to identify public opinions and priorities.

Over the last few years, the following user groups were surveyed for their opinions regarding the marine resources and fisheries in the U.S. Virgin Islands:

1) In 2000, a telephone survey of registered boaters, targeting boat-based fishers, was subcontracted to the Eastern Caribbean Center (ECC 2002).

2) In 2001, at the request of the St. Thomas/St. John Fisheries Advisory Committee (FAC), the USVI Division of Fish and Wildlife (DFW) conducted an opinion survey of USVI commercial fishers (Uwate et al. 2001).

3) In 2002, DFW conducted opinion surveys of commercial fishers and the marine recreational industry (Gordon and Uwate 2003).

4) In 2003, DFW conducted a survey of USVI recreational fishing club members (Messineo and Uwate 2004). This involved members of the two existing recreational fishing clubs in the USVI: 1) the Virgin Islands Game Fishing Club on St. Thomas, and 2) the Golden Hook Fishing Club on St. Croix.

5) In late 2003, a census of the commercial fishers of the USVI was conducted (Kojis 2004).

6) In 2004, DFW conducted an opinion survey of USVI marine researchers (Messineo et al. 2004).

Results of these surveys are presented in the section on priorities of marine resources and fisheries. These opinions provided essential input for the identification of (see Chapter V), and possible solutions to (see Chapter VI), the priority issues in this report.

(2) Soliciting Relevant Scientific and Technical Reports, and Setting up the Library

Prior to the start of this planning effort, a centralized technical report library did not exist at the Division of Fish and Wildlife. DFW staff inspected more than 150 boxes of files in various storage locations on St. Thomas. Relevant technical reports were identified and pulled out of these storage boxes. A library of technical reports was then started at the St. Thomas DFW. Reports were initially organized by subject. Since these initial holdings were so large and geographically diverse, all reports dealing with USVI marine resources and fisheries were identified, separated out, and re-organized by subject. Reports were then cataloged into an Access database.

Once the Access database was completed for DFW/STT holdings, a hard copy was printed of current holdings. DFW/STX staff investigated their office files and identified other USVI marine resource and fisheries reports at that office. Hard copies were made of these reports and forwarded to DFW/STT. In addition, DFW/STT staff searched their individual offices to identify relevant USVI marine resources and fisheries reports. These were also added to the DFW/STT library.

After the internal searches were completed and the Access database was up-dated, DFW staff visited relevant local agencies for any additional reports dealing with USVI marine resources and fisheries. External agencies visited include: the Main Library, Eastern Caribbean Center (ECC), and Center for Marine and Environmental Studies (CMES) at the University of the Virgin Islands (UVI), The Nature Conservancy (TNC, St. Croix Office), The Ocean Conservancy (TOC, St. John Office), Coastal Zone Management (CZM), the Island Resources Foundation (IRF), BioImpact (a private environmental consulting company based on St. Croix), the U.S. Geological Survey (USGS), and the National Park Service (NPS).

Copies were made of relevant USVI marine resources and fisheries reports based on the various searches identified above. These were added to the St. Thomas DFW library. The Access database of holdings was periodically updated. A literature search of Aquatic Sciences and Fisheries Abstracts (ASFA) using key words such as Virgin Islands, St. Thomas, St. John, and St. Croix resulted in more than 1,000 scientific articles. ASFA abstracts for these reports were downloaded and reviewed. A list of literature relevant to USVI marine resources and fisheries was then compiled. This list was compared with DFW Access data file of USVI marine resources and fisheries reports. Reports not in DFW Access data file were then acquired from the University of the Virgin Islands Main Library. Those reports that could not be located at UVI were requested directly from the authors. To date, more than 1,100 USVI marine resources and fisheries related reports have been collected and compiled at DFW/STT library.

(3) Review and Incorporate Reports into this Plan

USVI marine resources and fisheries reports collected were then available and easily accessible at DFW/STT. As each of the sections of this plan was developed, DFW Access database of USVI marine resources and fisheries reports was searched. Relevant reports needed as background for this plan were reviewed.

(4) Identify Priorities and Major Problems

There were two sources of guidance used to determine priorities and major problems with USVI marine resources and fisheries: literature review and opinion surveys. Relevant scientific literature and technical reports collected on USVI marine resources and fisheries were reviewed. In addition, results from six opinion surveys (see above) were reviewed. These reports identified specific priorities or major problems with USVI marine resources and fisheries. Based on the above, and internal DFW consultations, a list of priority issues and major problems with USVI marine resources and fisheries was prepared (Chapter V).

(5) Propose Solutions or Specific Actions to Address Priorities and Resolve Major Problems

As above, literature reviews and opinion surveys were also used to identify solutions and proposed actions for priorities and major problems in USVI marine resources and fisheries. Based on this, and internal DFW consultations, a list of solutions and proposed actions for the priority issues and major problems with USVI marine resources and fisheries was prepared (Chapter VI).

Some of these solutions were within the mandates of DFW, others were outside of DFW's mandates. For example, the Division of Environmental Enforcement (DEE), not DFW, would be the lead agency responsible for addressing the issue of enforcement. Collaboration is needed with appropriate agencies in order to develop and implement programs to address identified priorities. Proposed solutions or strategies for addressing priority issues and species of concern are identified and documented (Chapter VI). Key agencies with primary and secondary responsibilities in addressing these priority issues were then identified (Chapter VII). In addition, steps required to implement these proposed solutions or strategies were identified (Chapter VII).

(6) Propose Programs to Monitor Resolution of Priorities and Major Problems

The ultimate purpose of monitoring is to provide early detection of changes in the environment. Monitoring programs should be linked with, and made an ongoing part of, overall management strategies. Monitoring programs should trigger responsive actions of additional investigation when signs of change beyond normally anticipated levels are observed (U.S. Coral Reef Task Force 2000).

Once priorities, major problems, and their solutions were identified, steps for monitoring implementation of strategies and the key agencies responsible for monitoring implementation were identified (Chapter VIII).

Coupled with monitoring, is the need for assessing results, new information, or changing environments so that appropriate adjustments can be made to the conservation strategy. These feedback loops are critical to ensure that the conservation strategies are appropriate or are adjusted as necessary to ensure that objectives are addressed. This is essential for adaptive management of conservation strategies that will be applied during the implementation of this plan (Chapter VIII).

(7) Review of this Plan

Subsequent to internal review, the plan was sent to key individuals and agencies for external review and comments (see list of external reviewers in Acknowledgment section). Comments received from these individuals and agencies were reviewed and, as appropriate, were incorporated into the final draft of this plan. In addition to the people and agencies approached to review this plan, a series of public meetings were organized for public input into this plan. Copies of this plan were also made available for public review on the USVI DFW website (http://www.vifishandwildlife.com), in the St. Thomas/St. John and St. Croix DFW offices, and in public libraries on St. Thomas and St. Croix. Comments provided by the public were noted and as appropriate, incorporated in this plan. Unusual comments were documented in Appendix 4 of the plan.

(8) Decadal Review and Update of this Plan

Procedures and preliminary plans for a decadal review and update of this plan are explained in Chapter IX.

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CHAPTER III
OVERVIEW OF HABITATS, ECOSYSTEMS, AND SPECIES

1. PHYSICAL SETTING

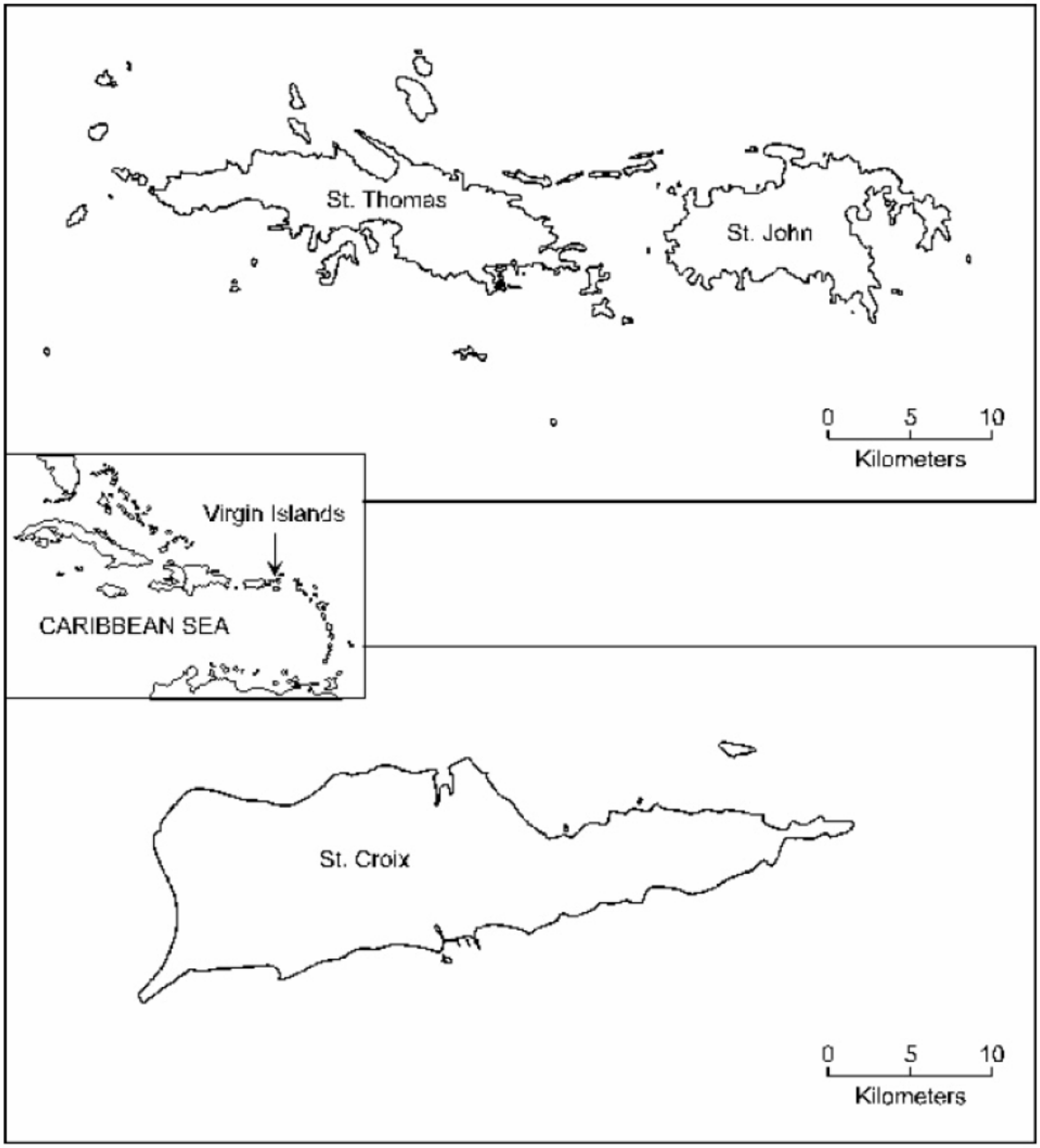
The U.S. Virgin Islands lie in the subtropics at approximately 18˚ north and 65˚ west (see Figure III-1). These islands, with the exception of St. Croix, are part of an island arc formed by the subduction of one tectonic plate below another (Whetten 1966). St. Croix is the result of an upthrust of ocean floor and is composed primarily of Cretaceous metasedimentary rock capped by limestone facies of more recent origin (Whetten 1966). St. Thomas and St. John are typified by steep mountainous or hilly slopes with little flat land suitable for agriculture or urban and residential development. Suitable flat plains are mostly confined to coastal areas, thereby isolating most of the population and industrial development to the coast. St. Croix, with its different geological history, is less hilly. The Atlantic Ocean and the Puerto Rico Trench lie to the north, with depths of 8,384 m (27,250 ft.). The Virgin Island Basin lies to the south of St. Thomas with depths of 4,116 m (13,380 ft.) (IRF 1985).

Winds are typically steady and out of the northeast (the Trade Winds), averaging about 4 m/s (7.8 knots) (Calvesbert 1970). Currents and waves are driven by the predominant Trade Winds and therefore generally flow from east to west (the North Equatorial Current). Nearshore flow patterns, however, may be more complex because of local physical features, semidiurnal and diurnal tidal cycles (mean tidal range 0.24 to 0.30 m (0.80 to 0.98 ft.)), and local wind patterns (IRF 1985). No upwelling is thought to occur around these islands, except possibly during strong tropical storms or hurricanes.

The average air temperature is warm (24° to 27°C (75.2° to 80.6° F)) and varies little throughout the day or throughout the year. The annual mean daily average difference ranges from 5° to 14° C (2.80° to 7.84° F) (Calvesbert 1970). The small temperature fluctuation is a result of fairly constant seawater temperatures and small island land masses. Warmest water temperatures occur in August and range from 27° to 28° C (80.6° to 82.4° F). In the coldest month (February), temperatures range from 25° to 26° C (77.0° to 78.8° F) (Calvesbert 1970).

Rainfall is accentuated by the mountainous terrain due to the rise and cooling of warm water-laden air masses that pass over areas of high elevation. Rain typically falls in intense cloudbursts, which lead to frequent flooding, even during months with lower average monthly rainfall (Calvesbert 1970; and NOAA 1989). A poorly defined seasonal variation in rainfall is evident, with December or January to April generally being considered dry months and May through November or December being considered wet months. Rainfall quantity and seasonal distribution vary regionally due to elevation and the location of areas behind mountainous barriers (Calvesbert 1970). Because of the constant high temperatures and steady winds, both evaporation and humidity are high. In areas of low rainfall, evaporation may exceed precipitation, resulting in the formation of hypersaline ponds (salt ponds) along the coast.

Figure III-1. Map of the U.S. Virgin Islands



The U.S. Virgin Islands lie within the broad path of Caribbean hurricanes, which typically pass from the southeast to the northwest. Hurricanes and tropical storms occur from June to December, but most occur in the months of August and September (Tetra Tech 1992). Hurricanes and large tropical storms that pass to the south and north may result in torrential rainfall, causing flooding, property damage, loss of human lives, and impacts on the coastal biota (Tetra Tech 1992). At least 12 major hurricanes and tropical storms have passed over or near these islands in the last half-century. Such hurricanes and storms not only cause physical damage to nearshore habitats, especially coral reefs (Edmunds and Witman 1991; Glynn et al. 1964; Rogers 1980b; and Rogers et al. 1982, 1983, and 1991), but they also bring heavy rainfall, which washes sediments and pollutants into coastal areas, where they may cause further damage.

Coastal marine environments in the U.S. Virgin Islands include a variety of supratidal, intertidal, and subtidal habitats with a range from hard-bottom to soft-bottom substrates (Tetra Tech 1992). The most distinctive of these habitats and perhaps the most widely studied are the coral, mangrove, and seagrass communities. These habitats are highly productive ecosystems that support a variety of organisms including important commercial species (Tetra Tech 1991a). They are habitats of special concern due to their value as highly productive ecosystems that provide natural resources (e.g., fish, shellfish, and recreational areas) for the human inhabitants of the area. These habitats also serve as invaluable ecosystems for scientific research due to their very high diversity, productivity, and the peculiar adaptations of resident species (Cintron and Schaffer-Novelli 1983; Hodgson and Smith 1990; Lessios 1988; Lugo et al. 1988; Odum et al. 1982; and Stevenson 1988). Furthermore, several coral reef species have the potential for use in drugs and as tools for bio-medical research (Angeles 1981; and Fenical 1982).

It is important to note that, although these three habitats (coral reefs, mangroves, and seagrass communities) are discussed separately in this document, they are not independent entities. These distinctive habitats are interconnected with each other, as well as with other marine and terrestrial ecosystems, by the exchange of nutrients, organic matter, and migratory animals (Tetra Tech 1991a). The destruction or impairment of any one of these habitats will result in deleterious impacts to adjacent habitats (Cintron and Schaffer-Novelli 1983; Bohnsack 1992; and Goenaga and Boulon 1992). For example, seagrass beds serve as nursery grounds and secondary feeding grounds for many coral reef animals and protect coral reefs by trapping sediment and lowering the potential for sediment resuspension and transport. Coral reefs, in turn, dissipate wave energy and protect inshore mangrove areas and quiescent lagoon areas which support the establishment of seagrasses (Cintron and Schaffer-Novelli 1983). Coral reefs also provide refuge for many animals that feed in seagrass and mangrove areas (Bohnsack 1992). Mangroves trap particulates carried by water, thereby protecting seagrass beds and coral reefs from excessive sediment loads. In addition, the export of mangrove leaf litter provides an important food source for organisms inhabiting seagrass and coral reef communities, and mangroves serve as spawning and nursery grounds for many animals that spend their adult lives in seagrass, coral reef, or open-water areas (Cintron and Schaffer-Novelli 1983).

In addition to coral reefs, mangroves, and seagrass beds, there are two other integral, though less well-known, marine habitats that are of considerable importance in the USVI. These are salt ponds and algal plains. Although the waters of the USVI have large areas of colonized hardbottom - stemming from the settlement of gorgonians, solitary corals, scattered hermatypic corals, sponges, etc. on geologic structure (i.e., bedrock) as well as on biogenic structure (i.e., dead coral, limestone rock), colonized hardbottom was not treated in this document as a separate ecosystem, or habitat, per se. This was mainly due to lack of information/data specifically concerning these areas, and to its ecological overlap with the above-mentioned habitats. Many nearshore or shelf areas in the USVI are colonized hardbottom (Jason Vasques, USVI DFW Fisheries Biologist III, personal communication). Most, if not all, of the priority issues and solutions that apply to coral reefs also apply to colonized hardbottom. For these reasons, colonized hardbottom will be treated under the coral reef category.

For maps illustrating type and areal extent of benthic habitat in the USVI, refer to Appendix 2.

2. CORAL REEFS

(1) General Description of Coral Reefs

Corals are animals whose fundamental unit is the coral polyp (Goenaga and Boulon 1992). Reef-forming corals are generally colonial and are placed in the order Scleractinia (scleractinian or stony corals), which are capable of secreting a calcium carbonate skeleton (Goenaga and Boulon 1992). The reef-building or hermatypic corals have a mutualistic, symbiotic relationship (living in close association that is also mutually beneficial) with zooxanthellae (intracellular algae), which may contribute substantially to the nutrition of the polyps. Corals may also rely on plankton, bacteria, and dissolved organic matter for nourishment. The dependence of some coral species on their photosynthetic symbionts results in their dependence on adequate light penetration for growth and reproduction (Rogers 1979). For the most part, this explains reef-building coral's requirement for clear, sediment-free water. Coral "bleaching" is the result of a breakdown in this close association. Bleaching in reef corals is due to the loss of zooxanthellae from the host tissues. Various physiological stresses can induce coral bleaching, such as high or low temperatures, high or low salinities, and high or low irradiance (Gladfelter 1988).

Major reef-building coral genera that occur in the Caribbean include *Acropora, Montastraea, Porites, Diploria, Siderastrea, and Agaricia* (Tetra Tech 1991a). Elkhorn coral (*Acropora palmata*) and boulder star coral (*Montastraea annularis*) are generally the most numerous coral species, although in some regions other species (e.g., staghorn coral, *Acropora cervicornis*) may be more common (Tetra Tech 1991a). In addition to these reef-building species, coral areas may contain a variety of gorgonian corals which come in a variety of shapes of whips and fans. Coral reefs also support a variety and abundance of reef associated organisms, including algae, sponges, bryozoans, fishes, lobsters, and sea urchins (Tetra Tech 1991a). Coral reefs may exist under a variety of conditions of water depth, bottom substrate, water quality, wave-energy, and currents (Tetra Tech 1992).

The coral reef ecosystem has a variety of useful roles, all of which have a relevant and positive influence on associated coastal habitats (UNESCO 1983). The most prominent role is the provision of a diverse habitat for a large number of sessile and mobile organisms. In this regard, one notable feature is the large proportion of species that live within the reef system but forage and feed in contiguous areas on a diurnal cycle (Ogden and Zieman 1977). Conversely, many non-reef species visit coral reefs at periodic intervals for the purpose of foraging and preying upon coral reef inhabitants. The coral reef ecosystem is thus both a habitat and source of nourishment for many species typically found in the coastal areas dominated by reefs (Ogden and Zieman 1977).

Although the coral reef ecosystem is dependent upon the seawater's having superior water-quality characteristics, the reef itself plays a role in maintaining the quality of local waters (Odum and Odum 1955). Water currents that circulate over and within a coral reef are "filtered" as the reef system takes up and utilizes a variety of inorganic minerals, oxygen, organic detritus, and plankton. The outflowing water carries small concentrations of metabolic wastes away from the reef as well as planktonic larvae that are dispersed into other areas (Odum and Odum 1955).

Coral reefs tend to be positioned perpendicularly to the mean direction of wind-generated currents flowing over the reef. Depending on the reef's proximity to adjacent coastal areas, this characteristic can serve to weaken incoming waves, storm surge, or tsunamis, thus minimizing erosion and coastal hazards behind the reef (Snedaker and Getter 1985). This creates a lagoon and a protected coastal environment. This is particularly important for regions with low-lying coastal plains (CFMC 1994).

Because of their high rates of calcification, coral reefs play a major role in the global calcium cycle despite their limited areal extent, fixing about half of all the calcium entering the sea into calcium carbonate (Fujita et al. 1992). Their role in the earth's carbon cycle and other geochemical cycles is presently under investigation (Fujita et al. 1992). Models and limited field data indicate that coral reefs, counter-intuitively, appear to be very small net sources of carbon dioxide (less than 0.1 billion tons of carbon per year, as compared to about 6 billion tons of carbon annually from fossil fuel combustion) to the atmosphere on decadal time scales (Fujita et al. 1992). This is due to the release of carbon dioxide during calcification, which involves the precipitation of calcium carbonate from bicarbonate and calcium in seawater (Fujita et al. 1992). In addition, while coral reefs absorb large amounts of carbon dioxide (per unit area) during photosynthesis, they generally release almost equivalent amounts via respiration, resulting in little net storage (Fujita et al. 1992).

Coral reefs have a large variety of direct and indirect uses that benefit man and society (Snedaker and Getter 1985). Their socioeconomic importance can be divided into three broad, albeit interrelated, categories. These encompass, first, their physical reef-forming activities (CFMC 1994). Coral reefs provide the habitat on which other vertebrate and invertebrate reef-associated organisms depend. Because of this their principal value is determined to be in non-consumptive uses (Goenaga and Boulon 1992). They are among the most productive ecosystems on earth, supporting a higher biological diversity than any other ecosystem, with the exception of tropical rain forests.

Second, is the biological diversity of associated fauna and flora which support many of the species exploited recreationally and commercially by man, and also generate a wealth of bio-compounds of tremendous actual and potential medical importance (CFMC 1994). The large yields obtained from marine fisheries supported by reef systems are estimated to be as high as five tons/square kilometer (12 tons/square mile) (Snedaker and Getter 1985). This yield is not limited to the fishes and crustaceans actually harvested from within the reef system, but also includes a larger variety and quantity of organisms caught elsewhere but whose existence is dependent upon the reef. Coral reef areas are the most productive tropical marine systems and thus are the backbone of the food chain (Snedaker and Getter 1985). At the end of this food chain are the fishery resources utilized by commercial and recreational fishermen. Coral reefs serve as breeding grounds, nurseries, feeding grounds, and refuge for most protected species, all of which, and including coral reefs, are vulnerable to overfishing.

Third, is their importance in the promotion and development of income-earning tourist industries (Snedaker and Getter 1985). The aesthetic and recreational aspects of coral reefs support major tourist industries that are aimed at divers and fishermen, as well as others, who value the presence of coral reefs for recreational purposes (Goenaga and Boulon 1992; and Tetra Tech 1992). The ecological habitats, marine aquatic life, consumption of fish and shellfish, swimming, boating, and the aesthetic enjoyment of the islands are reasons that vacationers visit the U.S. Virgin Islands (Tetra Tech 1992). The degradation of these resources, resulting in use impairments, will present problems if it becomes too severe, and once it becomes obvious that coastal areas are impaired, tourism is likely to decline (Tetra Tech 1992).

(2) USVI Coral Reefs

General coral reef types that have been observed in the U.S. Virgin Islands include the following (Rogers et al. 1994; and Tetra Tech 1991a):

1) Fringing reefs - A reef bordering a shoreline. These are emergent reefs extending directly from shore. These reefs are often found as extensions of headlands or points.

2) Fringing barrier reefs - Emergent reefs adjacent to the shore, but separated from shore by an open lagoon or channel.

3) Submerged-barrier reefs - Submerged fringing reefs that have not developed to the surface.

4) Patch reef - A small circular or irregular reef that rises directly from the bottom and is distinct from other reef sections. This isolated complex of corals provides a major change in topography.

5) Shelf edge reef – A reef located at the edge of the continental shelf.

The following references provide an inventory and guide to coral reefs in the USVI: Adey et al. (1977), Garcia Sais (2004), and Gladfelter (1988). For more information on the ecology of coral reefs in the USVI, see Bythell et al. (1992), Edmunds (1999), Gladfelter and Gladfelter (1978), Miller et al. (2001), Ogden and Zieman (1977), Roberts (1995), Rogers (1980a, 1982), Rogers et al. (1997), and UNESCO (1983). Adey (1975, 1998), Adey and Burke (1976), and Edmunds (2000) provide more detailed information on the structure and distribution of coral reefs in the USVI.

There are deep reefs around the USVI. Very little is known of these deeper reefs, especially in areas that may support critical grouper and snapper spawning aggregation sites along the shelf edge (Turgeon et al. 2002). Some have exceptionally high coral cover (Garcia Sais 2004; Goenaga and Boulon 1992).

Because of their slow regeneration rates and limited distribution on the insular platform of Puerto Rico and the U.S. Virgin Islands, many coral species are extremely vulnerable to unregulated harvest by commercial and amateur collectors and damage from growing tourist activity. Furthermore, because of their largely sedentary nature, corals are unable to escape the impact of a variety of anthropogenic activities, including anchoring, pollution, and damage by fishing gear.

For the following discussion of specific coral reefs in the USVI, please refer to the benthic habitat maps in Appendix 2 (St. Thomas/St. John—Appendix 2A; St. Croix—Appendix 2B).

St. Croix Coral Reefs

The St. Croix shelf is very different from the northern islands' shelf in that it is much narrower and shallower, which produces a compression of reef types and also allows less extensive areas of deep reef communities (Goenaga and Boulon 1992). The proximity and shallowness of the north shore shelf edge reefs has enabled them to be studied relatively extensively whereas the shelf edge reefs on the north sides of St. Thomas and St. John have not been studied at all (Goenaga and Boulon 1992). The shelf edge reef system on St. Croix's north shore runs fairly continuously from Butler Bay on the west coast to the western end of Long Reef on the north coast. The shelf edge reef along this shore ranges from several hundred meters to a little over half a kilometer (~ 0.2 to 0.4 miles) from the coastline. Just seaward of the coastline along this shore lies a zone of hard carbonate pavement followed by mostly dead reef patches encrusted with living coral (Multer 1974). These have produced an irregular and broken series of wave resistant spurs. The dominant coral on these structures is *A. palmata* with scattered growths of *A. cervicornis, P. astreoides, P. porites, D. strigosa, Millepora complanata* and others. The shelf edge reef is dominated by *Montastraea annularis* with varying amounts of *A. agaricites, P. astreoides, P. porites, Montastraea cavernosa*, and other species of hard corals (Goenaga and Boulon 1992). This reef has developed spurs made up of *Montastraea annularis* sometimes also having shingle-like layers of *A. agaricites*. These spurs alternate with sediment chutes floored with coarse sand which is being transported off the shelf via these chutes. Coral growth ends at 60 to 70 m (~ 200 to 230 ft.) and framework builders are replaced by sclerosponges such as *Ceratoporella nicholsoni* (Goenaga and Boulon 1992).

Adey et al. (1981) stated that "the 4,000 year old eastern and southeastern bank barrier reef of St. Croix is one of the best developed reef systems in the tropical-Atlantic Caribbean area." Adey et al. (1981) further stated that "with a length of 23 miles (37 km), it is the most extensive reef on the Puerto Rican-Virgin Island shelf." Adey et al. (1981) go on to suggest that this reef is the largest reef structure in U.S. territory, with the possible exception of U.S. controlled Indo-Pacific island reefs. Detailed maps and reef descriptions for St. Croix may be found in Adey (1975), Adey and Burke (1976), Adey et al. (1981), and Multer and Gerhard (1974). Also refer to Appendix 2B.

The Buck Island National Monument is located 2 km (~ 1.25 mi) north of Teague Bay on St. Croix. Fairleigh Dickinson University's West Indies Laboratory, formerly located on St. Croix, conducted nearly 20 years of ecological studies that established a baseline for Buck Island Reef National Monument, as well as other St. Croix sites (Bythell et al. 1992; and Hubbard 1991). The West Indies Laboratory on St. Croix was destroyed during Hurricane Hugo, in 1989, and never rebuilt. A barrier reef starts near shore at the southernmost point of Buck Island (Anderson et al. 1986). This reef forms an arc around the east end of the island, roughly paralleling the north shore. The crest of this reef is dominated by *Millepora spp.* The reef then grades into a contiguous series of patch reefs to the northwest of the island (Goenaga and Boulon 1992). This system of patch reefs extends approximately 2 km (~ 1.25 miles) northwest of the west tip of the island. *A. palmata* is a major constituent of this reef system. North and east of the barrier reef system is an extensive coral/gorgonian flat, nearly continuous to the shelf edge (Goenaga and Boulon 1992). Several massive *A. palmata* reefs are emergent at low tide. Although these reefs are composed of nearly 100% *A. palmata*, less than 20% of the coral is actually alive. The evidence of impact from white band disease on this species is strong (Davis et al. 1986), having reduced once world famous reefs to literal skeletons of their former selves.

While the types of communities surveyed by Davis et al. (1986) have not changed since the original descriptions in 1977 (Gladfelter et al. 1977), the condition of many of the communities has been dramatically altered. The lagoon area behind the barrier reef had a rich, live *A. prolifera* population in 1977 and now is consolidated *A. prolifera* rubble with an algal veneer. The *A. palmata* reefs show a reduction in live coral cover from nearly 100% in 1977 to only 20% in 1985. The cause or causes resulting in these dramatic changes are still not well understood (Goenaga and Boulon 1992).

A submerged barrier reef extends west of Buck Island, along the length of the north coast narrow shelf, broken only by Christiansted submarine canyon off Christiansted and the Salt River submarine canyon off Salt River (Adey et al. 1981). This submerged barrier reef ends near Annaly Bay. The walls of the Salt River canyon differ markedly in coral cover, possibly the result of differences in vertical profile and substrate type (Boulon 1979). The east wall ranged from less than 1% coral cover in the inner portion to 25% coral cover near the shelf edge. The most common species were *Mycetophillia spp., M. annularis, D. strigosa, Agaricia spp., and M. cavernosa*. The west wall is much steeper with solid substrate and ranged from 22% to 59% coral cover with the most common species being *M. cavernosa, Agaricia sp., Porites spp., and S. siderea.* Increases in sedimentation from upland sources have undoubtedly decreased coral growth and cover since this survey was made. The greatest number of coral species (20) was noted at the west wall of Salt River Canyon where *A. agaricities* was the dominant coral (Adey et al. 1981; Gladfelter et al. 1978; Rogers and Salesky 1981; and Rogers et al. 1982, and 1984).

Long Reef extends eastward to Fort Louise Augusta and is described as an emergent bank barrier reef with an extensive back reef lagoon (Goenaga and Boulon 1992). The reef is dominated by *A. palmata, M. annularis, Millepora spp., P. porites* and others (Goenaga and Boulon 1992). The reef is covered by high densities of algae probably due to eutrophication from human activities in Christiansted. This and channel dredging activities have reduced the living reef to less than 30% of the bottom surface. Seaward of this reef the shelf slopes out to the edge with *Agaricia lamarki* in large formations perpendicular to the reef and separated by sand channels.

The eastern part of Long Reef and Round Reef are described as in a less than "healthy" state (VIPA 1983). Live coral cover is low (6% to 23%) as compared to other reefs in the area (18% to 65%). The authors were unable to ascertain whether this is the result of a less than optimal natural physical environment or human impact. The combination of extremely low live coral coverage, the prevalence of small colonies, and large amounts of sediment on the deeper reef at the edge of the Christiansted Canyon all suggest that sedimentation is a major factor limiting reef growth in this area.

Most of the shoreline east of Long Reef to Teague Bay is fringing reef with scattered bank reefs dominated by *M. annularis* (Goenaga and Boulon 1992). The Teague Bay reef is about 5 km (~ 3 miles) long and is considered the most extensive bank barrier reef on St. Croix (Ogden 1974). The reef encloses a lagoon about 0.4 km (0.25 mile) wide and averaging 5 m (~ 16.4 ft.) deep. The back reef is dominated by *M. annularis, P. porites,* and *A. palmata*. The reef crest receives heavy wave energy and has a distinct zone of *M. complanata* mixed with *A. palmata*. The fore reef slopes to the sand channel separating St. Croix from Buck Island. The fore reef is primarily composed of *P. porites, A. cervicornis, M. annularis,* and *Diploria spp.* Main impacts to this reef system are from coastal and upland development and the increase in sediment input into the ocean. Anchor damage and boat groundings have also caused reef degradation (Goenaga and Boulon 1992). The percent live coral cover of Long Reef ranges from approximately 12.5% to 19.5% (Nemeth et al. 2003b).

Due to the prevailing wind and wave directions, the east end of St. Croix receives abundant clean water (Goenaga and Boulon 1992). This has resulted in well-developed coral reefs with little human impact except for overfishing (Goenaga and Boulon 1992). Nearshore are numerous fringing reefs dominated by *A. palmata,* and *M. annularis* (Goenaga and Boulon 1992). Offshore the shelf extends eastwards for about 20 km (12.4 miles) and averages 20 to 30 m (65.6 to 98.4 ft.) deep. A submerged reef complex rises to about 10 m (32.8 ft.) in depth along the seaward edge and is known as Lang Bank, due east of St. Croix (Goenaga and Boulon 1992). The bank is mostly cemented pavement with scattered sponges, gorgonians, and coral heads. Dominant corals here are *Porites spp., Diploria spp., Montastraea spp.,* and *A. cervicornis* (Goenaga and Boulon 1992). Well developed submerged reefs occur along the outer margins of the shelf (Nemeth unpubl. data).

The southeastern shore from East Point to Vagthus Point contains discontinuous bank barrier reefs enclosing shallow bays between rocky points (Goenaga and Boulon 1992). To the west of Vagthus Point large buttresses, as much as 5 m (16.4 ft.) in height, stand near to shore and reach to just below the surface (Palm Shores 1987). These buttresses contain large *D. labyrinthiformis* heads with diameters of over one meter (3.28 ft.). *A. palmata* is also found along with *Millepora alcicornis, Millepora complanata, Montastraea annularis, P. astreoides, P. porites, D. cylindrus,* and *A. agaricites*. Offshore of these structures lie a series of rubble reefs. All of the above listed corals with the addition of *A. cervicornis* occur on these rubble reefs.

On the broad shelf of the eastern and southern areas of St. Croix, numerous patch reefs may be found (Adey et al. 1981). The southwestern shore from Hess Oil to Sandy Point once contained relatively good reef development but the dredging of Krauss Lagoon and numerous dredgings of ship channels have killed most of the nearshore and bank reefs (Goenaga and Boulon 1992). The shelf is widest at this part of the island and there are numerous, scattered large patch reefs on the outer portions dominated by *M. annularis*. Deeper reefs off southwest St. Croix are comprised of approximately 36% live coral cover (Nemeth et al. 2004a).

Beginning with Airport Reef off Mannings Bay, small reefs occur along the south coast and merge with the extensive reef formations of the eastern end of the island (Adey et al. 1981). Based on limited data, live coral cover was lowest in Manning Bay (0% to 4%) and greatest at Isaac Reef (26.1% to 66.7%) (Tetra Tech 1985b).

The west end of St. Croix is a sand plain with scattered inshore areas of raised pavement supporting communities of hard corals mixed with gorgonians and sponges (Goenaga and Boulon 1992). Coral reefs are poorly developed from Fredricksted on the west coast to Long Point on the south coast (Adey et al. 1981).

Near Butler Bay the submerged barrier reef continues to Fredricksted (Adey et al. 1981). The shelf edge reef system starts off at Butler Bay and extends north towards Hams Bluff (Goenaga and Boulon 1992). At Hams Bluff, the submerged barrier reef continues to Hams Bay (Adey et al. 1981).

The percent live coral cover, based on quantitative observations, ranged from a few percent in areas of the south coast of St. Croix to almost 50% (Adey et al. 1981; Rogers et al. 1983, 1984). In areas where the coverage of staghorn coral was complete, coverage of 100% was possible (Tetra Tech 1992).

On St. Croix, the main stress on the shelf edge reef is the frequent anchoring of dive vessels. Several dive operations and sport divers come here to see the well-developed reef, the many fish, and to experience the spectacular wall dive (Goenaga and Boulon 1992).

In the past, staghorn and elkhorn corals have succumbed to white band disease off St. Croix, as well as throughout the Caribbean (Gladfelter 1982; and Rogers 1985). This disease of unknown etiology has killed up to 95% of the elkhorn corals off Tague Bay (Peters 1988).

Tropical storms have also impacted coral reefs on St. Croix. Hurricane Hugo struck the U.S. Virgin Islands in September of 1989, passing directly over St. Croix. Hugo battered St. Croix for over 12 hours, with a maximum sustained wind of 223 km per hour (~ 140 mph) and heavy rainfall (14.3 cm to 24.5 cm (~ 5.6 to 9.6 inches) recorded on St. John), and it devastated portions of coral reefs and seagrass beds off St. Croix (Gladfelter et al. 1991). Other recent storms that have affected U.S. Virgin Island reefs include Hurricane David and Tropical Storm Frederic in 1979, Tropical Storm Klaus in 1984, and Hurricane Gilbert in 1988, with Klaus and David probably the most destructive prior to Hugo (Rogers et al. 1991). Subsequent hurricanes continue to inhibit reef recovery.

St. John Coral Reefs

Much of the baseline information for coral reefs in the Virgin Islands National Park (VINP) comes from a series of reports by the Virgin Islands Resource Management Cooperative from 1983 to 1988 (Turgeon et al. 2002).

Beets et al. (1986) provided a semi-quantitative description of the marine communities of bays within the Virgin Islands National Park and Biosphere Reserve of St. John that includes descriptions of coral communities. The percent live coral cover was reported to range from less than 5% to 70%.

The best developed reefs at that time were Johnson's Reef on the east coast and in Haulover Bay (Beets et al. 1986). The areas with the greatest coral cover appear to be those that receive the least terrestrial runoff and/or are exposed to sufficient wave energy to quickly disperse excessive sediment loads (Hubbard et al. 1987). The most recent estimates of percent live stony coral cover for a reef on the north side of St. John was 15.6% in 1988 (Tetra Tech 1992). In 1992, live stony coral coverage was 11.0% for a reef on the south side of St. John and 19.2% for a reef on the northeast side of St. John (Tetra Tech 1992).

Scattered coral reef formations are found throughout St. John and associated islets and cays (Kumpf and Randall 1961). Coral reefs off the northern part of the island from the north of Cruz Bay to East End, and on the south from Drunk Bay to Fish Bay are within the Virgin Islands National Park administered by the National Park Service. Extensive, well-developed reefs can be found on the eastern edge of the island along the East End and from Johnson Bay to Rams Head (Kumpf and Randall 1961).

Approximately 56% of St. John's land area is a National Park (Turgeon et al. 2002). Along with this, 5,650 acres of submerged lands are also owned and managed by the National Park Service. While this has provided some protection for the marine resources, inholdings and nearby development have produced sedimentation in several of the bays under NPS jurisdiction (Hubbard et al. 1987). From 1983 to 1985 the NPS contracted with a number of local agencies to survey the marine resources within NPS waters (Goenaga and Boulon 1992). These projects resulted in fairly detailed reports of the benthic invertebrate and associated fish assemblages (Beets et al. 1986; and Boulon 1986). Descriptions for coral reefs and communities within the NPS rely considerably on these reports along with personal observations by R.H. Boulon (Goenaga and Boulon 1992).

Cruz Bay is the principal harbor and port of entry for St. John and, as such, is the most heavily utilized bay on the island. A shallow, mostly dead reef extends from the southern point (Gallows Point) and provides considerable protection for the bay (Goenaga and Boulon 1992). This reef has been killed due to sedimentation and vessel groundings. Thirty years ago, this reef was very healthy and good for snorkeling (Goenaga and Boulon 1992). Remains of *A. palmata* stands can still be seen. The north side of the bay contains some coral growth on subtidal bedrock with live cover less than 5% (Goenaga and Boulon 1992).

Solomon and Honeymoon Bays have subtidal bedrock off the points with coral cover of 5% to 10% (Goenaga and Boulon 1992). The predominant corals are *P. porites, A. palmata, A. cervicornis, S. radians, S. siderea, M. annularis, C. natans, D. clivosa,* and *D. strigosa*. A small patch of dead upper fore reef is off the southern point of Honeymoon Bay. A few small patches of *A. palmata* are surviving among many dead ones. Other corals are present with a live coral cover of 20% to 25% (Goenaga and Boulon 1992).

Caneel Bay and Scott Beach have patches of subtidal bedrock with low coral cover (less than 5%). Towards the northern point of Scott Beach the coral cover increases to 40% to 50% with *Millepora spp.* becoming dominant (Goenaga and Boulon 1992). Turtle Bay has a similar distribution of coral cover on subtidal bedrock with coral cover increasing towards the points (Goenaga and Boulon 1992).

The Durloe Cays (Henley, Ramgoat, and Rada) have varying amounts of coral cover around them on subtidal bedrock (Goenaga and Boulon 1992). The exposed northeast parts have higher cover (40% to 60%) which then decreases towards the southern parts. Some large colonies of *A. palmata* exist and *D. cylindrus* is unusually common around these cays. Other corals here include *D. strigosa, D. labyrinthiformis, D. clivosa, C. natans,* and *P. porites*. Southeast of Henley Cay are carbonate ridges with high coral cover (60% to 80%) with *M. annularis* being dominant. Surrounding all the Cays in deeper water is a zone of gorgonian/coral pavement with coral cover around 5% (Goenaga and Boulon 1992).

Hawksnest Bay is a deeply indented bay with several types of coral assemblages (Goenaga and Boulon 1992). The eastern and western shores are dominated by subtidal bedrock with low coral cover (5% to 10%). Four large patches of upper fore reef exist in the southern part of the bay. These are dominated by *A. palmata* which provides about 10% live cover. These reefs have been impacted by sediment runoff from the St. John Clinic at the top of the watershed and by boat groundings. The western part of the bay has areas of pavement with low coral cover (5% to 10%). These areas are bordered on the seaward side by lower fore reef having coral cover of 25% to 30% (Goenaga and Boulon 1992).

Dennis Bay and Perkins Cay have considerable reef development between them and off the beach (Goenaga and Boulon 1992). Large stands of *A. palmata* exist on the east and west sides of the beach with many of the colonies dead and low coral cover (5% to 10%). To the west and northeast of Perkins Cay the coral cover is higher (15% to 20%) with the dominant corals being *P. astreoides* and *A. palmata*. There is a narrow lower fore reef zone dominated by *M. annularis* and 20% to 30% coral cover (Goenaga and Boulon 1992).

Jumbie Bay has moderate sized patches of *A. palmata* which dominate the upper fore reef on the east and west sides of the bay (Goenaga and Boulon 1992). There is high mortality of *A. palmata* in this reef which has resulted in low live cover (5% to 15%). White band disease is evident here which may explain the mortality. A band of coral colonies stretches between the upper fore reef patches and is dominated by *M. annularis* (Goenaga and Boulon 1992).

Trunk Bay and Trunk Cay have little coral growth (Goenaga and Boulon 1992). Most of it is present on subtidal bed-rock around the cay and eastern point. An underwater trail is located on the western side of the cay and has suffered from breakage and abrasion from swim fins and collection of "souvenirs" by tourists. This trail is an example of the cumulative impact of many individuals over a long period of time (Goenaga and Boulon 1992).

Johnson's Reef is an extensive nearly emergent bank reef complex located north of Trunk Bay (Goenaga and Boulon 1992). The reef crest is dominated by *Millepora spp.* (30% to 40% coral cover) with small dead colonies of *A. palmata*, probably from storm damage. The upper fore reef is impressive with 40% to 50% coral cover dominated by moderate to large colonies of *A. palmata*. White band disease has been observed but not common. *P. astreoides* is abundant in patches. This reef sustains considerable damage from boat groundings (Rogers and Garrison 2001). The lower fore reef is a narrow band around the platform with *M. annularis* being dominant and coral cover of 30% to 40% (Goenaga and Boulon 1992).

Windswept Beach is located on an exposed point protected by a large fringing reef (Goenaga and Boulon 1992). The reef is dominated by *A. palmata* in relatively good condition. Storm and vessel damage is evident. During the years from 1982 to 1985, an average of 3 boats per week grounded on this reef (Goenaga and Boulon 1992). After NPS installed buoys marking the reef, fewer than one boat per month were observed to hit this reef. Total coral cover here is 30% to 40% with many small colonies of *A. palmata* growing in the nearshore parts of the reef (Goenaga and Boulon 1992).

The bays east of Windswept Beach to Mary's Point (Peter, Little Cinnamon, Cinnamon, Maho, Little Maho, and Francis) have little in the way of reef development (Goenaga and Boulon 1992). Peter Bay has a small patch of healthy *A. palmata* reef at the western end, but other coral growth in these bays is on subtidal bedrock or carbonate pavement with low coral cover (less than 5%). Mary's Point to Leinster Bay is all subtidal bedrock with low coral cover except for one area of carbonate ridges off the central part of the north shore of Mary's Point that has higher coral cover (probably 20% to 30%). Whistling Cay off the west end of Mary's Point has a small pavement area off the south side with scattered corals. The rest of the cay is mostly subtidal bedrock with corals growing on it (Goenaga and Boulon 1992).

Mary's Point Creek has several small reef areas at its mouth that have small stands of *A. palmata* and scattered other corals (Goenaga and Boulon 1992). Leinster Bay and Waterlemon Cay have several areas of carbonate pavement with scattered corals. Waterlemon Cay has several large colonies of *A. palmata* and *P. porites* on its northwestern side with 10% to 20% coral cover. The coast east to Brown Bay is mostly subtidal bedrock with encrusting corals. Just east of Thread-needle Point and Brown Bay is a well-developed fringing reef dominated by *A. palmata* and *Millepora spp*. (Goenaga and Boulon 1992).

Mennebeck Bay has fringing reefs extending from both points and forming a semi-enclosed bay (Goenaga and Boulon 1992). Reef development is diverse and healthy. The reef crests are dominated by *Millepora spp.* and the upper fore reef by *A. palmata* with 25% to 30% coral cover. The lower fore reef is dominated by *M. annularis* and *P. porites* with 35% to 40% coral cover. Haulover Bay has well developed reefs on the western side and a series of deep (22 m plus) (72.2 ft. plus) patch reefs in the middle of the bay. These patch reefs have high scleractinian diversity and large numbers of antipatharians with *Antipathes atlantica*, an unidentified species, and *Stichopathes lutkeni* being present. The unidentified species forms large colonies of 3 to 4 m (9.8 to 13.1 ft.) in crown diameter. There is evidence of some collection of these corals (Goenaga and Boulon 1992).

From the eastern point of Haulover Bay around East End to Red Point are some of the best developed, healthiest reefs left in the Virgin Islands (Goenaga and Boulon 1992). This stretch of coast includes Newfound Bay, East End Bay, Privateer Bay, and several small unnamed bays. These bays all have well developed fringing reefs and extensive areas of lower fore reef sea-ward of them. The fringing reefs are dominated by *A. palmata, Millepora spp.*, and *Porites spp*. The lower fore reefs are dominated by *Montastraea spp., Diploria spp., Agaricia spp.,* and others. Some of these reefs were affected by the oil spill that originated off St. Marten in 1991, but are not known to have suffered any mortality. Recent subdivision work in Privateer Bay threatens to produce sediment runoff which could affect these relatively pristine coral reefs. Flanagan Island, southeast of Privateer Point, is fringed by subtidal bedrock with encrusting corals (Goenaga and Boulon 1992).

Round Bay has little in the way of coral reefs (Goenaga and Boulon 1992). The shoreline has varying amounts of sub-tidal bedrock with encrusting corals. In mid-bay there are a number of raised patches of carbonate pavement with scattered corals and other organisms. From Hurricane Hole to Lagoon Point coral growth is limited to growth on subtidal bedrock at the points (Goenaga and Boulon 1992). These bays are deeply indented with substantial amounts of red mangrove development. Lagoon Point was once a well developed fringing reef with an extensive backreef flat. There are still some stands of *A. palmata* but storm damage and a few boat wrecks have reduced much of this reef to rubble. The lower fore reef is still relatively healthy with fairly high coral cover composed of *Montastraea spp., Diploria spp., Agaricia spp.*, and others (Goenaga and Boulon 1992).

John’s Folly Bay has a fringing reef extending off both points (Goenaga and Boulon 1992). This reef has also suffered considerable storm damage and has few large stands of *A. palmata* left. There is a relatively expansive lower fore reef seaward of this bay with good coral cover. Le Duck Island east of John’s Folly is mostly subtidal bedrock and carbonate pavement, both of which have only scattered corals. Eagle Shoal lies south of Le Duck Island and comes to about 2 m (6.6 ft.) from the surface. This shoal contains many grottos and caves in the boulders that create this structure. Coral cover is good with head corals predominating. To the west of Eagle Shoal lies Drunk Bay. This bay is mostly cobble and large subtidal bedrock boulders. However, there is a fringing reef along the north side of the bay dominated by *A. palmata* and having 25% to 30% coral cover. The east side of Ram Head is predominately subtidal bedrock and carbonate pavement with some lower fore reef along the edge (Goenaga and Boulon 1992).

The west side of Ram Head is mostly cobble bottom inshore with a lower fore reef having spur and groove formations offshore (Goenaga and Boulon 1992). Saltpond Bay has low coral cover (less than 5%) in the bay with high *Millepora* cover (30% to 35%) on the rocks at the mouth of the bay. Booby Rock has an extensive, tiered lower fore reef northwest of it with high coral cover (30% to 40%). Many large colonies of *M. annularis* and *C. natans* are present (Goenaga and Boulon 1992).

Coral communities in Kiddle and Grootpan Bays are primarily on carbonate pavement with generally low coral cover (less than 5%) (Goenaga and Boulon 1992). The west side of Grootpan Bay has an area of higher cover (up to 20% to 25%) with several large colonies of *M. annularis*, *C. natans,* and *D. cylindrus*. Kiddle Bay has a patch of lower fore reef in the middle of the bay with 20% to 30% coral cover of which *M. annularis* predominates. Off the western point of Kiddle Bay is a bank patch reef with low relief and total coral cover of 20% to 50%. *M. cavernosa* is the dominant coral (Goenaga and Boulon 1992).

Little and Greater Lameshur Bays contain considerable amounts of subtidal bedrock with coral cover ranging from less than 5% inshore to 10% to 20% near the points (Goenaga and Boulon 1992). *Millepora spp*. dominate near the points. Shallow carbonate pavement areas in both bays contain low coral cover (less than 5%). Little Lameshur has a small area of lower fore reef on the western side with a coral cover of 15% to 20% dominated by *P. porites* and *M. annularis*. In Greater Lameshur, a large area of lower fore reef occurs on the eastern side near the sites of the Tektite I and II programs during 1969 to 1971 (Clifton et al. 1970; and Clifton and Phillips 1972). Coral cover is 15% to 20% and is primarily *M. annularis*. This increases to nearly 50% coral cover in deeper areas of this site (Nemeth et al. 2003b). On the west side of Yawzi Point, which separates the two bays, coral cover is from 20% to 25% in mid reef and 30% to 40% near the edge with *M. annularis* dominant. The east side of the point is a coral garden with coral cover of 35% to 40%. *M. annularis* predominates with large colonies often forming continuous complexes. Several large colonies of *C. natans* and *P. porites* are also present. Greater Lameshur Bay had extremely high abundances of *Diadema antillarum* prior to the 1983 die-off (Goenaga and Boulon 1992).

Europa Bay is mostly subtidal bedrock on the points with low coral cover (less than 5%) (Goenaga and Boulon 1992). Some small colonies of *A. palmata* are present, but this species is the main contributor to the storm rubble present throughout this bay. There is a narrow reef crest composed of eroded carbonate mounds with few corals on their tops. The sides are colonized by *Diploria spp.*, *Montastraea spp.*, *Colpophyllia spp.*, *Porites spp.*, and *F. fragum*. A patch of lower fore reef is off the western shore and is dominated by *M. annularis* (Goenaga and Boulon 1992).

Reef Bay is the largest bay on the south side of St. John (Goenaga and Boulon 1992). Both sides of the bay have exposed reefs which form an incomplete barrier for the shore and back reef zones. All reef zones in this bay are in relatively good condition except for reef crest and upper fore reef zones which were severely damaged during Hurricanes David (1979), Frederick (1979), and Hugo (1989) (Beets 1993; Rogers 1980b; and Rogers et al. 1982, and 1991). The reef crests are ramparts of *A. palmata* fragments, the amount of which suggests a previously extensive *A. palmata* zone. The western side of the bay is currently experiencing sedimentation due to residential development using improper construction methods. The back reef on the eastern side of the bay is wide and contains large, healthy stands of *P. porites* which have grown to mean low water. The western back reef is very narrow but healthy with high coral cover (30% to 40%) of *P. porites* and *P. astreoides* (Goenaga and Boulon 1992). The fore reef zones in this bay are primarily carbonate pavement with mounds containing large colonies of *M. annularis, D. strigosa,* and *S. sidereal*. *A. palmata* rubble is abundant. There are several large offshore bank patch reefs in this area. Just south of White Cliffs is a large patch reef that rises to about 15 m

(49.2 ft.) from the surface from a sand plain at about 25 m (82.0 ft.). This reef has scattered corals on top with good coral cover near the edge. Large head corals predominate. South of the western end of Reef Bay lie several smaller bank patch reefs having low vertical relief but high coral cover (50% to 60%). *A. agaricites* is predominant with scattered large colonies of *M. annularis* and *C. natans*. Numerous other species are also present in small amounts (Goenaga and Boulon 1992).

Eastern Fish Bay is an extension of the western Reef Bay fringing reef system (Goenaga and Boulon 1992). The reef crest and upper fore reef exhibit similar types and amounts of storm damage as at Reef Bay. The upper fore reef is barren pavement with all *A. palmata* having been stripped off. A few large *M. annularis* colonies are still present. The lower fore reef is oriented as a series of spurs and grooves with high coral cover (40% to 60%). The western side of Fish Bay has an extensive lower fore reef with high coral cover (30% to 40%) dominated by *A. agaricites* (Goenaga and Boulon 1992).

Rendezvous Bay extends from Dittlif Point on the east to Bovocoap Point on the west. Most coral communities in this bay occur as scattered corals on carbonate pavement or on subtidal bedrock with low coral cover (Goenaga and Boulon 1992). The western side of Rendezvous Bay has a considerable amount of lower fore reef with moderate coral cover dominated by *M. annularis*. This zone extends around Bovocoap Point to Devers Bay. Extending south-west from Bovocoap Point is a series of raised carbonate ridges with extensive ledges around the edges. These ridges have low coral cover (less than 5%), most of which is composed of plate-like colonies of several species of head coral (Goenaga and Boulon 1992).

The shoreline from Devers Bay to Cruz Bay is mostly subtidal bedrock and nearshore carbonate pavement with low coral cover (Goenaga and Boulon 1992). Off Moravian Point are several patches of sub-tidal bedrock which are emergent at low tide. They contain scattered corals with *Millepora spp*. predominating. There is some lower fore reef associated with these patches. Stevens Cay to the west has extensive carbonate pavement surrounding it and a wide zone of lower fore reef further offshore. The lower fore reef has moderate coral cover with varying amounts of *M. annularis, A. cervicornis,* and *Agaricia spp*. (Goenaga and Boulon 1992).

Continued fishing, diving, and heavy boating activities, including anchoring and groundings, have resulted in continued degradation of NPS marine resources (Goenaga and Boulon 1992). Severe damage to reefs at St. John by Hurricane Hugo in 1989 was documented on the basis of long-term line transect, video transect, and photo-quadrat studies at sites off Yawzi Point, a rocky point that separates Little and Great Lameshur Bays (Rogers and Miller 2001; and Rogers et al. 1991). Rogers et al. (1991) found fragmented and overturned coral colonies and a significant decrease in total living coral cover from about 20% to 12%, with increased coverage by macroscopic algae and no measurable recovery by the live corals in the 12 months following the initial post-storm survey. The dominant reef-building coral there, *Montastraea annularis*, decreased by 35%. Edmunds and Witman (1991) observed similar levels of patchy destruction to coral colonies nearby. Tropical storm Klaus (1984) caused a significant reduction in mean percent live coral cover from 26% to 21% at Fish Bay, St. John (Rogers and Zullo 1987).

St. Thomas Coral Reefs

Limited information is available on the character and distribution of coral communities in the coastal waters of St. Thomas (Tetra Tech 1992). The percent live coral cover on reefs where quantitative observations have been made indicates that coral cover can be as high as 49% (Rogers et al. 1982, and 1983; and Tetra Tech 1985a). Most of the observations have focused on coral reef areas along the south coast of the island because of a need to assess this resource to determine possible impacts of continued human development in the area (IRF 1977b, and 1977c; and Rogers 1980a, and 1982).

The most extensive reef development in St. Thomas is along a submerged barrier reef that lies along the narrow shelf edge, beginning near Inner Brass Island and continuing west to the western end of St. Thomas (Tetra Tech 1991a). Scattered reef formations occur throughout the rest of the island and along cays and islets. Based on limited data (Rogers et al. 1983; Rogers 1980a, 1982; and Tetra Tech 1985a), live coral was lowest at Brewers Bay West (15% to 17%) and greatest at Brewers Bay Middle (33% to 45%). The greatest number of species (26) was noted at Red Point where the dominant coral species was *M. annularis. P. porites* was the dominant species at several reef areas surveyed (Tetra Tech 1991a). *Acropora spp.* was not the dominant species at any of the surveyed reef areas (Tetra Tech 1991a).

St. Thomas and St. John have extensive shelf habitats with the shelf being approximately 8 miles wide on the south and 20 miles wide on the north. Mean shelf-edge coral cover ranges from 37% to 49% (Herzlieb et al., in press). Observations from the Johnson Sea-Link have shown significant shelf edge reef development on the south side where the shelf edge is better defined (Goenaga and Boulon 1992). On the north, the shelf gradually slopes off into deep water. The shelf edge south of Saba Island was observed to occur at approximately 60 m depth (~ 200 ft.) and at one site it was comprised of 80% to 100% living coral cover (Goenaga and Boulon 1992). The predominant coral appeared to be *M. annularis*. From observations in January of 1990, a number of colonies exhibited varying degrees of coral bleaching (Goenaga and Boulon 1992).

Saba Island and Flat Cay are small uninhabited islands south southwest of the St. Thomas airport. Flat Cay has very good reef development off its windward (eastern) shore (Rogers 1982), and a submerged fringing reef on the western shore with approximately 16% live coral cover (Herzlieb et al., in press). Saba Island has a coral reef off its eastern shore, and a fringing reef on its western shore. From 1978 to 1981 a monitoring study (Rogers 1982) indicated a significant decrease in living coral cover at Flat Cay, probably due to filling activities at the airport runway extension and Hurricanes David and Frederic (August 30 to September 5, 1979). Extensive physical damage to *A. palmata* was observed about two weeks after these storms (Goenaga and Boulon 1992). Surveys in 2003 showed some recovery of *Acropora palmata, A. cervicornis, and A. prolifera* (Nemeth et al. 2004a). In 2004, waves generated by Hurricane Jeanne reduced much of this new growth to rubble (R. Nemeth personal comm., CMES/UVI).

Around Range Cay and along the eastern shore of Brewers Bay are found scattered corals on pavement. The western shore has a fringing coral reef and an extensive coral reef is found in the western and central portions of the bay (Goenaga and Boulon 1992). Seaward of the grass bed in eastern Brewers Bay are sparse coral communities on areas of raised pavement. Brewers Bay has been stressed by sand extraction, dredging, and some sewage effluent from the treatment plant located near the airport. The runway extension for the new airport partly closed the bay and has resulted in reduced flushing rates (Goenaga and Boulon 1992).

Perseverance Bay is to the west of Brewers Bay and is the largest bay on the south-western coast of St. Thomas. Fringing coral reefs exist along the western shore and extreme eastern shore near Black Point (Nichols and Towle 1977). The seaward reef faces are dominated by *A. palmata, Diploria, Montastraea, Porites, Meandrina,* and *Agaricia*. Signs of stress and attrition were evident in 1977 in the shallower reef platforms and shoreward portions of all the reefs. The lowered water quality observed by Nichols and Towle (1977) has improved with stabilization of bottom sediments in Brewers Bay and may presently be allowing for healthier communities. However, Perseverance still shows signs of degradation. Many of the reefs in the bay have large amounts of algae (mostly *Halimeda* spp.), which is typical of reef systems under stress (Jason Vasques, USVI DFW Fisheries Biologist III, personal communication). Currently, coral cover in Perseverance Bay ranges from 9.5% to 15.7% (Herzlieb et al., in press).

To the west of Perseverance Bay and around the west end of St. Thomas, including Kalkun Cay, West Cay, and Salt Cay, coral communities occur predominantly as scattered corals on submerged rocks or nearshore carbonate pavement (Goenaga and Boulon 1992). Most corals in these communities are small head corals like *Montastraea, Diploria, Siderastrea,* etc. Savanna Island has several fringing reefs along its shoreline and probably also has some deeper reef formations (Goenaga and Boulon 1992). There is approximately 25% live coral cover off Savanna Island (Herzlieb et al., in press). Salt Cay has a moderately well-developed spur and groove reef system (Jason Vasques, USVI DFW fisheries biologist, personal communication).

From Botany Bay to Stumpy Point on the northwest coast of St. Thomas, there is considerable development of both fringing and deeper bank reefs (Goenaga and Boulon 1992). Little to no work has been done here so descriptions of these reefs are limited to knowledge of the present conditions and what stresses may be impacting them. The primary natural controlling agent on reef structure in this area is the occurrence of large swells during the winter months. This level of energy limits coral growth to encrusting and head forms. Little human-induced stresses in this area allow for relatively healthy reef communities (Goenaga and Boulon 1992).

Most of the bays along the north coast of St. Thomas contain varying amounts of fringing reefs and hard bottom communities with scattered corals (Goenaga and Boulon 1992). The rocky coastlines between the bays support scattered corals growing on the submerged rocks. Varying degrees of exposure to wave energy from the north determine the coral types and growth forms present at different sites along this coast. Many of the inshore reefs along this coast are suffering from sediment runoff and/or nutrient loading from septic runoff during large rainfall events (Goenaga and Boulon 1992). The wide insular shelf along this coast can be characterized as being mostly composed of algal and sand plains with occasional raised carbonate ridges containing coral/gorgonian communities (Goenaga and Boulon 1992).

Inner Brass Island has been relatively well studied as a result of potential development on the island (Williams et al. 1990). Much of the island is surrounded by either hard bottom with sparse, mixed coral zones comprised of *A. palmata, Diploria, P. astreoides,* and *Millepora*. The northwest part of the island has several areas of good coral development where the slope is steep and deep water forms of *Montastraea*, *Diploria*, and others are abundant. The east side of the island receives considerable wave energy. Tyre Bay contains an extensive shallow-water *Montastraea* community inshore and dead *A. palmata* that most likely was killed by white band disease. Outer Brass Island is surrounded by deep water and coral growth is limited to subtidal rock surfaces and some hard bottom.

To the east, Hans Lollik Island has received considerable attention due to a very large proposed hotel/residential resort development (Tamarind Resort Assoc. 1991). Reefs surrounding this island include deep water, fringing, and patch reefs. An extensive fringing reef system borders almost the entire eastern shoreline, while the inner portion of Tamarind Bay contains small patch reefs. Along the eastern shore of the island, the fringing reef has created a channelized deep reef and reef wall, with a narrow lagoon inshore that is full of patch reefs and *A. palmata* flats. The northwest side of the island is mostly corals growing on subtidal bedrock and mixed coral/gorgonian flats. Deep bank reefs occur along the outer edge of the gorgonian flats on the southwest portion of the island. They also occur extensively on the fringe of the eastern gorgonian flats and extend to the north tip of Little Hans Lollikand Pelican Cay. Around the island, subtidal bedrock communities are dominated by *Diploria spp., Favia fragum,* and *Millepora spp.* The patch reefs are comprised of *M. annularis, M. cavernosa, P. porites, Agaricia spp., Diploria spp., Isophyllia sinuosa, Favia fragum, S. radians,* and *D. stokesi*. The deep bank reefs here are mostly composed of gorgonians with few hard corals (*Diploria spp., Montastraea spp., Favia fragum,* and *A. cervicornis*). Little Hans Lollik and Pelican Cay are surrounded primarily by coral encrusted subtidal bedrock and gorgonian flats.

Magens Bay on the north coast is a deeply indented bay. Extensive buttressed fringing reefs on the south side of the bay are mostly dead (Goenaga and Boulon 1992). This is most likely due to sediment runoff and septic loading of the soil which leaches into the water during large rainfall events (Goenaga and Boulon 1992). Residential development on the north shore of St. Thomas has skyrocketed during the past 20 years. The north side of the bay experiences heavy sediment loading from recent residential development, and when there are strong waves from northern swells. The north side of Magens Bay has scattered reef development on carbonate benches along the shore. Some of these reef areas are very healthy with the predominant corals being *M. annularis, Diploria spp., Porites spp.*, and some *A. cervicornis*. These areas do not appear to have been affected much by the water conditions on the other side of the bay (Goenaga and Boulon 1992).

Mandahl Bay, to the east of Magens Bay, has suffered some of the consequences of dredging and groin construction in the late 1960s (Goenaga and Boulon 1992). Present day reefs include a hard bottom area off the mouth of the channel created by the groins. This area has scattered *A. palmata, A. cervicornis, Montastraea spp.,* and others (Mandahl Bay Villas 1990). The western part of the bay contains scattered small corals on rocky ledges.

Most of the shoreline east of Mandahl Bay to Sapphire Bay is composed of rocky coastline with a few beaches (Goenaga and Boulon 1992). Coral communities along this stretch are limited to growth on subtidal bedrock or scattered corals on carbonate pavement (Goenaga and Boulon

1992), with a fringing reef around Coki Point. Several *Porites* patch reefs in southern Water Bay were destroyed by dredging activities in the 1960s and 1970s (Goenaga and Boulon 1992).

A line of islands stretch to the northeast and include Thatch, Grass, Mingo, Lovango, and Congo Cays, and Carvel Rock. The north sides of these islands are bordered by deep water and only support scattered coral colonies on the subtidal bedrock (Goenaga and Boulon 1992). The south sides have several deeper fringing reef areas and scattered corals on carbonate pavement. A submerged rock formation to the east of Lovango Cay has a relatively healthy veneer of corals growing on it. Strong currents here provide clean, food-rich water for these benthic organisms (Goenaga and Boulon 1992).

Sapphire Bay (Red Bay) once had a very healthy reef around Prettyklip Point but was destroyed by dredging and removal of beachrock which has resulted in increased water turbidity (Goenaga and Boulon 1992). Broken shafts of *A. palmata* up to eight feet long are now cemented into the existing reef (Sapphire Beach Hotel and Marina 1984). Small *Acropora spp.* and *Diploria spp.* occur offshore on submerged bedrock outcrops.

Vessup Bay on the east end of St. Thomas has fringing reefs along the north side of the bay (Goenaga and Boulon 1992). These reefs are composed of *M. annularis, D. labyrinthiformis, Porites spp., A. agaricites, S. sidereal,* and *A. cervicornis*. Many dead *Montastraea* and *Diploria* skeletons are found here with live coral cover being less than 10% (V.I. Port Authority 1988). The long history of dredging and heavy vessel traffic in this bay has taken a serious toll on these reefs (Goenaga and Boulon 1992). The south side of Vessup Bay has coral growth on subtidal bedrock around Cabrita Point.

Great Bay on the south side of Cabrita Point has scattered fringing reefs which are relatively healthy, but increasing development in this bay will almost certainly have an effect on them (Goenaga and Boulon 1992). The south side of the bay near Current Cut has extensive reef growth on pavement. Large colonies of *M. annularis* and *Diploria spp.* predominate. The channel between St. Thomas and Great St. James Island is composed of dense coral/gorgonian communities due to strong tidal currents flowing between the islands.

Most of the coral communities around the St. James islands and Dog Island are scattered corals on subtidal bedrock with some hardbottom areas (Goenaga and Boulon 1992). Whelk Rocks to the east of the channel between the St. James islands and Cow and Calf Rocks south of Deck Point, St. Thomas are boulder piles with encrusting corals (Goenaga and Boulon 1992).

Except for the barrier reef areas between Cas Cay and Patricia Cay, and Patricia Cay and Long Point, most of the south shore of St. Thomas is scattered coral communities on carbonate pavement (Goenaga and Boulon 1992). Most of these occur adjacent to shore but some occur as raised patches off Benner Bay and south and east of Dog Island. Seahorse Cottage Shoal, southeast of St. Thomas, has a significantly higher percent cover of living coral (~50%) and lower percent cover of dead coral covered with turf algae than does Flat Cay (~16% live coral cover), southwest of St. Thomas (Nemeth et al. 2004a; and Herzlieb et al., in press). It is difficult to attribute these differences to a specific cause. Both are mid-shelf reefs. Coral cover tends to increase from shore to mid-shelf to shelf-edge reefs (and from shallower to deeper water). The reef at Flat Cay is associated with a small island, while Seahorse Cottage Shoal is not, and Seahorse Cottage Shoal is at a greater depth than Flat Cay. Also, Flat Cay is frequently visited by recreational divers, while Seahorse Cottage Shoal is not. Given the position of Flat Cay southwest of heavily developed and industrial areas of St. Thomas (Charlotte Amalie, Krum Bay, Lindbergh Bay, and the Cyril E. King Airport), direction of current flow (south southwest), and differences in percent coral and algal cover between Flat Cay and Seahorse Cottage Shoal, Flat Cay may be considerably impacted by terrigenous stresses despite the reef's mid-shelf location (Nemeth et al. 2004a).

Coral encrusted boulder reefs occur at Triangle reefs east of Charlotte Amalie Harbor (Goenaga and Boulon 1992). Several small fringing reefs occur at Bolongo Bay and around Green Cay (Goenaga and Boulon 1992). The barrier reefs which form the southern arm of the Benner Bay Mangrove Lagoon have suffered storm damage but still have relatively high live coral cover. The reef crests are emergent at low tides and extensive backreef habitat is present. The upper fore reefs are composed primarily of *A. palmata*. The channel between Patricia Cay and Long Point has the remains of once healthy *Porites* reef flats. This channel to Inner Mangrove Lagoon was closed/obstructed after Hurricane Lenny in 1999. It was re-opened in 2003 by DFW, which will improve water circulation/exchange in the Inner Mangrove Lagoon (Ruth Gomez, USVI DFW fisheries coordinator, personal communication). Dredging for sand extraction in the 1960s may have killed this reef (Goenaga and Boulon 1992).

Buck Island (off St. Thomas, not St. Croix) is mostly surrounded by coral encrusted subtidal bedrock (Goenaga and Boulon 1992). The north side of the island has some relatively well-developed reefs, especially on the northeast end. This area is used by the Atlantis Submarine for its underwater tours. It is not known what effect, if any, this may be having on the reefs here.

Charlotte Amalie Harbor has nothing in the way of reef development (Goenaga and Boulon 1992). If it ever did, it would have been seriously impacted due to dredging, sewage disposal, cruise ships, etc. There are some deeper coral communities along the south and west shores of Hassel Island, which appear to be just out of the turbid water conditions inside the harbor (Goenaga and Boulon 1992).

Water Island has little in the way of coral reefs around it (Goenaga and Boulon 1992). Most of the coastline is rocky with scattered hard coral attached to the subtidal portions of the rocks. However, the southwest side has some reef, though it has been affected by turbid water from Crown Bay (Barbara Kojis, Director USVI DFW, personal communication). Along the southeastern shoreline, from approximately 5 m to 20 m (16.4 ft to 65.6 ft) in depth, there is a deep, buttressed reef formation with high living coral cover. The dominant coral on the buttresses is *M. annularis*. Sprat Bay on Water Island has relicts of a fringing reef on the northern side of the bay (mostly dead now) and live *A. palmata* on the southern side of the bay (Jason Vasques, USVI DFW Fisheries Biologist III, personal communication). Also, Sprat Bay and Honeymoon Bay are good *Thalassia* beds with juvenile Nassau grouper.

St. Thomas coral reefs were also impacted by tropical storms. Hurricane Hugo (1989) damaged portions of coral reefs and seagrass beds off St. Thomas, but quantitative observations are lacking (Aubrey et al. 1991; and Gladfelter et al. 1991).

(3) Priority Issues Concerning USVI Coral Reefs

Reefs face a wide range of natural and human threats (Endean 1976; Kuhlmann 1988; and Rogers 1985). Reef habitat can be damaged or destroyed by natural events: storms, hurricanes, exposure from extreme low tides, salinity changes, and unusually warm or cold water. During the 1982-1983 El Niño event, for example, unusually high surface water temperatures killed as much as 51% to 95% of the corals at some eastern Pacific reefs (Glynn et al. 1988). Natural diseases and red tides can kill corals (Bunkley-Williams and Williams 1990). Excessive or prolonged turbidity, whether from natural or anthropogenic sources, can be a major problem for reefs (Bohnsack 1992).

The effects of human activities on reefs broadly depend on two factors: the distance of the reefs from shore (inshore or offshore), and the general health of the reefs (Goenaga and Boulon 1992). In the U.S. Virgin Islands, anthropogenic damage is being done to reefs at both inshore and offshore areas: on the shelf edge, Long Reef, Teague Bay reef, St. Croix; Brewers Bay, north coast, Mandahl Bay, Magens Bay, Sapphire Bay, St. Thomas; bays in the national park, Cruz Bay, Trunk Bay, Johnson's Reef, and Windswept Beach, St. John.

Damage to reefs around the islands, and, by extension, organisms closely associated with reef habitats, is being caused by one or several of the following factors (Goenaga and Boulon, 1992): sedimentation and siltation; eutrophication; pollution (toxic and thermal); physical damage, and overfishing. According to the National Coral Reef Action Strategy (NOAA 2002), the main threats to coral reefs in the USVI are diseases, tropical storms, coastal development and runoff, coastal pollution, fishing, and damage caused by ships, boats, and groundings.

Natural Stressors

Damage to coral reefs in the U.S. Virgin Islands due to natural phenomena has been well documented. A large portion of the Caribbean lies within the hurricane belt and therefore reefs are frequently exposed to severe hurricane related impacts. Hurricanes can modify substantial portions of shallow reefs. Two tropical storms in 1979 (David and Frederic) caused extensive damage on the outer east coast and southern coastal reefs, especially in the shallow *Acropora palmata* zone, off St. Croix (Rogers et al. 1982). Hurricane Hugo caused a significant reduction in total living scleractinian cover on reefs on the south side of St. John (Rogers 1992). It devastated portions of coral reefs and seagrass beds off St. Croix (Gladfelter et al. 1991) prior to the onset of white band disease which killed up to 95% of the branching acroporid species, the dominant shallow-water corals. On the other hand, hurricanes may have been beneficial by displacing large numbers of fast growing, branching, coral species that monopolize the substrate thereby freeing space for slower growing, massive species. This appears to result in an increase in species diversity (Connell 1978), in the absence of additional stresses.

Bioerosion also constitutes a significant problem for Caribbean reefs. The proportion of reefs containing boring bivalves per coral head is higher in Caribbean reefs than in coral reefs in the Indian Ocean or in the western Pacific region (Highsmith 1980). Besides being a problem in itself, bioerosion may be an indicator of poor coral reef or ecosystem health. In other words, many boring worms occur in areas of higher pollution and on corals that are damaged or in poor condition (Jason Vasques, USVI DFW Fisheries Biologist III, personal communication). Bioerosion of living coral versus dead skeleton under living tissue does not necessarily reduce reef growth, however, unless it weakens live coral colonies which can be dislodged during storm events. Although hard corals, coralline algae, and other marine invertebrates secrete calcium carbonate reef material, natural and man-made forces continue to erode these substrates. Reports on the status of the Florida Reef Tract, for example, indicate that accretion and erosion processes may, at best, be in equilibrium (Norris and Wheaton 1991). Therefore, additional pressure on coral and reefs through fishing practices and other anthropogenic activities could result in net loss of these resources over time.

Coral diseases are also known to attack reef corals in the U.S. Virgin Islands (Bythell et al. 1993; Jolles et al. 2002; and Miller et al. 2003b). White band disease, for example, has caused population declines in *A. palmata and A. cervicornis*. This disease affected over 5 ha. (~12.4 acres) of the *A. palmata* reef at Buck Island Reef National Monument, St. Croix (Davis et al. 1986; Gladfelter, 1982; and Goenaga and Boulon 1992). The black band disease, caused by cyanobacteria, has been observed to affect corals in the Virgin Islands National Park on St. John and Buck Island, St. Croix (Edmunds 1991; Peters, 1984; and Rogers and Teytaud 1988). A study of coral diseases for St. Thomas, St. John, and St. Croix can be found in Nemeth et al. (2002, and 2004a).

The massive die-offs of the black sea urchin, *Diadema antillarum* (Lessios et al. 1984), a major herbivore of coral reef systems, throughout the Caribbean have also contributed to the modification of corals and the coral reef habitat (Carpenter 1990a, 1990b; Edmunds and Carpenter 2001; Lessios 1988; Levitan 1988; Miller et al. 2003a; Sammarco et al. 1974; and Vicente and Goenaga 1984). Individuals of this herbivorous species clear the substrate of fast-growing, fleshy and filamentous algae, allowing coral larvae to settle and grow. Algal biomass within coral reefs has increased following the urchin die-offs. If other herbivores do not increase concomitantly, the growth in algal biomass is likely to increase the availability of algal propagules, thereby potentially reducing substrate for coral settlement (Carpenter 1986; Hay 1984; Hughs et al. 1987; and Ogden and Zieman 1977). This situation is possibly worsened in eutrophic areas (excess nutrient enrichment, i.e., sewage, agricultural runoff, etc.) where algal growth is further stimulated (Goenaga and Boulon 1992).

Another recent source of stress to Caribbean reefs is massive coral bleaching (i.e., expulsion of zooanthellae or their *in situ* degeneration) whereby coral growth rates are slowed down, and the capacity to heal from wounds is possibly impaired. Events of this nature occurred Caribbean-wide in 1987 and 1990 (Goenaga and Canals 1990; and Williams et al. 1987). National Park staff on St. John observed bleaching in several hard coral species and in *Palythoa* in October of 1987. *Diploria labyrinthiformis* and *D. strigosa* were the most affected species and *Agaricia lamarcki* colonies as deep as 27 m (~88.5 ft.) were observed to have been bleached (Rogers and Teytaud 1988; see also Bythell et al. 1992; Edmunds 1994; Porter et al. 1989; Quinn and Kojis 1999; Rogers and Miller 2001; and Williams et al. 1987). During the El Niño year of 1998, some corals showed signs of bleaching, with the worst affected colonies showing signs of recovery within 6 months (Nemeth and Sladek-Nowlis 2001). Studies elsewhere in the Caribbean suggest that bleachings have been more severe in polluted areas.

Anthropogenic Stressors

Human activities can directly or indirectly damage reefs. Direct physical damage may occur by diver contact, anchor damage (Davis 1977), vessel groundings (Gittings et al. 1988; Rogers 1985; and Rogers et al. 1988a), and fishing methods that use explosives, chemicals, and trawls. Even lost fishing gear can damage reefs. Indirect effects may be more subtle but no less damaging. Events like oil spills and other types of pollution too numerous to treat in detail here may weaken or kill reef organisms (Glynn et al. 1989; and Kuhlmann 1988). Coastal development that destroys or degrades critical coastal habitats such as estuaries, mangroves, and seagrass beds is a major problem (Chambers 1991). In many areas, human activities change the nature of terrestrial runoff which can damage reefs. For example, excessive nutrients from sewage or agriculture may allow algal growth to overwhelm corals. Runoff damage can also occur from pestcides, herbicides, turbidity, and low salinity. Hudson (1981) noted that declines in coral growth were correlated with increased dredge and fill operations in the Florida Keys.

Synergistic interactions between factors can increase the damage. For example, coral populations that survived hurricane damage in Jamaica later collapsed from coral predation (Knowlton et al. 1990). Also, natural diseases may be much more damaging and widespread if corals are stressed by pollution. Human activities combined with unusually warm water temperatures may have contributed to the Caribbean-wide die-off (in 1983) of the sea urchin, *Diadema antillarum* (Lessios et al. 1984), and to the greater levels of coral bleaching due to chronic stressors such as sedimentation (Nemeth and Sladek-Nowlis 2001).

Potentially, the greatest benefits for reef protection are likely to come from managing human activities that cause damage; little can be done to prevent natural damage. Protecting habitat from direct damage is necessary but may not be sufficient if resident reef populations are depleted by fishing activities (Bohnsack 1992). An essential part of any habitat is the presence and interactions of resident fishes. Fisheries exploitation can reduce species abundance, alter species composition, and change biological interactions. Absence or reduced numbers of certain life stages or species, especially predators, could potentially disturb natural balances (Bohnsack 1992).

Fishing activities are probably the least acknowledged and the most often overlooked human threat to reefs. The importance of fishing activities is probably underestimated, both because fishing is considered an acceptable use of reef resources, and because the effects of exploitation are often indirect and poorly understood (Bohnsack 1992).

Numerous protected areas have been established world-wide to protect reefs and reef-associated habitats. Although most protected marine areas prohibit certain types of fishing, especially extremely damaging methods, most still allow some fishing (Bohnsack 1992). The underlying assumption is that fishing alone will do no harm. The critical management problems are to maintain adequate community balance and to protect a sufficient number of adults as sources of larvae for recruitment (Bohnsack 1992).

According to Rogers and Beets (2001), the large number of marine protected areas (MPAs) in the Caribbean (over 100) gives a misleading impression of the amount of protection the reefs and other marine resources in this region are receiving (Rogers and Beets 2001). Information on marine resources in two of the first MPAs established in the USA, the Virgin Islands National Park (1962) and Buck Island Reef National Monument (1961), provides compelling evidence that greater protection is needed (Rogers and Beets 2001). Most of the stresses affecting marine resources throughout the Caribbean (e.g., damage from boats, hurricanes, and coral diseases) are also causing deterioration in these MPAs. Living coral cover has decreased and macroalgal cover has increased. Seagrass densities have decreased because of storms and anchor damage. Intensive fishing in the USVI has caused loss of spawning aggregations and decreases in mean fish size and abundance. Groupers and snappers are far less abundant and herbivorous fishes comprise a greater proportion of samples than in the early 1960s. Effects of intensive fishing are evident even within MPA boundaries. These MPAs have not been effective because an unprecedented combination of natural and human factors is assaulting the resources, some of the greatest damage is from outside the control of park managers (e.g. hurricanes), and enforcement of the few regulations has been limited. Fully functioning MPAs which prohibit fishing and other extractive uses (e.g. no-take marine reserves) could reverse some of the degradation, allowing replenishment of the fishery resources and recovery of benthic habitats (Rogers and Beets 2001).

Goenaga (1991) identified several anthropogenic sources of stress to Caribbean coral reefs. The following text briefly discusses the primary sources of environmental stress that may impact coral reefs in coastal waters of the U.S. Virgin Islands.

1) <u>Oil pollution and dispersants</u> **-** The impacts of oil pollution on coral reefs have been reviewed by Loya and Rinkevich (1987). These authors reported that although earlier studies had suggested that oil pollution had negligible effects on coral reefs, more recent research has indicated that acute (Jackson et al. 1989) and chronic (Bak 1987; and Loya 1976b) exposure to oil pollution can be detrimental to coral reefs. Oil spills are a concern on St. Croix, where one of the largest oil refineries (Hovensa) in the Western Hemisphere is located, and in busy harbors such as Charlotte Amalie on St. Thomas.

2) <u>Siltation, groundwater contamination, and surface runoff</u> **-** The principal concerns in the U.S. Virgin Islands are siltation and sedimentation following removal of upland vegetation, and eutrophication, particularly in, although not necessarily restricted to, areas adjacent to inshore reefs (Goenaga and Boulon 1992). The turbidity associated with increased sediment load shades corals which require light for their algal symbionts (zooxanthellae), thus reducing productivity and growth. The metabolic cost to the coral of clearing away sediment is also a factor influencing growth, because of sediment resuspension (Rogers 1990). Sediment loading may also influence the incidence of coral diseases (Peters 1984) and coral bleaching rates (Nemeth and Sladek-Nowlis 2001). Sedimentation also reduces

substrate availability for the settlement of coral and other larvae. Turbidity has clearly been shown to influence fish abundance and diversity; in the Pacific, both were significantly reduced in areas with fine sediments, where these were allowed to accumulate (Amesbury 1981; see also Hubbard et al. 1987; and Loya 1976a).

Chronic sedimentation may reduce the abundance and diversity of corals and other reef organisms, increase coral stress and susceptibility to diseases, bleaching and predation, and reduce the ability of corals and other reef organisms to recover and regenerate after natural disturbances such as hurricanes (Acevedo and Morelock 1988; Rogers 1990; Rice and Hunter 1992; and Nemeth and Sladek-Nowlis 2001).

Land-use practices such as upland clearing of vegetation and urban development may also increase the runoff of nutrients (fertilizers) and other contaminants (e.g., pesticides and metals) and contaminate groundwater that is discharged to coastal zones. Nutrients enhance the growth of algae that compete with corals for space on the reef and influence coral larval recruitment (Birkeland 1977). Tomascik and Sander (1987) suggested that groundwater contamination in Barbados could be partly responsible for the impacts of eutrophication on coral reef areas observed along the shore (see Lewis 1985). Exposure of corals and associated biota to pesticides and other contaminants may result in toxic or sublethal impacts depending on the concentrations and duration of exposure.

In the U.S. Virgin Islands siltation from heavy housing development on the north coast of St. Thomas is a matter of concern in the area, although little data is available on point and non-point source sediment loading in the USVI. Mitigation of the negative impacts of increased sedimentation is possible and is an important part of soil conservation practice (Tetra Tech 1992).

3) <u>Wastewater discharge</u> **-** The impact of wastewater discharges on coral has been reviewed by Pastorok and Bilyard (1985) and Marszalek (1987). Impacts include effects due to turbidity, sedimentation, enhancement of algal growth, increased risk of coral disease, and toxic effects. Marszalek (1987) concluded that the toxic effects of municipal wastewater were overshadowed by the indirect effects of nutrient loading. However, effluent from Caribbean industries (e.g., rum manufacture, petroleum, and pharmaceutical industries) is discharged to coastal waters and may have toxic effects on coral reef biota.

Eutrophication (nutrient enrichment) by sewage disposal or land drainage can stimulate algal blooms which will outcompete or displace slower-growing organisms, such as corals. This can result in the proliferation of organisms that compete with, or damage, corals (e.g., burrowing bivalves and boring algae and sponges). Sewage pollution is known to stress reefs in the Virgin Islands (Rogers 1985; and Goenaga and Boulon 1992).

4) Dredging - The impact of dredging on coral reefs has been reviewed by Salvat (1987). Adverse impacts can result from increased sedimentation and pollutants contained in dredged material. Dredging activities to remove sand or bedrock not only result in siltation and increased turbidity, but also cause mechanical damage to reefs or complete substrate removal. Moreover, waters over dredged areas have significantly more bacteria than neighboring seawater (Galzin 1981). In Benner Bay, St. Thomas, toxic materials were resuspended into the water column during dredging where toxic metals from anti-fouling paints had leached into the water and adsorbed onto bottom sediments; metals may be detrimental to corals by impairing their physiological processes and possibly by weakening the structure of the aragonite skeleton (Howard and Brown 1984). CZM requires monitoring of dredging activities in waters of the Virgin Islands (see Cox et al. 2000; Grigg and VanEepoel 1970; IRF 1993b; Rogers 1990; and Tetra Tech 1991a).

5) Toxic and thermal pollution - Toxic and thermal pollution derive from agricultural, industrial, and residential origin and include toxins, biological pathogens, sediments, and thermal inputs (Tetra Tech 1992). The discharge of heated effluent from power plants can result in temperature stress to corals in the vicinity of the discharge and possible toxic effects due to the use of biocides to control bio-fouling (Goenaga 1991). Pollution by fecal bacteria and viral agents from inadequate sewage disposal practices can impact the reef environment and pose serious health hazards in coastal waters. A serious source of impairment of waterbodies in the U.S. Virgin Islands is NPDES-permitted (National Pollutant Discharge Elimination System) effluents. The majority of these effluents are from Secondary Treatment Plants (STPs) (Tetra Tech 1992). In the Tutu watershed on St. Thomas, the secondary sewage treatment plant was replaced with a tertiary treatment plant which discharges offshore. Also on St. Thomas, the Cyril E. King Airport primary sewage treatment plant is being upgraded to a secondary treatment facility. On St. John, the old sewage treatment plant with a larger secondary plant that discharges offshore. Coastal pollution seriously impacts nearshore reef areas and the communities and habitats associated with them.

6) Recreational activities - The impact of recreational activities on coral reefs has been reviewed by Tilmant (1987). Impacts include boat groundings, anchor damage, pollution associated with on-board waste disposal, accidental discharge of petroleum products, and damage to the reef caused by careless snorkelers and scuba divers (Dixon et al. 2001; Garabou et al. 1998; Hawkins et al. 1999; Plathong et al. 2000; Rouphael and Inglis 1995, and 1997; Rogers et al. 1988a; and Talge 1990, and 1992). Anchor damage, primarily due to recreational boating activity, has been cited as a significant source of damage to coral reefs in some areas of the Caribbean (Goenaga 1991).

Anchoring on top of corals can seriously disrupt coral reef communities and is a serious concern as boating and tourism increase in reef areas (Allen 1992).

Between January and March 1987, Rogers et al. (1988a) studied anchor damage in several northern and northwestern bays on St. John. Of the 186 boats surveyed, 32% were anchored in seagrass and 14% in coral. With an estimated 30,000 anchors being dropped in Park waters each year, this can result in considerable physical disruption of these areas (see Garrison 1993; and Link 1997).

Anchor chains can do more damage than anchors as they drag across the bottom. In 1989, a 440 ft. sailing cruise ship, the "Wind Spirit" dropped its anchor on a reef off northern St. John and destroyed some 300 m^2 (~3,200 $ft.^2$) of coral reef (Rogers and Garrison 2001). Extensive tourism activities, including boating and diving, are resulting in considerable damage from anchors and boat groundings. At Windswept Reef on the north shore of St. John, an average of five boats per week were striking the reef prior to installation of marker buoys, which considerably reduced the frequency of groundings (Goenaga and Boulon 1992).

7) Ship grounding-propeller scour **-** Groundings of large commercial vessels occur on occasion, causing significant physical damage to coral reefs. A ship grounding off Bermuda in 1978 directly damaged about 44.0 ha (108.7 acres) of reef area (Smith 1985). Groundings may also be associated with accidental releases of pollutants such as diesel fuel and oil. Commercial shipping activity in shallow urban and industrial port centers also resuspends sediment due to propeller scour. The reduced light availability and increased sediment loading may contribute to the coral reef degradation observed in these areas (Tetra Tech 1991b). In addition, abandoned vessels and hurricane-damaged vessels that are now derelict and half sunken around the island can also impact reefs, seagrass beds, and mangroves.

8) Destructive fishing methods **-** The use of various harvest methods in reef areas can cause direct physical damage to reef structure and can reduce the percentage cover of live coral (Russ 1991). For example, careless use of barrier nets to capture fish, the use of crowbars or other tools to remove substrate and live-rock, manual displacement of coral heads to collect organisms underneath, and the use of chemicals, all threaten to damage the reef and reef-associated organisms (Sadovy 1991). Harvest of live-rock directly removes substrate and invertebrate communities with the additional problem of inadvertent inclusion of young coral colonies. Reduction of coral and reef heterogeneity due to damage or removal of physical structure can seriously impact available shelter for juvenile fishes and larval settlement, and a number of studies have shown a correlation between topographic relief and fish abundance (Carpenter et al. 1981).

9) Overfishing **-** The effects of overfishing on reef community structure, and thereby on the condition of the reefs themselves, are little understood. However, a habitat must include a reasonable balance of resident organisms in order to function. Reef fishes are especially vulnerable to overfishing because they are generally long-lived, slow growing, recruitment limited, and spatially restricted (Bohnsack 1992; also see Bohnsack 1987; Garrison et al. 1998; and Roberts 1995).

Community imbalances in reef-associated organisms may result from large-scale reduction in cover or structural heterogeneity of live coral or other substrate, or from overfishing of certain components of the commercial fishery. For example, Carpenter et al. (1981) showed that biomass of fishes increased with greater structural diversity of the substrate. Work by Hughes et al. (1987) in Jamaica indicated that increasing fishing pressure on coral reef herbivores, such as parrotfish, may account for observed increases in algal biomass which, in turn, reduces living invertebrate cover. Reef herbivores may reduce the abundance of certain competitively superior algae, thus allowing corals and cementing coralline algae to survive (Birkeland 1977; and Ogden and Lobel 1978).

Hay (1984) suggested that overfishing and hunting of herbivores in the Caribbean (fishes, green sea turtles, and manatees) may have caused disruptions in the abundance and the impact of unharvested herbivores (the sea urchin *Diadema antillarum*). Ogden et al. (1973) suggested that the high densities of *D. antillarum* in St. Croix could have been due to overfishing of the reefs. Carpenter (1990a, 1990b) demonstrated that *D. antillarum* was a key species of control of benthic algal biomass, productivity, and species composition, and Sammarco (1980) discussed the importance of grazing by *D. antillarum* to juvenile corals.

The importance of *D. antillarum* to reef communities can be inferred by changes in reef structure that occurred following a sudden Caribbean-wide mortality of a large portion of these urchins. This resulted in increased abundances and biomass of benthic algae (Carpenter 1988). Because benthic algae compete with corals for available substrata, increased abundance of benthic algae could impact the whole reef community structure.

According to the management guide for coral reef protected areas (U.S. Coral Reef Task Force 2000), coral reef MPA managers should assess and, as needed and feasible, address the following:

1) <u>Harvesting activities</u> - decline of populations and loss of higher level carnivores within the ecosystem from overharvest, physical damage from fishing gear and techniques.

2) <u>Recreational use</u> **-** anchor and diver damage to corals, disturbance of reef organisms, pollution of the reef environment.

3) <u>Water pollution</u> **-** various impacts ranging from loss of light to nutrient changes, direct toxicity to marine organisms, and disease introductions.

4) <u>Coastal development</u> **-** increased sedimentation, altered upland runoff and nutrient input to the reef system, loss of juvenile nursery habitat.

(4) USVI Coral Reef Monitoring

Long-term monitoring programs have been established on several reefs around the USVI by the USVI Division of Fish and Wildlife and scientists from the National Park Service (NPS), University of the Virgin Islands, and other agencies. These include: habitat survey project, coral reef monitoring project, and Reef Check. These programs will allow scientists to differentiate between changes on the reefs which are occurring because of human activities and those which are from natural processes.

Various habitat surveys have been and are being done in the USVI (DFW 1994b; Kojis et al. 2000; Volson 2001). The objectives of habitat survey projects are to identify and determine the status of habitats, including coral reefs, seagrass beds, and algal plains, which support recreationally important fishes in the U.S. Virgin Islands. The habitats supporting recreational fish species in the USVI are generally fragile (Appeldoorn et al. 1997). As such, there is a need to assess the current state of these resources, monitor any changes, and establish long-term management strategies to ensure their sustainability. This is particularly true of the deeper water shelf habitats of the Virgin Islands, which have not been studied as much as the shallower reefs. NOAA has produced maps of nearshore habitats (see Appendix 2) based on aerial photography, however use of aerial photography to map and define benthic habitat is depth limited (~ 20 m, or 66 ft., in clear tropical waters; less in turbid bays and nearshore areas) (Kendall et al. 2001). Characterizing the deeper water shelf habitats can be done with technologies such as side scan sonar (Geophysics International 2003; and Hatchette 2001).

A variety of coral reef monitoring projects have been recently completed or are ongoing (see Nemeth et al. 2002, 2004a; Toller 2002, 2004; and Herzlieb et al., in press). In 2001, the USVI Territorial government initiated a long-term monitoring program of coral reefs with financial support from the National Oceanic and Atmospheric Administration (NOAA). This program will help establish a baseline condition of coral reefs and fish populations for determining the effectiveness of various management initiatives on the sustainability of these important resources. As an example of this, fish communities were surveyed on St. Croix in 2004 using two census methods (Toller 2004). The first was the belt transect method of Brock (1954) as described by Nemeth et al. (2004a). The second fish census method was the Roving Diver Survey (Kimmel 1985b; and Kramer and Lang 2003). On St. Croix, eight sites were surveyed between June 24 and August 24, 2004. The same eight sites were surveyed in 2003 (Nemeth et al. 2004a), and five of these were surveyed in 2002 as well (Toller 2002).

The last fisheries stock assessment for the USVI was conducted 12 years ago (Appeldoorn et al. 1992) and harvest patterns have changed in the interim. However, bio-statistical data from USVI commercial fisher port sampling program have been collected for reef fish landings on St. Croix for over 20 years (Brandon 1985; DFW 1994a; and Tobias 1982, 1985, 1991, and 1993). This under-utilized database could be used to focus sampling and analytical efforts towards targeted fish species (Toller 2004).

More recently, Reef Check surveys were completed on St. Thomas (Hodgson 2001; and Vasques 2003). As part of a grant to assess benthic habitats in the U.S. Virgin Islands, the Division of Fish and Wildlife (DFW) employed the Reef Check protocol to survey habitat, invertebrate cover, and fish assemblages at two sites around St. Thomas. The Reef Check program is a global volunteer program designed to provide public education and raise awareness of the status of the world's coral reefs through the biological monitoring of key reef species. The Reef Check program provides a broad assessment of reefs which may be repeated annually for monitoring purposes. For more information of the Reef Check program, see Hodgson et al. (2003) or the Reef Check website at: http://www.reefcheck.org

The National Park Service (NPS) and United States Geological Survey (USGS) in the USVI have collected some of the longest time-series data sets on coral reefs in the Caribbean, some dating back decades (Turgeon et al. 2002; and Miller 2001).

Several innovative marine research and monitoring projects have been conducted in the USVI. The Tektite I and II underwater habitat projects were done on the south side of St. John from 1969-1971 (Collette and Earle 1972; and Earle and Lavenberg 1975), and approximately 80 Hydrolab (1977 to 1985) and 13 Aquarius (1987 to 1989) underwater habitat missions were conducted around St. Croix (Turgeon et al. 2002).

The Buck Island Reef National Monument (BIRNM) and the Virgin Islands National Park (VINP) both have formal monitoring programs dating to the late 1980s (Bythell et al. 1992; Turgeon et al. 2002; and Miller 2001). These focus on coral reef condition, reef fish, sea turtle populations, and seagrass beds (VINP only). Each year three coral reef sites (20 transects each) at VINP and two at BIRNM are monitored using this protocol (Miller 2001; and Turgeon et al. 2002). For the past 14 years, reef fish in the VINP have been monitored at between 4 and 16 reef sites (15 to 18 censuses are conducted at each site) and fish censuses were recently re-established at BIRNM (130 censuses). Research and monitoring on both nesting and juvenile sea turtles at BIRNM has been summarized in Hillis-Starr and Phillips (1998).

Benthic habitat types found throughout the USVI have been digitally mapped (Appendix 2), as part of the NOAA/NOS Biogeography Program, to a depth of 20 meters (65.6 ft.) (Kendall et al. 2001). These habitat maps could be the basis for establishing a number of permanent sites as part of long-term monitoring program.

There are numerous methods, techniques, and protocols for monitoring, surveying, and assessing coral reefs (Bacle 2002; Bohnsack and Bannerot 1986; Brock 1954; Bythell et al. 1993; Hodge 2001; Hodgson and Wilkinson 2001; Miller et al. 2003b; Nemeth and Sladek-Nowlis 2001; Nemeth et al. 2002, 2003a, 2004a; Rogers and Miller 2001; Rogers and Zullo 1987; Rogers et al. 1983, 1988a, 1994, 2001, 2004; and Smith and Renard undated).

Tracking trends in ecosystem structure and changes in reef fish assemblages requires long-term data from a number of locations, over appropriate temporal and spatial scales (Turgeon et al. 2002). While Federal monitoring programs sponsored by the NPS may be adequate for those jurisdictions, there needs to be coral reef monitoring across all three islands in a coordinated and scientifically justifiable manner (Turgeon et al. 2002).

In the USVI, all agencies involved in coral reef monitoring suffer from a shortage of staff and dedicated funding. Enforcement of regulations that protect marine resources has been limited both at the Federal and Territorial levels (Turgeon et al. 2002).

(5) Current USVI Coral Reef Management Measures

The U.S. Department of Interior, U.S. Department of Commerce, and the Government of the Virgin Islands all have jurisdiction over submerged lands within the USVI. Federal Marine Protected Areas (MPAs) provide varying levels of protection and enforcement for USVI coral reef ecosystems (Turgeon et al. 2002). Refer to Figures VI-1, VI-2 (Chapter 6), and Appendix 3 for maps of MPAs.

St. Croix Protected Coral Reefs

Aspects of St. Croix's coral reef ecosystems are protected by six federal MPAs (Turgeon et al. 2002). The NPS manages the Buck Island Reef National Monument (BIRNM), established on St. Croix in 1962 (Presidential Proclamation 3443) to protect one of the finest coral reef ecosystems in the Caribbean. Additional marine portions were added in 1975 (Presidential Proclamation 4346) and 2001 (Presidential Proclamation 7392). Current size of BIRNM is 71 ha (175.4 acres) of land and 77.7 km^2 (30 sq. miles) of submerged lands, of which 9 km^2 is within the St. Croix insular shelf and contains coral reefs and associated habitat.

Presidential Proclamation 7392 declared the entire BIRNM a no-fishing and no-anchoring zone, ending over 40 years of legal extractive use within BIRNM. This monument is the first substantial no-take area established for the island of St. Croix and will require consistent and enhanced law enforcement to protect the area and effect the recovery of St. Croix's depleted reef fisheries. Until 2001, only a small eastern section (49.7 ha) (122.8 acres) was designated a no-take zone, thus most of the current BIRNM was open to extractive uses, including setting of fish traps, cast net, hook and line, and hand collection of conch and lobster. The NPS has had limited success in controlling illegal fishing due to lack of law enforcement staff (Turgeon et al. 2002).

The St. Croix East End Marine Park, managed by the V.I. Government, was designated on January 9, 2003 (TNC 2002). Regulations are pending that will designate certain restricted zones within the park boundary.

The NPS and the Government of the Virgin Islands manage the Salt River Bay National Historical Park and Ecological Preserve, established on St. Croix in 1992, to preserve, protect, and interpret for the benefit of present and future generations certain nationally-significant historical, cultural, and natural sites and resources (16 USC 410tt). This park and preserve includes approximately 1.6 km^2 (0.62 sq. miles) of land and 2.5 km^2 (0.96 sq miles) of water that extends seaward to about 91 m (298.6 ft) depth (Turgeon et al. 2002). It includes the water surface and marine resources of the Salt River Bay, Triton Bay, and Sugar Bay. Fishing is allowed in this MPA (Turgeon et al. 2002).

From March 1 to June 30 each year, NOAA and the V.I. Government prohibit all fishing within the Mutton Snapper Spawning Aggregation Area (refer to Figure VI-4, page 203), a 3.75 km^2 (1.45 sq miles) MPA south of St. Croix (50 CFR 622.23, see Appendix 3).

Like the Mutton Snapper Spawning Aggregation Area, NOAA closes the Red Hind Spawning Aggregation Area (Figure VI-4, page 203) from December 1 through February 28 each year (Turgeon et al. 2002; see also Appendix 3). It is a federally protected MPA, 3.9 km^2 (1.51 sq miles) located on Lang Bank, east of St. Croix (50 CFR 622.23).

St. John Protected Coral Reefs:

The NPS manages the Virgin Islands National Park (VINP) (see Figure VI-3, page 202) that was established off St. John, USVI in 1956 to preserve significant coral gardens, marine life, and seascapes for the public (16 USC Sec. 398). Marine portions were added in 1962, as was Hassel Island in St. Thomas Harbor.

VINP occupies 56% of the 48 km^2 (18.53 sq miles) island of St. John and 23 km^2 (8.88 sq miles) of the surrounding waters (Turgeon et al. 2002). Traditional fishing with traps is allowed. Trunk Bay, the site of an underwater trail, is the only no-take zone in the VINP (40 acres). All anchoring is prohibited on the south side of the VINP and spearfishing is illegal in all park waters.

NPS manages the Virgin Islands Coral Reef National Monument (VICRNM), established in 2001 on St. John (Presidential Proclamation 7399). The 51.4 km^2 (19.85 sq miles) MPA is a no-take and no-anchor zone with limited exceptions (see Figure VI-3, page 202). Regulations guiding the management of this new NPS unit have been published within the Code of Federal Regulations, Title 36, Chapter 1.

St. Thomas Protected Coral Reef

A seasonal closure (proposed by the Caribbean Fisheries Management Council but managed by NOAA) was enacted at the red hind spawning site off St. Thomas in 1990 (Turgeon et al. 2002). In November 1999 this 41 km^2 (15.83 sq miles) MPA, the Red Hind Bank Marine Conservation District (see Figure VI-3, page 202), south of St. Thomas, was designated a marine reserve (year-round closure) with all fishing and anchoring prohibited (50 CFR 622.23; see Appendix 3). Average length of spawning red hind have increased from 29.5 cm TL (11.6 in) in 1988 to 38.8 cm TL (15.3 in) in 2000, and the number of spawning red hind increased from 5 to 25 fish/100 m^2 (1,076.4 sq ft) (Turgeon et al. 2002; and Nemeth, in press).

(6) Regulations Applicable to USVI Coral Reefs

The U.S. Department of the Interior, U.S. Department of Commerce, and the USVI Territorial Government all have policies, laws, and legislation relating to coral reef conservation.

The Code of Federal Regulations Title 36, the enabling legislation for VINP (16 USC 398), and the BIRNM Presidential Proclamation relate to reefs in national parks. The Caribbean Fishery Management Council (CFMC) has Reef Fish, spiny lobster, conch, and Coral Reef Management Plans (CFMC 1985a, 1985b, 1990, 1993, 1994, 1995, and 1996) with regulations pertaining to federal waters.

Federal Laws, Policies, and Regulations Applicable to USVI Coral Reefs

1) Magnuson Fishery Conservation and Management Act of 1976 as Amended: 16 U.S.C. 1801-1882 - The Magnuson Act mandates the preparation of fishery management plans for important fishery resources within the EEZ. All FMPs and their respective management measures must be based on ten national standards as prescribed in the Magnuson Act.

   The amended Magnuson-Stevens Act of 1996, also known as the Sustainable Fisheries Act (SFA), included new Essential Fish Habitat (EFH) requirements, and as such, each existing, and any new, FMP must describe and identify EFH for the fishery, minimize to the extent practicable adverse effects on the EFH caused by fishing, and identify other actions to encourage the conservation and enhancement of that EFH. The Magnuson-Stevens Act defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity". NOAA Fisheries issued its final EFH regulation-guidelines on January 17, 2002. The regulations provide guidelines to fishery management councils for developing the EFH sections of fishery management plans and establish procedures to be used by NOAA Fisheries and other agencies to consult and coordinate regarding federal and state agency actions that may adversely affect EFH.

2) Fishery Management Plans - Current FMPS for the USVI include: (1) the corals and reef-associated plants and invertebrates FMP (CFMC 1994, and 2004); (2) the spiny lobster FMP (CFMC 1985a, and 2004); (3) the conch resources FMP (CFMC 1996, and 2004); and (4) the reef fishery FMP (CFMC 1985b, 1990, 1993, and 2004).

3) Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA), Title III as Amended: 16 U.S.C. 1431-1445 - This Act provides for establishment of marine sanctuaries and may include regulation of the fishery resource within them.

4) Clean Water Act (CWA) as Amended: 33 U.S.C. 1251 et seq. - The CWA requires that a National Pollutant Discharge Elimination System (NPDES) permit be obtained before any pollutant is discharged from a point source into waters of the United States, including waters of the contiguous zone of the adjoining ocean.

5) Marine Protection, Research, and Sanctuaries Act (MPRSA), Title 1 as Amended: 33 U.S.C. 1401-1421; 1441-1445. - The transportation of materials for ocean dumping requires a permit. EPA issues the permits, except for transportation of dredged materials that is issued by the Corps of Engineers. Criteria for issuing such permits include consideration of effects of dumping on the marine environment, ecological systems, and fisheries resources.

6) Coastal Zone Management Act of 1972, as Amended (CZMA): 16 U.S.C. 1451-1464 - The principal objective of the Coastal Zone Management Act is to encourage and assist states in developing coastal management programs, to coordinate state activities, and to safeguard the regional and national interests in the coastal zone. Under the CZMA states are encouraged, with federal funding, to develop coastal zone management programs that establish unified policies, criteria, and standards for dealing with land and water use in their coastal zone. Coastal states also can control activities in estuarine areas to protect particularly sensitive resources. The CZMA has been amended to include non-point source pollution from upland areas.

7) Endangered Species Act of 1973, as Amended: 16 U.S.C. 1531-1543 - The Endangered Species Act provides for the listing of threatened or endangered plant and animal species. Once listed as a threatened or endangered species, taking (including harassment) is prohibited (CFMC 1994). Federally listed endangered/threatened species of relevance to the coral FMP are (CFMC 1994):

a) the endangered leatherback sea turtle – *Dermochelys coriacea*
b) the endangered hawksbill sea turtle – *Eretmochelys imbricata*
c) the threatened green sea turtle – *Chelonia mydas*
d) the threatened loggerhead sea turtle – *Caretta caretta*
e) the endangered manatee – *Trichechus manatus*

8) National Environmental Policy Act (NEPA), as Amended: 42 U.S.C. 4321-4370a - NEPA requires that all federal agencies recognize and give appropriate consideration to environmental amenities and values in their decision-making (CFMC 1994). NEPA requires that federal agencies prepare an Environmental Impact Statement (EIS) before undertaking major actions that might significantly affect the quality of the human environment. Alternatives to the proposed action must be carefully assessed.

9) Fish and Wildlife Coordination Act, as Amended: 16 U.S.C. 661-666c - Under the Fish and Wildlife Coordination Act, the USFWS and the NMFS (NOAA Fisheries) review and comment on aspects of proposals for work and activities sanctioned, permitted, assisted, or conducted by federal agencies that take place in or affect navigable waters (CFMC 1994). The review focuses on potential damage to fish and wildlife and their habitat, particularly in nearshore waters, and may, therefore, serve to provide protection to fishery resources from federal

activities. Federal agencies must consider the recommendations of the two agencies.

10) Fish Restoration and Management Projects Act, as Amended: 16 U.S.C. 777-7771 - Under this Act, the Department of Interior apportions funds to state fish and game agencies for fish restoration and management projects. Funds for protection of threatened fish communities located within state waters, including marine areas, could be made available under the Act.

11) National Park Service Organic Act, as Amended: 16 U.S.C. 1-4, 22, 43 - The National Park Service under the Department of Interior may regulate fishing activities within park boundaries (CFMC 1994). The St. John National Park and Buck Island Reef National Monument (St. Croix, USVI) are both in this management unit.

12) Lacey Act, as Amended: 16 U.S.C. 1540, 3371-3378 - The Act prohibits import, export, and interstate transport of illegally taken fish or wildlife. This Act strengthens and improves enforcement of federal fish and wildlife laws and provides federal assistance in enforcement of state and foreign laws (CFMC 1994).

13) Marine Mammal Protection Act of 1972, as Amended: 16 U.S.C. 1361-1407 - This Act makes it unlawful (except for some native Americans) to kill, capture, or harass any marine mammal or attempt to do so; prohibits the importation of pregnant, nursing, or illegally taken marine mammals; and prohibits whaling within U.S. areas of authority. If the fishery potentially affects marine mammal populations, these impacts must be analyzed in the EIS (CFMC 1994). Councils must consider actions to mitigate adverse impacts.

14) Convention on International Trade in Endangered Species (CITES) - CITES is an international agreement between Governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Although CITES is legally binding on the member Parties, now totaling 167 Parties, it does not take the place of national laws. Rather it provides a framework to be respected by each Party, which has to adopt its own domestic legislation to make sure that CITES is implemented at the national level.

The Caribbean Fishery Management Council (CFMC) currently has a fishery management plan in effect for corals and reef-associated invertebrates of the federal waters around Puerto Rico and the U.S. Virgin Islands (CFMC 1994, and 2004).

CFMC prohibited the take of all coral, dead or alive, and live rock since 1995 (MerrellKatsouros, LLP 2003). Fisheries in the Caribbean are coral reef based fisheries, both in shallow and deep waters. CFMC is currently involved in the mapping and assessment of coral reefs in the EEZ (MerrellKatsouros, LLP 2003). A GIS map will be prepared from the historical information on deepwater coral reefs (MerrellKatsouros, LLP 2003).

CFMC's fishery management plan for coral and reef-associated plants and invertebrates includes over 100 species of coral (including stony corals, sea fans, and gorgonians) and over 60 species of plants (including seagrasses) and invertebrates (CFMC 1994, and 2004). The plan covers two distinct components. The first is a fishery for live invertebrates which are marketed for the marine aquarium trade. Aside from reef-associated invertebrates, this fishery includes what is widely known as live-rock (rock substrate supporting diverse invertebrate life forms). Live-rock is highly valued by aquarists and there is a rapidly growing market for this resource (ReefKeeper 1993). The second component of the plan comprises corals and coral reefs. These resources are of enormous value for the reef communities that they support, for their physical capacity to protect coastlines and for their aesthetic value. Indeed, traditional coastal fisheries in the Caribbean may best be characterized as coral reef fisheries intimately dependent on the backbone of habitats created by coral reefs and associated invertebrates (MerrellKatsouros, LLP 2003).

The FMP for coral and reef-associated plants, invertebrates (CFMC 1994, and 2004) addresses various concerns over the present and probable future condition, in the absence of further regulation, of component species through a number of management measures. These include:

1) prohibits the harvest or possession of stony corals, sea fans, gorgonians, and any species in the fishery management unit if attached or existing upon live-rock, except under legal permit for research, education, and restoration;

2) prohibits the sale or possession of any prohibited species unless fully documented as to point of origin;

3) prohibits the use of chemicals, plants or plant derived toxins, and explosives for harvest;

4) limits harvest of other invertebrates to dip nets, slurp guns, by hand, and other non-habitat destructive gear with an exception for permitted scientific, education, and restoration programs; and

5) requires permitting and reporting by harvesters, dealers, and exporters of invertebrates.

Local Laws, Policies, and Regulations Applicable to USVI Coral Reefs

Title 12 of the Virgin Islands Rules and Regulations (VIRR) presents environmental laws and regulations of the Virgin Islands. Several sections of the St. Croix reef system have been designated Areas of Particular Concern by the USVI Department of Planning and Natural Resources (NOAA 1988). However, with the exception of the East End Marine Park, there is no management plan in place and no enforcement activity (Turgeon et al. 2002). The Coastal Zone Management (CZM) permitting process requires a permit for any land or water disturbance that could impact territorial waters (to the 3 mile territorial limit). The USVI Division of Environmental Protection regulates discharge into territorial waters.

The Department of Planning and Natural Resources (DPNR) regulates commercial and recreational fishing activities with the advice of the Division of Fish and Wildlife and the St. Thomas/St. John and St. Croix Fisheries Advisory Committees (Uwate 2002). The DPNR/Division of Environmental Enforcement is responsible for enforcing regulations within USVI waters (Uwate 2002), and DEE officers are also deputized to enforce Federal regulations. There are size restrictions and seasonal closures on certain fisheries species (DPNR 2004; also see Appendix 3).

In addition to VIRR, Title 12, there is the Indigenous and Endangered Species Act 5665, December 1990. This Act has the purpose of protecting, conserving, and managing indigenous fish, wildlife, and plants, and endangered or threatened species. The Act allows for the issuance of permits to collect and/or transit (export) indigenous or endangered species for commercial, private, educational, or scientific use, and covers the collection of aquarium fish, invertebrates, or live-rock, maintenance in captivity or shipping of any indigenous or endangered species, or cutting or pruning of mangroves. Special permits may be issued for collectors from recognized museums, research organization, etc., scientists, and for recovery and propagation activities. A list of endangered or threatened animals in the USVI of relevance to this plan can be seen in Table V-4 on page 191 and 192 of Chapter 5.

(7) Current Projects Related to USVI Coral Reefs

The Caribbean Fisheries Management Council (CFMC), in collaboration with the Woods Hole Oceanographic Institution, the University of Puerto Rico, USVI DFW, and the University of the Virgin Islands, has begun to identify species composition of the deepwater reef-forming corals in the EEZ using high-resolution digital photos (Merrell-Katsouros, LLP 2003). The preliminary results show an incredible diversity of species in healthy coral reef communities that are worth preserving for future generations (MerrellKatsouros, LLP 2003).

The Council has also contracted to map and obtain high-resolution bathymetry (now completed) through side scan sonar and multi-beam of the Marine Conservation District (MCD) no-take zone, established in 1999, off St. Thomas, USVI and the deepwater seasonally closed areas of St. Croix, USVI (Geophysics International 2003). These areas are thought to be fish spawning aggregation sites for groupers, snappers, and other fish species. These areas have been identified as spawning aggregation sites in ReefKeeper International's spawning aggregation database (Rielinger 1999), which further cites Olsen and LaPlace (1978) and Beets and Friedlander (1992) as source documents. Also see Beets and Friedlander (1998), Nemeth et al. (2004), Nemeth (2005), and Luckhurst (2003). Mapping of these deepwater habitats in the EEZ is a high priority in the efforts of the Council to identify and describe essential fish habitat. In addition, the Council will be funding a new project on coral reefs. This will produce an inventory and atlas of coral and coral reefs, with emphasis on deepwater coral reefs within the U.S. Caribbean EEZ. This project was approved as part of the NOAA Coral Reef Program, which funded the Councils that have coral and coral reefs under their area of authority (MerrellKatsouros, LLP 2003).

There are several projects currently being undertaken by the government of the Virgin Islands (DPNR/DFW), the University of the Virgin Islands, and other federal agencies and NGOs, concerning the protection and conservation of coral reefs, in particular, and habitats, in general. These include:

1) The implementation of a one-time trammel and gill net buy-back program in St. Croix (grant no. WC133F03SE1088), intended to reduce gear impacts to benthic habitat, in particular corals, by facilitating the removal of trammel and gill nets from the inshore fishery (Tobias 2004; and NOAA 2003). Commercial landings by trammel net and gill net fishers on St. Croix now exceed landings by trap fishers (NOAA 2003). The species targeted by trammel and gill net fishers are herbivores. Heavy harvesting of herbivores may affect the health of the coral reefs of the area. In addition, the nets are placed on hard and soft corals and removal of nets can cause damage to the reefs.

2) The installation of mooring buoys in the St. Croix East End Marine Park (Boating Infrastructure Grant, Tier 1; no. Y-2-1) to facilitate access for vessels and to minimize anchor damage to critical marine habitats such as coral and seagrass areas (DFW 2004a). There is also a project for deployment and maintenance of day-use mooring buoys around St. Thomas and St. Croix (DFW 2004b). Also, the Virgin Islands National Park (VINP) in St. John has a day-use mooring buoy program and has about 200 day-use buoys installed in the VINP (VINP undated).

3) The assessment of recreational fisheries habitats for St. Thomas/St. John (grant no. F7-19). Refer to Coral Reef Monitoring Section—Habitat survey project, above.

4) The implementation of a long-term coral reef monitoring and assessment program, by the government of the Virgin Islands, in coordination with federal agencies and the University of the Virgin Islands. Refer to Coral Reef Monitoring Section - Coral reef monitoring project, above.

5) The development and implementation of protocols, by the NPS and USGS, to monitor and inventory coral reef and seagrass communities in the Virgin Islands National Park and Buck Island Reef National Monument (Rogers et al. 2004).

For information on research priorities for Caribbean coral reefs, see McManus (2001).

3. **MANGROVES**

The wetlands of the U.S. Virgin Islands are limited in area but are an important natural resource. They are generally coastal wetlands such as mangrove forests and salt-ponds and are classified as estuarine or marine (USGS 1994). For the discussion below, much of what is referred to as wetlands is applied to mangroves and salt ponds. Wetlands in the U.S. Virgin Islands occupy less than 3% of the land area (USGS 1994). The largest of the wetlands are on St. Croix, where the terrain is less steep and the drainage basins are larger than on St. Thomas or St. John (USGS 1994). On the basis of mapping by the USFWS's National Wetlands Inventory, there are 960 acres of wetlands on St. Croix, 320 acres of wetlands on St. Thomas, and 425 acres of wetlands on St. John (USGS 1994).

Estuarine intertidal vegetated wetlands in the USVI are dominated by red, white, and black mangroves (USGS 1994). Saltponds are the predominant marine wetlands in the USVI (USGS 1994). They are tidal flats or basins that are at least partially separated from direct contact to the sea by a beach berm (USGS 1994).

(1) Mangrove General Description

Generally speaking, mangrove forests are one of the most important intertidal plant communities found along low wave-energy shorelines in the tropics (Lewis 1983). They are highly productive environments that support a variety of flora and fauna. Cintron and Schaffer-Novelli (1983) reported a daily rate of organic matter fixation of 20 $g/m^2/day$. Mangroves produce large quantities of organic detritus which may support the high secondary productivity observed in nearshore open waters and embayments (Aiken and Moli de Peters 1988).

The term mangrove is used to loosely define members of approximately 12 plant families that consist of more than 50 species (Odum et al. 1982). Seven species of mangrove trees are found in the Caribbean region (Cintron and Schaffer-Novelli 1983). Three species of red mangrove (*Rhizophora mangle, R. harrisonni,* and *R. racemosa*) are found in the Caribbean, with *Rhizophora mangle* being the most common. Two species of black mangrove occur in this region (*Avicennia germinans* and *A. schaueriana*), with *A. germinans* being the most common. Two other common mangroves found in the Caribbean region are the white mangrove (*Laguncularia racemosa*) and the buttonwood mangrove (*Conocarpus erecta*).

Each of these species of mangroves has special ecological requirements and adaptations which determine their distribution, areal extent, and response to pollution stresses (Cintron and Schaffer-Novelli 1983). Generally, these adaptations are reflected by the distinctive zonation patterns observed within mangrove forests. Cintron and Schaffer-Novelli (1983) provide an explanation for these zonation patterns. Usually the red mangrove is the first species to colonize a new area due to its tolerance of high water and its seed dispersal mechanism. Following the establishment of red mangroves and the accumulation of sediment and organic matter, conditions become suitable for the establishment of black and white mangrove species. These species are generally more tolerant of higher salinities and are better able to withstand long periods of flooding. The buttonwood mangrove tends to be found along the upland fringe of a mangrove area, or in coastal areas where other mangrove trees do not occur.

Although mangroves were originally thought to trap sediment and gradually accumulate sediment and grow seaward, it appears that generally, mangroves only stabilize regions of sediment deposition and that little offshore expansion occurs (Lugo and Snedaker 1974). Due to the global rise in sea level, mangroves have actually migrated landward in response to higher sea level (Cintron et al. 1978). However, on shorter time scales (several years), areas colonized by mangroves may fluctuate due to damage caused by storms or changes in patterns of seawater exchange within the mangrove as the result of creation and destruction of sediment barriers on the seaward fringe (Cintron et al. 1978). More detailed descriptions of the ecology of mangrove forests are presented by Lugo and Snedaker (1974), Odum et al. (1982), and Lugo et al. (1988).

In general, mangroves exhibit relatively high rates of gross primary productivity under favorable conditions (Lugo and Snedaker 1974; and Snedaker and Brown 1982). Part of the organic production not used in respiration is accumulated as forest biomass and a significant fraction also goes to the production of leaf litter and woody debris. Although rates of productivity and biomass accumulation may vary by orders of magnitude, leaf litter production remains relatively uniform (i.e., between one and four grams carbon/square meter/day) (Snedaker and Brown 1982). Highest productivities occur under conditions of moderate salinity, year-round warm temperatures, regular surface-water flushing, and exposure to terrestrial-water runoff.

Mangrove communities have a variety of recognized roles in the larger ecosystem in which they occur (Snedaker and Getter 1985). The most prominent role is the production of leaf litter and detrital matter which is exported, during the flushing process, to the nearshore marine environment (Snedaker and Getter 1985). Through a process of microbial breakdown and enrichment, the detrital particles become a nutritious food resource for a variety of marine animals. In addition, the soluble organic materials which result from decomposition within the forest also enter the near-shore environment where they become available to a variety of marine and estuarine filter feeders and benthic scavengers. The organic matter exported from the mangrove habitat is utilized in one form or another, including utilization by inhabitants of seagrass beds and coral reefs which may occur in the area (Snedaker and Getter 1985). Whereas the role of mangroves in the production and maintenance of nearshore fisheries is becoming an accepted fact (Adams and Tobias 1994; Adams and Ebersole 2002; Boulon 1992; Dennis 1992; Mateo and Tobias 2001; Mateo et al. 2002; Mateo 2001a; Tobias 1996, 1998, 2001; and Thayer et al. 1987), mangroves have other roles which are recognized in different parts of the world. In areas of annual cyclonic storm activity, the shoreline mangroves are recognized as a buffer against storm-tide surges that would otherwise have a damaging effect on low-lying land areas. Elsewhere, mangroves are noted for their ability to stabilize coastal shorelines that would otherwise be subject to erosion and loss (Saenger et al. 1983). Probably one of their more important roles is the preservation of water quality. Because of their ability to extract nutrients from circulating waters, the eutrophication (excess nutrient enrichment) potential of nearshore waters is minimized. Also, the saline and anaerobic (no oxygen) mangrove sediments have a limited ability to sequester and/or detoxify common pollutants (Snedaker and Brown 1981). For example, some heavy metals are sequestered as insoluble sulfides, and certain organic pollutants are oxidized or decomposed through microbial activity.

In addition to their ecological role in coastal areas, mangrove forests are a source of many different products having commercial and domestic importance (Snedaker and Getter 1985). In many parts of the world, where direct dependency on local resources is the basis for survival, human populations heavily rely upon products from this habitat. In recent times, as resources have become scarcer, the mangrove habitat and forests have become recognized as resources for commercial utilization for such products as timber, pulpwood, and chips, fuel wood and charcoal, honey production, and sundry domestic products (Snedaker and Getter 1985). Where it is recognized that societal lifestyle and survival are dependent upon a functioning mangrove system, care is usually taken by the inhabitants to protect it. It is the various uses of mangrove forest products and the plant and animal materials associated with them that lead to pressures concerning their utilization. Integrated planning, which involves simultaneous attention to all sectors and considers the maximum sustained yield of each resource, is an approach which is especially important in the management of mangrove forests.

Mangrove ecosystems support a high diversity of fish, birds, and other wildlife (UNESCO 1983). Mangrove lagoons are important habitat for juveniles of many fish species (Heald and Odum 1970; Austin 1971a and 1971b; Austin and Austin 1971; Olsen 1972 and 1973; Cintron-Molero 1987; Thayer et al. 1987; Boulon 1992; and Tobias 1996). They can provide nursery areas for estuarine as well as reef fishes (Odum et al. 1982; Boulon 1985 and 1992; and Tobias 1996). Many juveniles use detritus and mangrove-associated invertebrates and fish as a food source (Zieman et al. 1984; and Thayer et al. 1987). The complex prop-root habitat may also provide protection from predation (Orth et al. 1984; and Sogard and Olla 1993). In addition to providing important habitat, mangroves filter sediment and help maintain the integrity of the lagoon and seagrass habitat (Cintron-Molero 1987), also an important nursery area (Dennis 1992).

Of particular concern to fisheries managers are economically important species, such as those targeted by recreational and commercial fishermen (Tobias 1996). The utilization of mangrove habitats by these economical species and their prey species is important (Robertson and Duke 1987). The documentation of mangroves as nursery areas for recreationally and commercially valuable species, and their prey species, provides impetus for including mangrove habitats in fisheries management plans and designating these areas as essential fish habitat (Tobias 1996).

The documentation of mangroves as nursery areas for recreationally and commercially valuable species, and their prey species, provides impetus for including mangrove habitats in fisheries management plans (Adams and Tobias 1994; Adams and Ebersole 2002; Boulon 1992; Dennis 1992; Mateo and Tobias 2001; Mateo et al. 2002; Mateo 2001a; Tobias 1996, 1998, 2001; and Thayer et al. 1987). However, in light of the interactive system of mangrove lagoon, seagrass, and coral reef, and the complex communities they support (UNESCO 1983), it is important that the evaluation of mangrove lagoon nursery areas is not limited to fishery-important species. Direct recreational exploitation of species that utilize the mangrove nursery area is not the only gauge of the importance of the mangrove habitat to the fishery. Many of the species present in mangrove lagoons are potential prey for recreationally or commercially targeted species (Odum and Heald 1972; Robertson and Duke 1987; and Thayer et al. 1987). In addition, while the carbon derived from the mangrove detritus is primarily cycled within the lagoon (Fleming et al. 1990), it directly (detritivores) or indirectly (carnivores) supports the nursery community. The juveniles that then migrate to the reef as adults are effectively exporting the energy of the mangrove lagoon to the reef system. This is a significant contribution, since fish density may be 35 times higher in mangrove prop-root habitat than in seagrass (Thayer et al. 1987). Thus, even species that are not recreationally exploited likely play an important role in the health of the recreational fisheries.

(2) USVI Mangroves

Mangrove forests may develop under a variety of conditions of water depth, salinity, hydrologic regime, and wave energy. Mangrove habitat in the U.S. Virgin Islands is primarily mangrove fringe along lagoons and oceanic bays (Boulon 1992). General mangrove forest types that have been observed in the Virgin Islands include the following (Tetra Tech 1991a):

1) Riverine forests - These forests develop along the edges of river estuaries.

2) Basin forests - These forests develop in coastal floodplains and are often associated with riverine forests.

3) Fringe forests - These forests develop along shores or the edges of offshore cays.

4) Salt ponds - These ponds are lagoonal fringe forests that have lost their regular tidal connection with the ocean and only periodically receive large amounts of fresh water.

In the USVI, mangroves contribute many benefits to the island's ecosystems (Tetra Tech 1992). They protect the islands from storm tides and hurricanes, and help to stabilize the shorelines. They act as sediment traps and pollution filters for runoff from the watersheds on hillsides above the mangroves and reduce the amount of silt and chemicals which reach the seagrass beds and coral reefs. They also trap and cycle various organic materials, distributing important nutrients to nearby marine habitats. Their roots provide the surface to which mangrove oysters and other marine animals attach themselves. These filter-feeding animals also trap and cycle nutrients. Mangroves provide a wide range of habitat types for aquatic and land-dwelling wildlife. They offer protected nursery and feeding areas for a variety of juvenile marine life, including snappers, grunts, parrotfish, barracuda, baitfish, lobster, conch, and numerous other aquatic animals (Mateo and Tobias 2001). Many of the fish seen on the local reefs grow up among red mangrove prop roots before they migrate out to the reef (Adams and Tobias 1994). Coastal mangroves are therefore essential for maintaining healthy recreational and commercial fisheries in the USVI, as well as in balancing the reef ecosystems.

There has been much discussion about the role of coastal habitats, in general, and mangrove habitats in particular, as nursery grounds for commercially and recreationally important fishes in the USVI (see Tobias 1996, 1998, and 2001; Boulon 1991 and 1992; Mateo 2001a; Mateo et al. 2002; Dennis 1992; Mateo and Tobias 2001; Adams and Tobias 1994; and Adams and Ebersole 2002).

In the USVI, mangrove wetlands are located on prime coastal real estate (Tobias 1996). As a result, they are often threatened by commercial and residential development. A review of aerial photographs of the USVI revealed that an alarming portion of the mangroves have been lost in just the last few decades. The Virgin Grand Hotel (now the St. John Westin) at Great Cruz Bay on St. John and the Sapphire Beach Resort, Grand Palace, and Sugar Bay Resort on St. Thomas sit on what were formerly mangrove wetlands. Southgate pond on St. Croix and the mangrove wetland at Benner Bay on St. Thomas have been substantially altered by marina construction.

The Virgin Island Port Authority (VIPA) container port, Hovensa oil refinery, and Alcoa aluminum plant were constructed in the early 1960s on what was once Krause Lagoon, the largest mangrove system in the Virgin Islands.

A recent assessment of the shallow water reef fish in the U.S. Caribbean (Appeldoorn et al. 1992) showed further declining trends of inshore fisheries resources that cannot be attributed to overfishing alone. In general, unregulated development of upland and coastal areas have resulted in increased sedimentation rates and the introduction of pollutants which have degraded the water quality of coastal environs (Saenger and McIvor 1974; Tobias 1996). Mangrove habitat in the U.S. Virgin Islands has been severely reduced by shoreline development for marine-related activities (i.e., marinas and commercial ports) (USGS 1994). Impacts by natural disasters (i.e., hurricanes) have been severe in recent years (USGS 1994).

Each time a mangrove wetland is substantially altered or destroyed its benefits to humans and animals are diminished or destroyed with it. The USVI's coastal areas are no longer buffered from storms (USGS 1994). Silt and pollution spill over onto seagrass beds and coral reefs. Fishermen's livelihoods are threatened. Wildlife species are diminished and biodiversity, the wide range of plants and animals living in and around the wetland, decreases (Knowles and Amrani 1991). As the environmental quality of the islands diminishes, fewer tourists may select the USVI for their vacation, with consequent negative impacts on the economy.

The wetlands (mangroves) of the U.S. Virgin Islands have been impacted by both natural and anthropogenic forces. Hurricane Hugo, which passed directly over St. Croix in September 1989, was the last major storm event to significantly alter the wetlands of the islands. Hurricane winds defoliated mangroves to such an extent that many died. In addition, a number of black and white mangroves were uprooted (Knowles and Amrani 1991). Although recovery might be slow (perhaps as long as 50 years), the impacted wetlands should become re-established if properly managed.

St. Croix Mangroves

On St. Croix, the southern-most of the U.S. Virgin Islands, the fringing mangroves (red mangrove, *Rhizophora mangle*) have a well developed, permanently submerged prop-root system that provides potential nursery habitat (Tobias 1996). Three prominent mangrove systems remain on St. Croix: Salt River, Altona Lagoon, and Great Pond. However, very limited information on the mangrove forests of St. Croix is available. Formerly the largest mangrove area on the island, Krause Lagoon is now occupied by the South Shore Industrial Complex (Tetra Tech 1992). Currently, the best mangrove stands occur in the area of Great Pond on the south coast (Tetra Tech 1992). Many of the mangroves of St. Croix are associated with salt ponds because of the lack of permanent rivers and the high evaporation rate relative to rainfall. A well-developed mangrove forest also fringes the shoreline of Salt River (Tetra Tech 1992).

Island Resources Foundation (1985) reported that the Great Pond on the south coast of St. Croix had some of the best red and black mangrove stands remaining in the U.S. Virgin Islands. Mangrove forests were also reported for Salt River, Altona Lagoon, Southgate Pond, and

Coakley Bay on the north coast and Sandy Point, Long Point, and Robin Bay on the south coast (IRF 1985).

Two studies were designed to determine the areal distribution of red mangroves, as nursery habitat for certain fishes, on St. Croix and to characterize them on the basis of environmental condition, to determine quantitatively the species composition and abundance of recreationally important fish species occurring in the mangrove fringe habitat, to identify immediate and long-term threats to the existing habitat, to estimate their potential impact on recreational fisheries, and to suggest possible mitigation measures. The first study (Tobias 1996) provided information on Salt River and Altona Lagoon, and the second study (Tobias 1998) was conducted in Great Pond. These are the three prominent mangrove systems on St. Croix, with fringing mangroves that have well developed, permanently submerged prop-root systems that provide potential nursery habitat. Both studies demonstrated that the fringing red mangrove ecosystems provide important nursery habitat for juveniles of numerous reef fish species, many of which are recreationally important as primary target species or food fishes for primary target species.

In 1999, the St. Croix office of the Virgin Islands Marine Advisory Service (VIMAS), the St. Croix Environmental Association (SEA), and DFW began a 3-year reforestation project to restore the mangrove forest within Sugar Bay on St. Croix. With funding from the V.I. Dept. of Planning and Natural Resources through the federal Clean Water Act, and the Royal Caribbean Ocean Fund, 18,000 red mangroves (*Rhizophora mangle*) and 3,000 black mangroves (*Avicennia germinans*) were planted. The project utilized a planting method called the Riley Encased Methodology (REM) to replant the red mangroves. This methodology incorporates a two-part PVC system to encase the propagule and provide protection against extended periods of submersion, damage from floating debris, and crab predation on the young trees.

On St. Croix, the largest mangrove estuary system in the U.S. Virgin Islands, Krause Lagoon, consisting of more than 700 acres of wetlands, was destroyed in the 1960's with the development of an industrial complex, consisting of an oil refinery, an alumina plant, and a commercial port facility (USGS 1994). The mangrove wetland which existed at Krause Lagoon on St. Croix has been replaced by refineries and storage tanks (USGS 1994). Also see APC and APR reports for St. Croix mentioned above (IRF 1992d, 1992e, 1993g, 1993h, 1993i, 1993j, 1993k, 1993l, and 1993m).

St. John Mangroves

On St. John, mangroves were noted in Leinster Bay and Newfound Bay on the north coast (IRF 1985). A fringing mangrove stand was noted at Lagoon Point-Johnson Reef in Coral Bay on the east coast, and a large red and black mangrove stand was noted in Great Lameshur Bay on the south coast. Examination of topographic maps (USGS 1982) indicated that mangrove coverage exists in Reef Bay and Fish Bay on the south coast, in Great Cruz Bay on the west coast, and in Peter, Cinnamon, Maho, and Francis Bays on the northwest coast. Many of these mangrove areas are associated with salt ponds (Stengel 1998). Impact of erosion and sedimentation in Fish Bay, and a proposal for a restoration project in Fish Bay were reported by Anderson and MacDonald (1995 and 1998), IRF (2003), MacDonald et al. (1997 and 2001), and the APC and

APR reports mentioned above (IRF 1992c, 1993e, and 1993f). The Great Lameshur mangrove system was severely damaged due to Hurricanes Hugo (1989) and Marilyn (1995). A recently completed reforestation project replanted several hundred red, white, and black mangroves (Nemeth et al. 2004b).

St. Thomas Mangroves

Numerous small mangrove areas are found along the coast on St. Thomas, often in association with salt ponds (Stengel 1998; and Tetra Tech 1992). The largest mangrove system on the island is found in Mangrove Lagoon/Benner Bay on the southeast coast (IRF 1985). Several cays within the bay are mangrove covered, and mangroves fringe the shoreline in some areas. These mangroves are threatened with further encroachment of the human inhabitants and human-induced pollution stresses (Grigg et al. 1971; and Phillip 1993). The mangrove and salt pond of Perseverance Bay have also been described (IRF 1977b, and 1977c; and Rogers 1980a and 1982). Also see the APC and APR report (IRF 1993b) and Stengel (1998) concerning the ecology of Mangrove Lagoon/Benner Bay.

The Benthic Habitat Assessment Project (BHAP), conducted by the USVI Division of Fish and Wildlife (DFW), was developed to record current and long-term changes in a variety of under-water habitats around the USVI (Adams et al. 1998; Chapman 1996; and Chapman et al. 1996). The focus of BHAP is to provide data on the distribution and abundance of important recreational fisheries habitat and to install permanent transects at sites to monitor change which characterize the predominant shallow water benthic habitats in the USVI. The initial work is being performed in the Cas Cay/Mangrove Lagoon, which contains the largest mangrove system on St. Thomas, and St. James Marine Reserve, as both areas have been identified as primary fishery nursery grounds (Adams et al. 1998; Chapman 1996; and Chapman et al. 1996).

(3) Priority Issues Concerning USVI Mangroves

Natural Stressors

Lugo et al. (1981) identified both natural and human-induced sources of stress to mangrove environments. Natural stresses include unseasonably low and high temperatures, changes in soil salinity due to changes in hydric regime, wind damage and sediment deposition resulting from storms and floods, sea level rise, coastal erosion, and damage due to grazing by insect herbivores. The response of mangroves to particular stressors was described by Cintron and Schaeffer-Novelli (1983), Lugo and Snedaker (1974), Lugo et al. (1981), and by Odum and Johannes (1975). The impacts of some natural stressors on mangroves are briefly described below:

1) Eustatic sea level rise and coastal erosion **-** The global sea level is rising at a rate of 1.5 mm/yr (~0.06 inch/year) as a result of global warming (Cintron-Molero and Schaeffer-Novelli 1992). Mangroves accommodate to rising sea-level either by opportunistic colonization of new landforms created by rising wave-energy levels,

by utilization of sheltered areas, or by encroachment on landward areas subject to marine intrusions. On the other hand, they will disappear or occupy relic habitats in coastal areas with steep topography. Rapid sea-level rise will result in the fragmentation of mangrove areas. However, since mangroves are generalists, they should be able to accommodate to these rapid changes.

2) Hypersalinity **-** High salinity is a chronic natural stressor under severe water deficits. Highly saline conditions (interstitial salinities >90 ppt) lead to the development of vegetation-free areas common to arid coastal landscapes (Cintron-Molero and Schaeffer-Novelli 1992). Here mangroves form narrow fringes along the margins of water bodies. In the Caribbean, these salt flats develop where precipitation is less than 1300 mm/yr (51 inches/year). Die-backs occur as a result of drought. Mangrove coverage is actually unstable, with coverage fluctuating between periods of expansion (following storms or a succession of very moist years) and contraction (triggered by a succession of dry years). In very dry areas, basin forests, which are more dependent on land runoff, may disappear altogether, leaving thin red mangrove fringes or riverine forests backed by hypersaline lagoons and/or salt flats. In most of these arid areas, mangrove systems are delicately poised. Reduction of water flows or impoundment (e.g., roads, dikes, causeways) can cause massive die-offs by exacerbating the naturally rigorous conditions.

3) Hurricanes **-** Hurricanes are common in many geographic areas containing mangroves, and even areas normally outside the influence of hurricanes may occasionally be struck (Cintron-Molero and Schaeffer-Novelli 1992). Fully formed hurricanes may reach wind speeds near the center of more than 119 km/hr (~74 mph). Mangroves are particularly vulnerable to these disturbances because of their exposed locations, their shallow root systems, and the poor cohesiveness of most mangrove soils. Stands are also exposed to erosion by flood currents and scouring by waves. Tall forest stands are prone to greater destruction by rare but powerful events with long recurrence intervals. Canopies of mangrove stands in storm areas are fairly even, reflecting the destruction of emergent trees and the occupation of the area by dense, even-aged stem populations.

Anthropogenic Stressors

Because most wetlands occur along coveted coasts, the major threat to wetlands is filling, drainage, or alteration (e.g., opening to sea, dredging) for development. Many have already been destroyed or severely altered by development. Other major threats include pollution, sedimentation, and disturbance by human visitors. Given the prospect of rising sea levels, the loss of wetlands may become more catastrophic as coral reefs die and mangroves drown, thus exposing shores to the more frequent coastal storms predicted by current climate change models.

Several of the anthropogenic sources of stress to mangrove habitats listed by Lugo et al. (1981) are identical to those identified for coral reefs (e.g., oil pollution, siltation, surface runoff).

Additional sources of stress that are unique to mangroves include fire, alterations in drainage patterns, application of herbicides, and harvesting. Anthropogenic sources of stress to mangroves that were not included by Lugo et al. (1981) include sewage effluent and cooling water discharge from power plants. The following text briefly summarizes the important sources of environmental stress that may impact mangroves in coastal waters of the U.S. Virgin Islands (Tetra Tech 1991b).

1) Sewage effluent - Municipal wastewater discharge was not included by Lugo et al. (1981) as a source of stress to mangroves. However, Clough et al. (1983) reviewed the impact of sewage on mangroves and concluded that although nutrient enrichment of mangrove areas did not appear to be harmful, the impact of other effluent constituents (e.g., pesticides, metals, and organic carbon) could lead to additional stress on mangrove sediment fauna and mangrove trees.

2) Thermal effluent - Kolehmainen et al. (1973) reported that the discharge of cooling water from a power plant in Guayanilla, Puerto Rico, caused greater densities of prop roots, a reduction in leaf size, and possibly a decrease in net productivity due to increases in plant respiration. The diversity of organisms growing on prop roots also decreased with distance downstream of the power plant. These effects were attributed to the increased temperature of the cooling water discharge.

3) Oil pollution - The impact of oil on mangroves has been reviewed by Lewis (1983). Examination of the reported damage from a number of oil spills led Lewis (1983) and Lugo et al. (1981) to conclude that although the amount of oil spilled varied considerably, the extent of degradation to mangroves was dependent primarily on the tidal regime and wave-energy of the site.

4) Fire - Mangrove areas may catch fire and burn, especially those occurring in drier, upland areas. In agricultural areas where fire is used to clear land (e.g., Puerto Rico), fire can be a threat to upland fringes of mangrove (Tetra Tech 1991b). This is especially true in areas where agricultural land (including cattle grazing land) encroaches on the landward edge of mangroves.

5) Excessive harvesting - Mangroves are harvested commercially for their value in the leather tanning industry, for construction materials, and for firewood and charcoal (Tetra Tech 1991b). Over-exploitation of this resource can lead to a decline in areal coverage. When harvesting is accompanied by residential or agricultural encroachment, these activities may lead to permanent loss of harvested areas.

6) Herbicides and pesticides - Herbicides have been shown to have adverse impacts on mangrove forests and pesticides may adversely impact biota associated with these habitats (Lugo and Snedaker 1974; and Odum et al. 1982). Culic (1984) demonstrated the sub-lethal effects of the herbicide 2,4-D on the growth of red mangrove seedlings in the laboratory. Although the levels of herbicide used by

Culic (1984) exceeded levels likely to occur in runoff, sub-lethal impacts to mangroves from herbicides remain an important concern, particularly for mangroves occurring in agricultural areas.

7) Alterations of drainage - The most serious impact to mangrove forests is likely due to changes in water drainage patterns (Tetra Tech 1991b). Alterations can cause changes in flooding and stagnation that result in changes in soil salinity and the length, frequency, and depth of water inundation. These changes can be induced naturally (hurricanes and floods) or through human influence (construction, channelization, drainage or pumping activities). Mangrove areas isolated from sources of freshwater and frequent flushing by tides will gradually become hypersaline and unsuitable for mangrove growth. Similarly, areas cut off from the influx of tidal seawater and receiving large quantities of freshwater will also become unsuitable for mangrove growth.

8) Impoundment - Diking cuts off nutrient sources, while raised water levels interfere with gas exchange by covering lenticels and pneumatophores (Patterson-Zucca 1978). In dry areas, salinities will increase, causing degradation and mortality. Road building may impound mangrove areas if care is not taken to preserve water flows.

9) Sedimentation - Mangroves are adapted to high-sedimentation environments, but sudden deposition of large quantities of sediments may cause mortalities (Cintron-Molero and Schaffer-Novelli 1992). Deposition of dredge spoils is a common cause of extensive mangrove die-offs. Areas may be reinvaded by mangroves after the fill material has settled and subsided. Because of the edaphic and hydrologic changes, these new stands usually differ substantially in floristic structure and composition from the original stands, reflecting the malleability of mangroves.

10) Development - A major problem that affects mangrove habitats results from man's desire to convert mangrove areas to residential, commercial, industrial, and agricultural developments (Snedaker and Getter 1985). In these situations, the basic habitat and its functions are lost, and that loss is frequently greater than the value of the substituted activity. In general, these kinds of problems are generated by an unawareness of the natural values provided by a functioning system and by the absence of planning for integrated development that takes these functions and values into account as trade-offs.

Development of the watershed above a mangrove wetland may also negatively impact the wetland (Tetra Tech 1992). Removal of watershed vegetation results in soil erosion and subsequent siltation of the wetland (Tetra Tech 1992). Altering groundwater patterns may either drown mangroves in the case of too much runoff, or cause their death by diverting the water which sustains them. Much advance planning and care during the construction process must be involved in watershed development. Runoff and encroachment from landfills is also problematic in the USVI.

(4) Monitoring USVI Mangroves

The primary source of wetland impairment is dredging and filling, non-point source pollution, construction intrusions, and sedimentation from upland runoff (DEP 2002). Wetland areas (i.e., mangroves and salt ponds) can be monitored in a number of ways, including:

1) Water quality,
2) Species abundance/diversity,
3) Sedimentation rates,
4) Percent cover, and
5) Monitoring development/construction.

Water Quality

Under the provisions of the Territorial Pollution Control Act of 1972 (Title 12, Chapter 7, Virgin Islands Code), the Virgin Islands Water Pollution Control (WPC) Program is mandated to conserve, protect, preserve, and improve the quality of water for public use, and for the propagation of wildlife, fish, and aquatic life in the Virgin Islands. This includes the assurance that all projects are in compliance with the Water Quality Standards as set forth in the VI Environmental Laws and Regulations (specifically, Virgin Islands Code, Title 12, Chapter 7, § 184, as interpreted below).

The role of the WPC program is to facilitate the preservation and - where necessary - make improvements to water quality conditions so as to ensure that water quality standards are met; to monitor health; and to ensure that permitted discharges to waters of the VI meet effluent limitations. The DPNR/DEP is charged with the task of implementing and enforcing these provisions (DEP 2002).

The WPC comprises two programs:

1) The Territorial Pollutant Discharge Elimination System (TPDES) Program involves the permitting of wastes to be discharged from point sources into the waters of the VI, so as to ensure that those wastes meet the Water Quality Criteria in the Virgin Island Code (VIC).

2) The Ambient Monitoring Program involves the collection of samples to comprehensively evaluate coastal water quality.

The Ambient Monitoring Program involves the collection of water samples to comprehensively evaluate coastal water quality. The Department of Planning and Natural Resources (DPNR) and Division of Environmental Protection (DEP) conduct the sampling with cooperation from the Division of Environmental Enforcement (DEE) and Division of Fish and Wildlife (DFW).

Under the Water Pollution Control Grant (pursuant to Clean Water Act (CWA) § 106), the Division of Environmental Protection has been entrusted with the task of monitoring the marine waters of the USVI and controlling discharges to those waters. The Ambient Monitoring Program involves the collection of samples which will give scientific data regarding water quality, and the TPDES Program which involves the permitting of wastes to be discharged into the waters of the Virgin Islands. Permitted effluents, however, must meet the Water Quality Criteria as set forth in the Virgin Islands Code. Both programs work in conjunction with one another to preserve the quality of the ambient marine waters for the people of the Virgin Islands. The water quality standards are to be reviewed and, if necessary, updated every three years to preserve the designated uses by including more criteria with which to monitor (DEP 2002).

For example, the water quality at Mangrove Lagoon and Benner Bay, St. Thomas has been monitored irregularly between 1972 and 1993 by the Division of Environmental Protection (DEP) to keep track of any changes in temperature, salinity, dissolved oxygen concentration, and the concentration of nitrate, nitrite, and phosphorus that might be associated with development. Nitrate, nitrite, and phosphorus were sampled in 1985 only. Water turbidity, suspended solids, secchi depth, and fecal coliform levels have been monitored also. Data collected should give an understanding of the impact of the development in the area on the lagoon ecosystem. Since the Mangrove Lagoon-Benner Bay area is classified as a Class B wetland (used for propagation of desirable species of marine life and for primary contact recreation such as swimming and water skiing) with specific quality criteria (USVI Govt. 1979), the water condition of the area can be compared to Class B standards (Phillip 1993).

Species Abundance/Diversity

The Division of Fish and Wildlife (DFW) is presently establishing species diversity indices for wetlands. Species diversity in wetlands varies according to the availability of water and migration periods, together with other factors. As a result, any assessment of changes in living resources is difficult to estimate. Coastal Zone Management (CZM) has undertaken a project to create a current delineation of the wetlands in the U.S. Virgin Islands. Once a more current delineation is completed, it may lead to more active wetland monitoring (DEP 2002). Species abundance/diversity will be covered in more detail in the terrestrial wildlife portion of this plan.

Sedimentation Rates

One of the major challenges of habitat monitoring and assessment is to quantify the impact of development on the marine environment, while accounting for natural variation in the measured parameters. For management purposes, it is also important to determine the distribution of these sediments across the nearshore environment and to know when thresholds in the allowable amounts of sediment originating from a development are exceeded. Data on sedimentation rates are important for nearshore habitats, all of which are vulnerable to sedimentation from dredging operations and erosion. By collecting samples both at and above the substrate, one can estimate the sediment being stirred up from and transported along the bottom (the “bedload” component) as well as the sediment that is settling out of the water column.

Over the past several decades the Virgin Islands have experienced rapid development from the shoreline to the mountain tops. The removal of the natural vegetation and construction of unpaved roads has greatly increased erosion rates relative to natural conditions (Anderson and MacDonald 1998; and MacDonald et al. 1997). This load of silt and clay poses a direct threat to the health of the corals and other reef organisms (Rogers 1990; and Sladek-Nowlis et al. 1997). The Virgin Islands Coastal Zone Management (CZM) has recognized this threat and has begun to implement a strict code for developers proposing to build projects in sensitive shoreline areas. In a recent case in St. Thomas, CZM required the developer of the Caret Bay Villas project to install and maintain strict sediment control measures as recommended by the University of the Virgin Islands Cooperative Extension Service (Wright 1997). These measures included minimal disturbance of natural vegetation, properly built and maintained sediment fences and sediment basins, and placement of straw matting on bare soils until vegetative ground cover was established. The developer was also required to fund a 4-year monitoring program intended to record the condition of the reef complex along the coast of the development and to determine if there were any adverse effects on the reef environment due to development (Nemeth and Sladek-Nowlis 2001).

Percent Cover

One of the most cost effective technologies for monitoring percent cover and the overall health of mangroves, as well as other marine habitats, could be through the use of conventional aerial photo interpretation assisted with GIS based image analysis. Aerial photographs were used to develop the Benthic Habitats of the Florida Keys digital data atlas and just recently, a similar effort was performed for the U.S. Virgin Islands and Puerto Rico as part of the National Ocean Service’s continuing effort to document coastal resources (Kendall et al. 2001). Aerial photographs were used to create maps of the region’s coral reefs, seagrass beds, mangrove forests, and other important habitats. In addition, remote sensing, as a monitoring tool, could be used for:

1) Study of coral reefs;
2) Mapping of bottom topography;
3) Sedimentological studies;
4) Ecological mapping;
5) Studies of water circulation, sediment plumes, and effluent dispersal; and
6) Establishing a base survey for future studies of time-variant phenomena.

Monitoring Development/Construction

The Department of Planning and Natural Resources (DPNR) monitors wetlands to guarantee that unpermitted activities are not taking place and that authorized activities are in full compliance with permit requirements.

(5) Current USVI Mangrove Management Measures

Federal Regulations Applicable to USVI Mangroves

Development within or near wetlands is regulated by several Federal statutory prohibitions and incentives that are intended to slow wetland losses. Some of the more important of these are contained in the 1899 Rivers and Harbors Act; the 1972 Clean Water Act and amendments; the 1985 Food Security Act; the 1990 Food, Agriculture, Conservation, and Trade Act; the 1986 Emergency Wetlands Resources Act; and the 1972 Coastal Zone Management Act. In the following description of wetland-related Federal legislation, regulations that apply to States also apply to the U.S. Virgin Islands.

Section 10 of the Rivers and Harbors Act gives the U.S. Army Corps of Engineers (Corps) authority to regulate certain activities in navigable waters. Regulated activities include diking, deepening, filling, excavating, and placing of structures. The related section 404 of the Clean Water Act is the most often-used Federal legislation protecting wetlands (USGS 1994). Under section 404 provisions, the Corps issues permits regulating the discharge of dredged or fill material into wetlands. Permits are subject to review and possible veto by the U.S. Environmental Protection Agency. The U.S. Fish and Wildlife Service (USFWS) has review and advisory roles (USGS 1994). Section 401 of the Clean Water Act grants to States and eligible Indian Tribes the authority to approve, apply conditions to, or deny section 404 permit applications based on a proposed activity’s probable effects on the water quality of a wetland.

Most farming, ranching, and silviculture (forestation) activities are not subject to section 404 regulation, but the “Swampbuster” provision of the 1985 Food Security Act and amendments in the 1990 Food, Agriculture, Conservation, and Trade Act discourages (through financial disincentives) the draining, filling, or other alteration of wetlands for agricultural use. The law allows exemptions from penalties in some cases, especially if the farmer agrees to restore the altered wetland or other wetlands that have been converted to agricultural use. The Wetland Reserve Program of the 1990 Food, Agricultural, Conservation, and Trade Act authorized the Federal Government to purchase conservation easements from landowners who agree to protect or restore wetlands. The Consolidated Farm Service Agency (formerly the Agricultural Stabilization and Conservation Service) administers the Swampbuster provisions and Wetlands Reserve Program. The Natural Resources Conservation Service (formerly the Soil Conservation Service) determines compliance with Swampbuster provisions and assists farmers in the identification of wetlands and in the development of wetland protection, restoration, or creation plans.

The 1986 Emergency Wetlands Resources Act and the 1972 Coastal Zone Management Act and amendments encourage wetland protection through funding incentives. The Emergency Wetlands Resources Act requires States to address wetland protection in their Statewide Comprehensive Outdoor Recreation Plans to qualify for Federal funding for State recreational land. The National Park Service (NPS) provides guidance in developing the wetland component of their plans. Coastal states that adopt coastal zone management programs and plans approved by the National Oceanic and Atmospheric Administration are eligible for Federal funding and technical assistance through the Coastal Zone Management Act.

Large tracts of land, many containing wetlands, are managed by the U.S. Fish and Wildlife Service (USFWS) and the National Park Service (NPS) (USGS 1994). The largest area in the USVI managed by the USFWS is the 326-acre Sandy Point National Wildlife Refuge in southwestern St. Croix (USGS 1994). The NPS manages most of the island of St. John, along with extensive offshore areas adjacent to Park land, and BIRNM on St. Croix (USGS 1994). The NPS has received authorization to acquire lands around Salt River Bay on St. Croix (to become the Salt River Marine and Wildlife Sanctuary). Not only is this area one of the U.S. Virgin Islands' most important remaining wetland complexes, but it is also a valuable historical resource believed to be the landing site of Christopher Columbus on his second voyage to the Americas in 1493 (USGS 1994).

Territorial Regulations Applicable to USVI Mangroves

The USVI Department of Planning and Natural Resources (DPNR) is the principal agency requiring permit application for construction activities in the coastal zone, where wetlands usually form (USGS 1994). This responsibility was granted to DPNR by the Coastal Zone Management Act passed in 1978. In addition to evaluating permit requests, DPNR comments on Federal permit applications to ensure consistency with the Coastal Zone Management Plan. When wetland losses are unavoidable, DPNR requires mitigation actions to ameliorate anticipated losses. DPNR also monitors wetlands to ensure that unpermitted activities are not taking place and that authorized activities are in full compliance with permit requirements. The Territorial Legislature adopted the Indigenous and Endangered Species Act of 1990, in which section 104(e) establishes a policy of "no net loss of wetlands" to the maximum extent possible.

The national Coastal Zone Management Act, while noting the importance of the entire coastal zone, declares that certain areas are of yet greater significance (NOAA 1988). As a prerequisite to program approval, the Act requires "an inventory and designation of Areas of Particular Concern" (Section 305(b)(3)). A number of these APC reports have been written, and all pertain to wetland areas in the USVI (see Figures I-3 and I-4 in Chapter I). In addition, it is necessary that "the management program makes provision for procedures whereby specific areas may be designated for the purpose of preserving or restoring them for their conservation, recreational, ecological, or esthetic value" (Section 306(c)(9)) (NOAA 1988).

St. Croix APC and APR (Areas for Preservation and Restoration) reports include:

1) Christiansted Waterfront APC (IRF 1993g);
2) Southgate Pond/Chenay Bay APC and APR (IRF 1993k);
3) St. Croix Coral Reef System APC and APR (IRF 1993m);
4) East End APC and APR (IRF 1992d);
5) Great Salt Pond Bay APC (IRF 1992e);
6) Southshore Industrial Area APC (IRF 1993l);
7) Sandy Point APC (IRF 1993j);
8) Frederiksted Waterfront APC (IRF 1993h);
9) Salt River Bay APC and APR (IRF 1993i).

St. Thomas APC and APR reports include:

1) St. Thomas Waterfront and Harbor APC (IRF 1993d);
2) Botany Bay APC and APR (IRF 1993a);
3) Magens Bay APC (IRF 1992a);
4) Mandahl Bay APC and APR (IRF 1993c);
5) Vessup Bay/Red Hook APC (IRF 1992b);
6) Mangrove Lagoon/Benner Bay APC and APR (IRF 1993b).

St. John APC and APR reports include:

1) Cruz Bay/Enighed Pond APC (IRF 1992c);
2) Chocolate Hole/Great Cruz Bay APC and APR (IRF 1993e);
3) Coral Bay APC and APR (IRF 1993f).

(6) Current USVI Mangrove Projects

Although interest in mangrove biology goes back a long time, scientific knowledge of this intriguing ecosystem is still rudimentary, and key questions remain largely unanswered. Are mangrove communities as rich and productive as other tropical environments? Is their role in protecting juvenile fish indeed as important to commercial fisheries as many people believe? Do mangrove swamps serve to protect coastlines from erosion? Although researchers have made detailed observations of many different mangrove swamps around the world, a huge gap exists in the understanding of how the different components of such intricate natural systems work together.

Previous research on wetlands in the USVI has focused on: inventories of important saltwater wetlands (Boulon and Griffin 1999; Knowles 1997; Norton 1986; Stengel 1998); the impact of sedimentation on salt ponds (Nichols and Brush 1988); analyses of freshwater resources (Cosner and Bogart 1972); a survey of fishes to assess the importance of mangroves as nurseries for recreational fisheries (Adams and Tobias 1994; Adams and Ebersole 2002; Boulon 1991, and 1992; Dennis 1992; Mateo 2001a; Mateo and Tobias 2001; Mateo et al. 2002; Thayer et al. 1987; and Tobias 1996, 1998, and 2001); environmental studies of Mangrove Lagoon/Benner Bay, St. Thomas (Grigg et al. 1971; Olsen 1972, and 1973; Island Resources Foundation 1977d, and 1993b; Nichols and Towle 1977; and Nichols et al. 1979).

Currently, a project undertaken by the University of the Virgin Islands' MacLean Marine Science Center (MMSC), and funded by the University of Puerto Rico Sea Grant College, will make a quantitative assessment of nursery habitats for fishery stock enhancement (refer to UVI website: http://marsci.uvi.edu/research.htm). To demonstrate the importance of mangrove and seagrass habitats to reef fisheries production, studies will be carried out to quantitatively determine the proportion of a population that pass through a nursery habitat before reaching a reef and the actual rates of survival and growth experienced by fish in these different habitats.

4. SEAGRASS BEDS

(1) General Description of Seagrass

Worldwide, there are approximately 45 species of marine seagrasses (Tetra Tech 1992). Seagrasses are very productive systems. Zieman and Wetzel (1980) reported maximum productivity of *Thalassia* of up to 16 g C/m^2/day which suggests that tropical seagrass beds may be one of the more productive communities existing. Most Caribbean seagrass beds are typified by three species of angiosperms: turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), and shoal grass (*Halodule wrightii*) (Ogden 1980). *S. filiforme* and *H. wrightii* generally are the first to colonize bare sediments (Williams 1987). *T. testudinum* becomes established later and gradually becomes the dominant seagrass (Williams 1987). Often, species of macroalgae (e.g., *Caulerpa* and *Halimeda*) are interspersed between the grass blades and the grass blades themselves are colonized by epiphytes. A fourth seagrass genus, *Halophila*, that includes two species (*H. decipiens* and *H. baillonis*) does not generally occur in mixed beds of the above species, but may be found in shallow turbid waters or to depths of 50 m (160 ft.) in clear water due to its adaptation to low light intensity (Ogden 1980). A more detailed description of the Caribbean seagrass community can be found in Ogden (1980).

Seagrasses are seed-producing, flowering marine plants (halophytes) that occur in shallow, nearshore, temperate, and tropical waters (Snedaker and Getter 1985). They are able to reproduce by vegetative spreading in addition to the annual production and dispersal of seeds. As a benthic plant community, they are extremely productive and are associated with an abundance and variety of small fishes and invertebrates such as shrimp and crabs (Thorhaug 1981). For these organisms, the seagrasses provide a habitat and source of food materials consisting of the leaves of the grasses, and the epiphytes (mostly algae) that live on the leaf surfaces as well as the microfauna and rich layer of microbes. The leaves and leaf detritus also represent a food resource for many other marine animals (e.g., certain reef fishes, sea turtles, conch) that regularly visit seagrass areas for feeding and foraging on both the plants and their animal associates. Seagrass communities are also noted for their ability to trap and bind sediments which prevents erosion of the shallow sediments (Thayer et al. 1975).

The seagrasses dominate many of the temperate and tropical coastal environments of the world where there exists a suitable shallow substrate, having water of a high transparency and occurring in areas that are relatively free of strong wave action (Snedaker and Getter 1985). As a result, they are seldom found in any great abundance near high-energy beaches, particularly in or near the surf zone, or in the deltaic areas of major rivers that carry high sediment loads. Their broad range is further attributable to the fact that seagrasses as a whole can tolerate wide salinity ranges which vary in concentration from that of almost fresh water to that of full-strength and higher (hypersaline) seawater (Thayer et al. 1975).

Different genera and species of seagrasses are found at different optimal depths (Snedaker and Getter 1985). The observed distributional patterns result from differing competitive adaptations related to a complex set of environmental factors which include wave energy, currents, substrate turbidity, and light penetration. Most seagrasses occur within a depth range between mean low water and 30 meters (Thayer et al. 1975).

Seagrasses can occur in a variety of spatial and compositional patterns, such as extensive mixed or uniform meadows covering large areas, as small patches, or as dispersed, isolated plants (Snedaker and Getter 1985). They have an ability to propagate by vegetative growth of the subsurface rhizome (root) system. Thus, they tend to have the growth form of a terrestrial sod grass as opposed to that of a bunch grass. Seagrasses thrive where deep, soft sediments are found, although individual plants will survive in areas with very little substrate. This, more than other factors, is responsible for their structural formations, or the shape of the seagrass bed itself.

Seagrasses represent one of the most highly productive, tropical marine ecosystems (Snedaker and Getter 1985). Dry-weight values of gross primary productivity have been estimated as high as 8 grams carbon per square meter per year (Thorhaug 1981). High productivity is associated with both seagrass growth and the production of plant epiphytes attached to the leaf surfaces. In addition to these sources, seagrass-system productivity is augmented by contributions from benthic micro- and macro-algae, phytoplankton, and shore-based vegetation (Thayer et al. 1975). As means for comparison, productivity levels for two common genera have been determined to be higher than values calculated for corn and rice cultivation in the United States (Thayer et al. 1975).

The dominant contributions of a seagrass community are in the habitat it provides for a variety of resident animals and the organic production which provides a food resource for both permanent and temporary residents (Thorhaug 1981). In addition to the food resource value of the seagrasses and their epiphytes, the small resident fishes and invertebrates serve as a food source to larger marine animals found in adjacent waters. During winter die-back periods (in temperate regions) and during annual storm events, seagrass leaf blades break off and are transported from the system in mass. This material, when collected in windrows on beaches or in the intertidal zone, becomes a food substrate and habitat for small invertebrates during the period of decomposition and breakdown. Other masses of leaf material that are swept into deeper offshore areas also have a role in the nutrition of other marine organisms. Another well-recognized role is one that is associated with the rhizome system whereby loose sediments are consolidated and held into place, particularly during storm events (Thayer et al. 1975). In addition, seagrass beds help maintain water clarity by trapping fine sediments from upland soil erosion and serve as nursery areas, providing refuge for many recreationally and commercially valuable species of fish and other marine life.

While seagrasses have no major economic or commercial uses, they have been reportedly used as a source of fertilizer, chemicals, and fodder (McRoy and Helffrich 1980). The primary uses and subsequent value of seagrasses reside in their roles in providing a major habitat and food resource for nearshore fisheries, marine reptiles and mammals, and coastal stabilization (McRoy and Helfrich 1980).

The basic habitat requirements for seagrasses are a shallow, soft substrate and water of high transparency (Thayer et al. 1975). In addition, they require circulation of the overlying water which delivers nutrient and substrate material and removes metabolic waste products. In the regions in which they do occur, seagrasses do not develop in shallow areas that are exposed at low tide, although they can survive brief exposure during periods of exceptionally low tide. Because of their requirement for a relatively high light intensity, they are limited to water depths that do not exceed 20 meters unless the overlying water is extremely clear and transparent (Livingston 1982). They are commonly associated with coral reef communities because of their similar requirements for water of superior quality. Conversely, they are only rarely found occurring contiguously to mangrove ecosystems because the dark, organic-stained waters flushed from around mangroves on falling tides can limit photosynthesis. Although seagrasses are a hardy group of plant species, they are extremely sensitive to excessive siltation, shading, water pollution, and fishing practices that use bottom trawls which scrape the beds (Zieman 1975). Siltation and shading reduce ambient light levels in the water, resulting in a lowering of the rate of photosynthesis or, in extreme cases, completely inhibiting it. Certain pollutants in water have toxic effects on the growth and development of not only seagrasses, but also many of their animal associates. They are also sensitive to hot-water discharges and are usually eliminated from areas subjected to effluents from power plants (Zieman 1970). For reasons that are not clearly established, seagrasses only slowly, if at all, re-vegetate areas that have been dredged (VanEepoel et al. 1971). Typically, when a seagrass community is eliminated, its marine animal associates also disappear from the area.

The major problems that affect seagrasses throughout the world are their destruction through widespread dredge and fill activities, sand mining, and water pollution which include brine disposal from desalination plants and oil production facilities, waste introductions around industrial facilities, accidental spills of petroleum and petroleum products, and thermal discharges from power plants (UNESCO 1983). Other coastal engineering works may so alter currents that seagrass beds are destroyed. Other physical disturbances include anchor and propeller damage. The loss of seagrasses is also indicative of a significant loss in marine animal production, primarily because of habitat destruction (Zieman 1970). The animal communities of seagrass beds are readily overfished because of their accessibility and visibility (UNESCO 1983). Beach-seining for little fishes is very destructive. Conch (*Strombus* spp.) and edible echinoid populations (*Tripneustes* spp.) have been drastically reduced in some parts of the Caribbean (UNESCO 1983). Additionally, many hoteliers around the USVI replenish their beaches with new sand and it is unknown what effect the repeated erosion and sediment transport may have on seagrass beds In many areas, the disappearance of seagrass communities is only noted by local fishermen because, unlike mangroves and coral reefs, seagrass communities are not visually obvious to most observers.

Sediments rendered unstable by removal of seagrasses can be shifted by currents or storms and may have a deleterious impact on adjacent seagrass beds, mangroves, coral reefs, beaches, or navigational channels (UNESCO 1983). There will no longer be a supply of particulate organic matter exported to other systems and secondary productivity will be reduced. A nursery and feeding ground for reef fishes and invertebrates will have been destroyed.

(2) USVI Seagrass

Four species of seagrass that are common to Virgin Island waters include the following (Ogden and Zieman 1977).

1) Shoal-grass (*Halodule wrightii*) - An early colonizer of disturbed areas and usually grows in water too shallow for other species. The leaves are thin and flat in cross-section.

2) Turtle-grass (*Thalassia testudinum*) - The most common of the local grasses, characteristically has deeper root structures than the other seagrasses. The leaves are ribbon-like and can be over a foot long.

3) Manatee-grass (*Syringodium filiforme*) - Easily recognized because the leaves are round in cross-section.

4) Small turtle-grass (*Halophila baillonis*) – With small, rounded leaves, usually paired. This seagrass is found deeper than the other species and looks very delicate.

Seagrasses in the Virgin Islands are disappearing due to many of the reasons stated above (Tetra Tech 1991b) including dredging and filling projects, soil erosion, and increased levels of water pollution. As residential and commercial development continues to reach outward to coastal areas, seagrass beds continue to be affected. Other factors are also affecting the health and stability of local seagrass beds (Tetra Tech 1991b). Strong waves caused by storms can rip the roots from the seafloor. Heated water discharged from industrial plants can inhibit seagrass growth. Elevated salinity levels caused by the discharge of salt water from desalination plants can be harmful to seagrass beds. Poisons and other pollutants cloud the water, preventing the grasses from receiving the sunlight needed for growth.

In the U.S. Virgin Islands, the proliferation of residential septic tanks has resulted in high soil loading which, during high rainfall, generates nutrient-rich runoff into the sea (UNESCO 1983). This has caused short-term eutrophic conditions in various bays around St. Thomas and St. Croix. Excessive nutrient enrichment of seagrass beds could result in the replacement of seagrass with phytoplankton or benthic algae (Zieman 1982). Boaters can cause significant damage by anchoring and boating on seagrass beds.

Drastic interference in the marine environment has caused stress to local marine habitats over the last decade (Adams et al. 1998). Increasing anthropogenic interference such as boat anchors are constantly ripping through seagrass beds (Adams et al. 1998). The need for long-term assessment of seagrass habitats in the USVI has been a critical one.

A Benthic Habitat Assessment Project (BHAP) was developed to record current and long-term changes in a variety of underwater habitats around the U.S. Virgin Islands, including seagrass beds. This is an on-going, long-term project funded under the Sport Fish Restoration Act (16

U.S.C. 777-777K). The assessment is being conducted by USVI's Division of Fish and Wildlife (Adams et al. 1998; Chapman 1996; and Chapman et al. 1996). The main focus of BHAP is to provide data on the distribution and abundance of various recreationally important fisheries habitats through the installation of permanent transects (Bohnsack and Bannerot 1986; Osborne and Oxley 1995; and Rogers et al. 1994). These transects are used to characterize the predominant shallow water benthic habitats and to monitor change over time. One aspect of this study (grant no. F7-19) was designed to determine the status and quantify the extent of various recreationally important fisheries habitats within the Cas Cay and Great St. James Marine Reserves and in adjacent areas. This study will provide databases needed for Geographic Information System (GIS) maps detailing critical information on the extent and condition of recreational fisheries habitat types. Areas will be identified that could be included in a system of marine conservation zones. The databases and associated GIS maps could then be used to monitor long-term changes in the different habitats. This information could then provide a better insight for the development of management strategies in order to protect these critical marine habitats (Adams et al. 1998).

St. Croix Seagrass

Well-developed seagrass communities occur throughout the island (Tetra Tech 1992; also refer to Appendix 2B). The presence of turtle grass, manatee grass, and shoal grass has been noted in Manning Bay on the south coast (Tetra Tech 1985b) and in Tague Bay Lagoon (Williams 1987, 1990). The presence of *Halophila* has been noted in the Salt River submarine canyon (Williams 1988a).

St. John Seagrass

Seagrass communities are distributed throughout the coastal areas of St. John (Tetra Tech 1992; also refer to Appendix 2A). Williams (1987, and 1988b) has reported on the seagrass beds of Hawksnest, Trunk, Cinnamon, Maho, and Francis Bays. Maho and Francis Bays support turtle grass beds. Hawksnest, Trunk, and Cinnamon Bays contain communities composed of manatee and shoal grass.

St. Thomas Seagrass

Limited information on the seagrass communities in St. Thomas indicates that beds of turtle and manatee grass are common and have been noted near Saba Island, in Perseverance Bay and Brewers Bay (Rogers 1982) and in Lindberg Bay (Zieman 1975). Generally, seagrass beds may occur throughout the islands in association with coral reefs and mangrove areas. Refer to Appendix 2A.

(3) Priority Issues Concerning USVI Seagrass Beds

Sources of stress to seagrass beds are similar to those identified for coral reefs and mangroves. Seagrasses have received less attention than coral reefs or mangroves, therefore, a thorough review of the impacts is not possible. However, a brief listing of the sources and causes of natural and man-induced stresses (Thorhaug 1981; Zieman 1975) includes the following.

1) Natural Stressors
   a) Wind and sea stress - Tropical storms and hurricanes.
   b) Grazing by herbivores - Natural exploitation of resource.

2) Anthropogenic Stressors
   a) Dredging and filling - Construction activities.
   b) Eutrophication - Wastewater discharge, non-point source pollution.
   c) Temperature and salinity - Power plant and desalination effluents.
   d) Oil pollution - Petroleum refining and transport.
   e) Physical disturbance - Boat propeller and anchor damage.
   f) Chemical pollutants - Industrial effluents, non-point source pollution.

(4) Monitoring USVI Seagrass Beds

Monitoring of degraded and healthy habitats needs to be implemented, particularly near recent sources of pollution and/or other detrimental activities. Photographic documentation can lead to very valuable information on short to medium term changes in the community structure. The resources needed and the time needed to be spent to carry on this activity are minimal for the quality of the information obtained.

(5) Current USVI Seagrass Management Measures

Seagrass fall within the scope of both federal and territorial regulations concerning marine habitats and coastal zone management.

Federal Regulations Applicable to USVI Seagrass

There are no specific federal regulations regarding seagrasses. However, in a broad perspective, seagrass is covered under the Coastal Zone Management Act of 1972. In recognition of the importance of coastal resources to the nation’s economic and environmental well being, and of the escalating and conflicting demands for their use, Congress enacted the Coastal Zone Management Act of 1972. The intent of the Act is to stimulate state and territorial leadership in planning and managing the use of coastal areas. The Act establishes grant programs to financially assist the states and territories in developing management programs (NOAA 1988).

At the Federal level, responsibility for administering the Coastal Zone Management Act has been delegated to the Office of Coastal Zone Management (OCZM) within the U.S. Commerce Department's National Oceanic and Atmospheric Administration (NOAA). Its major responsibilities involve the disbursement of grant funds and the establishment of program guidelines. Fulfillment of these guidelines (Program Elements) is necessary for program approval and receipt of Section 306 Administration Grants. The Program Elements are:

1) Delineation of the boundary of the geographic area to be managed.

2) A determination of land and water uses which have a direct and significant impact on coastal waters and which will be managed. Priority of use as well as permissible coastal uses are to be identified.

3) A designation and inventory of geographic areas of particular concern.

4) Public and governmental involvement.

5) Consultation and coordination with relevant Federal agencies, and consideration of the national interest.

6) Development of an organizational structure and legal authorities to implement the Program.

Amendments to the Coastal Zone Management Act in 1976 specify three new 305 elements that must be completed. They are:

1) A planning process that identifies public shorefront areas appropriate for protection and/or increased access,

2) A planning process that can anticipate and manage the impacts from energy facilities in or on the coastal zone, and

3) A method of assessing the effects of shoreline erosion.

Within the general Federal planning framework, each of the thirty-three coastal states and territories has considerable flexibility to create a program and develop an approach which addresses their particular coastal problems and needs. In the Virgin Islands, the Department of Planning and Natural Resources (DPNR) is responsible for program development (NOAA 1988).

Territorial Regulations Applicable to USVI Seagrass

Marine reserves in the U.S. Virgin Islands, especially those within territorial waters (less than 3 miles from shore), include seagrass beds, even though the reserves may not have been specifically created for that resource (Hinds Unlimited 2003; Impact Assessment 1997; and NOAA 1981). The laws, and rules and regulations, for territorial waters are codified in the

Virgin Islands Code (VIC) and in V.I. Rules and Regulations (VIRR—primarily within Title 12), respectively. Various marine reserves have been designated in the VIC and by the Commissioner of DPNR, which were identified in the previous section on agencies involved in fishery and resource management. Rules and regulations for the mooring and anchoring of vessels and houseboats are also covered in VIRR, Title 25, Chapter 16. In addition, 18 Areas of Particular Concern (APCs), although lacking management plans, have been designated under Federal and Territorial authority which undoubtedly include seagrass beds (NOAA 1988).

One of the more promising aspects of the Virgin Islands Coastal Zone Management Program has been the prospect that Areas of Particular Concern (APC) management plans would provide needed conservation guidelines and site protection strategies for valuable resource features within each of the 18 identified APCs, all sited within the V.I. coastal zone (NOAA 1988). However, owing to the unrealistic scope of these APCs and the huge amount of money that would be required to adequately plan and implement each of these APCs, this has not happened.

Although part of the Virgin Islands CZM Program, APC planning was initially shunted aside (except for a half-dozen good-intentioned, rough-draft plans developed by Robert Teytaud, first under the direction of the Dept. of Conservation and Cultural Affairs and later DPNR, in the 1980s (IRF 2002). Nothing else was done until 1991 when the Island Resources Foundation was contracted by DPNR to research and produce all 18 APC management plans in draft form in less than 24 months. Each draft plan was reviewed in a series of public meetings. A disagreement over the scope of the documents followed after all 18 APC plans had been accepted by DPNR, and the Island Resources-generated documents have since been redefined as background documents. Subsequent contractors have failed to complete the required “management plans” for a selected and limited number of APC sites. To-date, no APC management plan has been approved by the Virgin Islands Legislature, a step required under CZM legislation prior to plan implementation (IRF 2002).

(6) Current USVI Seagrass Projects and Research Overview

At this time, there are no current projects that deal solely with seagrass. Most of the projects mentioned in the preceding section on coral reefs also apply to seagrass beds. There are a few monitoring projects that target marine benthic habitats, including seagrass. These include the following:

1) St. Thomas Habitat Surveys – This project was conducted by the USVI DFW. Habitat surveys included surveys of seagrass beds (Volson 2001).

2) Benthic Habitat Assessment Project – The focus of the Benthic Habitat Assessment Project is to provide data on the distribution and abundance of important recreational fisheries habitat and to monitor change by installing permanent transects at sites which characterize the predominate shallow water benthic habitats in the Virgin Islands (Chapman 1996; Chapman et al. 1996; Adams et al. 1998; and Kojis et al. 2000).

5. SALT PONDS

(1) General Description of Salt Ponds

The U.S. Virgin Islands were formed during tectonic plate movement and subsequent volcanic activity in the late cretaceous period (USGS 1994). The U.S. Virgin Islands and its cays (excluding St. Croix, which was formed from a different geological process) are craggy, mountainous, steeply sloping islands with irregular shorelines. Due to their topography, and the abundant coral reef found in the warm waters, these islands exhibit a wetland formation phenomenon found only in similar geographic regions around the world. This phenomenon is the formation of salt water ponds, or “salt ponds”. Saltponds are the predominant marine wetlands in the USVI (USGS 1994). They are tidal flats or basins that are at least partially separated from direct contact to the sea by a beach berm (USGS 1994).

Occasionally subject to intertidal flushing, by breach of the berm, most salt ponds are separated from the sea for long periods of time. Tidal flushing usually occurs in periods of extreme high tides caused by storm surges or hurricanes. Some ponds may also receive an influx of salt water as tides rise and sea water seeps through the permeable berm (Grigg and VanEepoel 1970).

Salt ponds are a variable wetland habitat (Stengel 1998). Because salt ponds are isolated from the sea with infrequent tidal flushing, salinity, temperature, size, and even longevity of the ponds are all parameters subject to change. Seasonal depth of water and size of a given pond will vary depending on environmental factors such as the rate of evaporation and amount of rainfall (Barnes 1980). Salinity of the water in each pond will also vary accordingly. Salt concentration can range from below that of sea water to super saturated. Salt pond size, salinity, and depth can change from month to month, making it difficult to define boundaries and give a concise description of the pond.

(2) USVI Salt Ponds

The wetlands in the U.S. Virgin Islands occupy about 3% of the land area (USGS 1994). Based on measurements taken from the U.S. Fish and Wildlife Service’s (USFWS) National Wetlands Inventory, there are about 960 acres of wetlands on St. Croix, 320 acres of wetlands on St. Thomas, and 425 acres of wetlands on St. John (USGS 1994). Much of these wetlands are salt ponds.

Buttonwood, found at 80% of the ponds, is the most prevalent species of mangrove around salt ponds in the USVI (Stengel 1998). Buttonwood is usually located furthest from the pond where fluctuations in water depth and salinity does not inhibit growth. White mangroves are found at 71% of the salt ponds, and black mangroves are found at 45% of the ponds in the USVI (Stengel 1998). Perhaps in ponds where conditions allow for healthy growth of white mangroves, black mangroves are being squeezed out by competition. Red mangroves are found at 30% of the salt ponds in the USVI (Stengel 1998). Evidence by Barnes (1980) suggests that red mangroves are characteristic of wetlands with more stable water levels. Since annual fluctuations of water level in many ponds range from dry to fully flooded, red mangroves would be less likely to be found at such ponds.

With more than 80 ponds on St. Thomas, St. John, St. Croix, and the adjacent cays, salt ponds are the dominant form of marine wetlands found throughout the USVI (USGS 1994). Salt ponds are small bodies of saltwater which form into intertidal basins. Originally open to the sea as part of a bay or inlet, salt ponds become separated as land forms across the bay, effectively isolating the pond from the sea. This isolation occurs, over time, from storm surges washing coral, cobble, and sand onto an existing obstruction (i.e., fringing coral reef or sandbar). Despite their variability, and shifting boundaries, salt ponds play an important role in the ecology of the Virgin Islands (Stengel 1998).

Of the approximately 82 salt ponds found in the U.S. Virgin Islands, 18 are located on St. Thomas, 33 are on St. John, 13 are on St. Croix, and 18 are found on the smaller, adjacent islands and cays (Stengel 1998). Salt ponds in the Virgin Islands are extremely variable in their parameters. Salt ponds range in size from the 0.16 ha (0.4 acre) Hassel East salt pond on Hassel Island to the 9.75 ha (24.1 acres) Grootpan Bay on St. John. Salinities range from near freshwater at 10 ppt, at Great Bay South on St. Thomas, to more than 100 ppt at Salt Pond on St. John. Pond depth ranges from 0 meters at dry ponds such as the Privateer Bay on St. John to more than 2.5 meters (8.2 ft) for fully flooded ponds such as Enighed Pond on St. John (Stengel 1998).

Vegetation diversity and abundance also varies for each pond (Stengel 1998). Surrounding vegetation ranges from lush thickets of mangrove forests, found in Bolongo Bay and Perseverance Bay both on St. Thomas, to arid, sparse, scrubby vegetation found at Southside Pond on St. John (Stengel 1998). Ten ponds support all four types of mangroves, while seventeen ponds support only one type of mangrove (Stengel 1998).

Salt ponds serve several beneficial purposes in the USVI. First, they provide an essential habitat for indigenous and migratory birds, many of which are either locally or federally threatened or endangered (Philibosian and Yntema 1977). It is estimated that 90% of the resident and migratory birds in the U.S. Virgin Islands are dependent on wetlands for feeding, nesting, or roosting (Philibosian and Yntema 1977). As the dominant type of wetlands in the USVI, salt ponds are essential habitat for these resident and migratory species.

In the USVI, only coral reefs surpass mangrove habitat in terms of wildlife diversity (Grigg and VanEepoel 1970). Mangroves are essential to the food chain in the salt ponds (Lugo and Snedaker 1974). Mangrove leaf litter decays providing highly organic detritus for small invertebrates to feed on (Lugo and Snedaker 1974). These invertebrates are in turn fed upon by birds and other wildlife. Mangroves in ponds open to the sea provide a nursery habitat for larval and juvenile fish and marine invertebrates (Kaplan 1988; Lugo and Snedaker 1974). Protection from predators is provided among the extensive mangrove root systems.

Another essential benefit salt ponds provides is that of a natural sediment trap for runoff and pollutants (Lugo and Snedaker 1974; Grigg and VanEepoel 1970). Rain can wash debris, soil, chemicals, and other pollutants down the steep drainage. Sediment and debris then flows into the sea, degrading seagrass beds and coral reefs, both essential to marine ecology. Salt ponds located in these drainage basins function as natural filters. Pollutants and sediment found in runoff flow into the salt pond basin, where debris then settles to the bottom of the pond instead of flowing freely into the ocean. Sediment is trapped within the pond, straining it from the water in the runoff. This protects reefs and seagrass beds from harmful contaminants found in runoff and promotes better water quality.

Salt ponds are also beneficial as an aid in flood control (Dahl and Johnson 1991). During storm surges, the presence of salt ponds and their traditional mangrove vegetation act to help dissipate wave action. This lessens the effect of pounding waves on upland property. The ponds provide a catchment basin for rising tides, holding flood waters at bay, again dampening damage to upland areas. The salt pond basin also continues to hamper sedimentation. As a catchment and barrier against waves, salt ponds can help prevent shoreline erosion.

Man-induced wetland alterations have been severe and will likely be long lasting. Wetlands remained virtually untouched until the 1960s (USGS 1994). Then, during the economic growth period of the 1960s and 1970s, approximately 14 wetland sites were altered on St. Thomas and St. John (USGS 1994). The most extensive wetland alteration took place at Kraus Lagoon on St. Croix, the largest of the U.S. Virgin Island wetlands. By the late 1970s, the wetland complex was virtually eliminated by dredging and filling for construction of port facilities for a major oil refinery, an aluminum plant, and a container manufacturer. An important large wetland complex, Mangrove Lagoon-Benner Bay on St. Thomas, has been similarly impacted. Mangrove Lagoon is one of the U.S. Virgin Islands largest wetland complexes consisting of salt ponds, barrier reef, and fringing mangroves. Loss of mangroves and associated submerged seagrasses and corals has resulted from construction of recreation facilities and businesses, and from encroachment by a major landfill. Turpentine Run, which debouches into Mangrove Lagoon, was channelized to allow this development. The result is extensive flooding of homes and businesses constructed in the lower flood plain of the stream whenever rainfall is heavy.

Wetlands of the U.S. Virgin Islands remain susceptible to development (USGS 1994). Their location along the shoreline make them particularly attractive as sites for tourist facilities and water dependent developments. It is relatively easy to construct marinas from salt ponds, as was done in Southgate Pond on the north shore of St. Croix and Mandahl Pond on St. Thomas. The pressure for such facilities is particularly heavy with over 5,000 vessels registered in the U.S. Virgin Islands (C. Lowry, DEE, personal communication).

Wetlands are also susceptible to degradation by sedimentation from upland areas (Knowles and Amrani 1991; and Knowles 1997). The extent to which this type of impact is occurring is unknown; however, the possibility is such that watershed management should be considered as part of an overall wetland protection strategy. With salt ponds playing such important roles as habitat, flood control, and sedimentation basin, the need to preserve and maintain these wetlands increases. Since salt ponds are the predominant type of wetland in the USVI, maintaining them should be a top priority.

(3) Priority Issues Concerning USVI Salt Ponds

The priority issues concerning USVI salt ponds are essentially the same as those concerning USVI mangroves (refer to priority issues concerning mangroves). The greatest factor effecting loss of USVI wetland habitat, in general, and the loss of salt ponds, in particular, is human impact (Stengel 1998). All salt ponds are coastal wetlands subject to extreme developmental pressure. As tourism and population in the U.S. Virgin Islands increases, the demand for more waterfront property increases. Restauranteurs and hoteliers look to wetlands, salt ponds and mangroves, because they are prime real estate locations. In addition, tourism boosts the need for more marinas and larger transportation facilities (ferry docks). Much of the coveted waterfront property in the Virgin Islands is currently wetlands (Stengel 1998).

Historically, and currently, wetlands have been destroyed both legally and illegally despite federal laws mandating otherwise (Stengel 1998). Dredge and fill materials have been dumped into the salt ponds to create foundations for the homes, hotels, and restaurants. This destroys crucial habitat for local and migratory species of animals. The irrevocable damage not only affects wildlife within the salt pond boundaries but nearby marine life is affected as well. Coral reefs and seagrass beds are no longer protected as sedimentation flows unchecked into the ocean (Stengel 1998).

The last 50 years have seen a dramatic increase in commercial and private development (Stengel 1998). Wetland losses have also increased within the same time period. St. Thomas has experienced many salt pond losses as the direct result of development. The Wyndam Sugar Bay Resort sits on the remains of an old dump site, which prior to that was the location of several salt ponds. A large two hectare (~5 acre) salt pond was filled in to create land on which to build the Cabrita Point condominium complex. Another salt pond at Vessup Bay was filled to create a road. Many other salt ponds have been opened to the sea including Flamingo Bay on Water Island, Mandahl Pond on St. Thomas, Chocolate Hole North and Enighed Pond both on St. John, and what is now Sapphire Beach Resort Marina on St. Thomas (Stengel 1998). The Cyril E. King Airport was built on what was the largest salt pond on St. Thomas.

The need for shoreline property conflicts with the need to conserve and preserve wetlands. With salt ponds playing such important roles as habitat, sedimentation basin, and flood control, the need to preserve and maintain these wetlands increases (Stengel 1998). Since so many salt ponds have been lost, and because salt ponds play so many important roles in the USVI, maintaining them should take top priority (Stengel 1998).

(4) Current USVI Salt Pond Management Measures (Federal and Territorial)

The current management measures that apply to salt ponds, in particular, and wetlands, in general, are the same as those that apply to mangroves (see the USVI mangrove section above). For federal and territorial regulations related to salt ponds, see the discussion above related to USVI mangroves.

(5) Current USVI Salt Pond Projects and Research Overview

DFW Wildlife staff are currently working on a wetlands conservation plan for the USVI. This includes an assessment of the wetlands breeding bird population on St. Croix and a general assessment (general physical characteristics, condition, and priority needs) of the salt ponds on St. Thomas and St. John (Dr. Renata Platenberg, DFW Wildlife Biologist III, personal communication).

6. ALGAL PLAINS

(1) General Description of Algal Plains

Algal species that stabilize the sediment of algal plains include *Halimeda, Udotea,* and *Caulerpa*, together with other algae such as *Anadyomene, Agardhiella,* and *Gracilaria* spp (Olsen et al. 1981). Large red algae (*Laurencia, Gracilaria, Halymenia, Dasya, Chondria*, etc.) are commonly attached to shells or coral rubble. Both the density and diversity of algae increases away from nearby reefs. The bottom area covered by major clumps of associated algae/sponges at 40 m (131.2 ft) from the reef ranges from 20% to 35%. At further distances from reefs, a total of 60% to 85% of the algal plain area has at least some animal or plant cover, if only a light cover of diatoms, blue-green films, or filamentous red algae.

Algal plains follow a gradual transition to adjacent coral reefs, reflecting the effects of grazing fishes that move out from the reef (Earle 1972; and Dahl 1973). The sediment of the algal plain is coarse sand and coral rubble (Ballantine 1977). Besides carbonate nodules (see below) and the sponges mentioned above, an occasional patch reef, coral head, empty conch shell, or sand mound may also provide some limited vertical relief (Kimmel 1985a). Algal plains also contain a diverse assemblage of rooted macroalgae, tunicates, and other benthic animals, which may cover 40% to 50% of the area (Dahl 1973). Strong erosive forces caused by surface weather conditions may uproot algal species such that both floral and faunal communities undergo periodic qualitative and quantitative changes (Kimmel 1985a).

(2) USVI Algal Plains

The predominant benthic habitat in the Virgin Islands is the algal plain, which covers most of the non-reef areas deeper than 20 meters (~65.6 ft.) (Holmes 1978). Algal plains are sandy bottoms which are dominated by algae. In the Virgin Islands much of the algal plain is covered with carbonate nodules which are formed by coralline algae called rhodoliths (*Lithothamnion spp.*) and encrusting foraminifera (Holmes 1978). Rhodoliths are a prominent component of the shelf, particularly on the shelf south of St. Thomas (Jason Vasques, USVI DFW fisheries biologist, personal communication). Rhodoliths act as rubble and help stabilize the sediment. These nodules also provide habitat for many fishes like juvenile *Cephalopholis fulva*, and adult *Serranus tigrinus, S. tabacarius,* and *S. tortugarum.* Carbonate nodules and the occasional large sponge provide some limited habitat complexity in what is otherwise a very flat and relatively featureless area. This community is extremely productive under normal conditions but is sensitive to light reduction (Wells and Olsen 1973).

Algal plains and sand were the most abundant habitat types encountered during a survey around St. Thomas and St. John conducted by Friedlander (1997). Total area covered during the survey was 74,226 m^2 (18.3 acres) with algal plains accounting for 34% of the total area, and 25% sand, 14% seagrass, 14% coral reef, and 13% coral rubble. Overall, algal plains account for 70% of the insular shelf area of the Virgin Islands. Algal plains occur in a wide range of water depths, although the most extensive areas are essentially bare sand and occur below 60 feet in depth. Even here, the lack of extensive plant growth is not easily explained, but may be due to low light intensity and/or the nature of the sediment. Another possible explanation may be that the sand is shifting at a rate which prevents plant establishment. Sand bottoms with algal cover are often called algal plains, even though the algae may not cover a large area.

In a survey of an algal plain off St. Thomas (Olsen et al. 1981), over 52 species of algae, dominated in large part by chlorophycean (green) algal species, were collected during quadrat sampling. The dominant plant species included the spermatophyte (seed-producing) *Halophila baillonis*, the chlorophytes *Caulerpa*, *Halimeda*, *Udotea*, *Penicillus*, *Anadyonemes, Valonia,* and *Avranvillea* and the Phaeophytes (brown algae) *Pocokiella* and *Dictyota*. Crustose coralline algae (encrusting red algae) like *Goniolithon sp.*, two species of *Lithothamnion* and another unidentified crustose coralline made up over 60% of the coverage. As part of that study, a fish census was completed (Olsen et al. 1981) in which 43 species of fish were observed. Almost all of these were smaller, inconspicuous forms like wrasses, basselets, blennies, and damselfish. The only commercial species of consequence was the queen triggerfish, *Balistes vetula*, which was rather common. It has also been speculated that algal plains may play a significant role as habitat for postlarval settlement of other commercial species of fish.

Sponges appear to comprise the majority of the biomass of major (sedentary) faunal groups occurring on the algal plains (Dahl 1973). These filter-feeding organisms provide a structural habitat and shelter for a variety of organisms, and are themselves consumed by certain fishes (Randall 1983). Tunicates, bryozoans, molluscs, polychaetes, and gorgonians comprise other faunal groups of the plains, containing both filter-feeding and deposit-feeding organisms. Many of them, like the algae found here, appear to be adapted for reestablishment after dislocation by current or waves (Olsen and Sheen 1975).

Dahl (1973) reported only light grazing pressure by herbivorous fish on the algal plain. Instead, the major herbivores of the plains are snails, which graze on macroalgae and epiphytes. The molluscan fauna of the algal plain is distinct from the deepwater, depauperate sand area. The American thorny oyster (*Spondylus americanus*) is commonly encountered in the algal plain. The queen conch, *Strombus gigas*, is found in the algal plain but not in the adjacent depauperate sand area. The boundary between the two is marked by a band of the carrier shell, *Xenophora conchylifera*, both dead shells and live animals. Crustaceans include the hermit crabs *Dardanus venosus* and *Clibinarius tricolor*. Several species of burrowing polychaetes are also prevalent.

In a study of queen conch around the northern Virgin Islands (Friedlander 1997), algal plains had the highest density of adult conch, followed by seagrass beds and sand. Juvenile conch showed less preference for a particular habitat but were still most abundant in algal plain habitats.

Algal plains have not been well studied for values or impacts, but these areas are often located offshore in deeper water and are relatively tolerant of development and human activities (IRF 1977a). Possible negative impacts could include anchor damage by large ships, light attenuation from sediment plumes after heavy rainfall events, pollution, and overfishing.

(4) Priority Issues Concerning USVI Algal Plains

The priority issues concerning USVI algal plains are essentially the same as those concerning coral reefs and seagrass beds (refer to priority issues sections for coral reefs and seagrass beds).

(5) Current USVI Algal Plain Management Measures

There are little or no management measures, such as MPAs, APCs, fishing regulations, etc., specifically aimed at algal plains. However, some management measures probably do apply to areas that include some portions of algal plains (CFMC 1985b, 1990, 1993, and 1994). In addition, management measures designed to control sedimentation, pollution, etc., and primarily intended for other habitats (e.g., wetlands, coral reefs, seagrass beds, etc.) also benefit algal plains (NOAA 1988).

(7) Current USVI Algal Plains Projects and Research Overview

There is little or no research specifically aimed at algal plains. DFW has done species counts on algal plains areas adjacent to potential artificial reef sites off St. Croix (Tobias 2000).

7. MARINE SPECIES

There are literally hundreds of marine species within the waters of the U.S. Virgin Islands. In 2004, as part of the draft amendment to the Sustainable Fisheries Act, CFMC completed a review of more than 100 marine species (see CFMC 2004). Instead of repeating this exercise, relevant sections of CFMC (2004) have been extracted and included in Appendix 1. Reef fish are included in Appendix 1A, invertebrate species are in Appendix 1B, and other species are included in Appendix 1C.

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CHAPTER IV
OVERVIEW OF FISHERIES AND MARINE RECREATION

1. COMMERCIAL FISHERIES

(1) Description of USVI Commercial Fisheries

Surveys of the commercial fishery of the USVI go back to at least 1930 when Fiedler and Jarvis (1932) conducted a survey of 85% of the fishers and described the fisheries of all three major islands: St. Thomas, St. John and St. Croix. This survey was part of President Hoover's initiative to improve the economic condition of US Virgin Islanders by analyzing the economic potential of the fishery of the USVI. In 1959, a survey of the commercial fishery of St. John was performed by Idyll and Randall (1959) at the request of the U.S. National Park Service. A brief summary of the St. Croix fishery was presented in 1961 (Anon. 1961) to a meeting of Caribbean Fisheries officers in San Juan, Puerto Rico (Swingle et al. 1970). The last major survey of USVI fisheries was in 1967-68 when Swingle et al. (1970) surveyed an estimated 69% of full-time fishers and 25% of part-time fishers. Since there was no commercial fisher license in either 1930 or 1967, the total number of commercial fishers could only be estimated when these surveys were conducted. In 1996 a rapid socioeconomic evaluation, consisting of a literature review and fisher interviews, was undertaken to ascertain the impact on local fishers of a proposed area closure (marine conservation district) south of St. John (Downs and Peterson 1997).

Over thirty years have passed since the last detailed survey of the fishers and fisheries of the USVI (Swingle et al. 1970). Current and detailed information about the commercial fisheries and commercial fishers was sorely needed. In 2003, NOAA Fisheries and the Caribbean Fishery Management Council (CFMC) identified this need and asked the Department of Planning and Natural Resources, Division of Fish and Wildlife to carry out a census of the commercial fishers of the USVI patterned after the periodic census of commercial fishers conducted in Puerto Rico (Matos Caraballo and Torres Rosado 1989).

In mid-2003, a new commercial fisher census was initiated (Kojis 2004) to describe the socioeconomic and demographic characteristics of commercial fishers in the USVI and to provide information on their fishing equipment (boats and fishing gear) and fishing related activities. Additionally, fishers were asked their opinions on the condition of their fishery compared to 10 years ago.

According to Kojis (2004), commercial fishers in the US Virgin Islands were on average 50.5 years old, had fished almost 23 years, and planned to continue to fish for the rest of their lives. Over half the commercial fishers in the USVI had not completed high school. The level of education of commercial fishers in St. Croix District was significantly lower than in St. Thomas/St. John District. More than half of the licensed commercial fishers in St. Croix District had only completed elementary or junior high school. The largest percentage of commercial fishers in the USVI was black. On St. Thomas/St. John the majority of fishers were of French descent while on St. Croix the largest percentage of fishers was Hispanic. Two-thirds of fishers in the USVI identified themselves as full-time fishers and one third identified themselves as part-time or opportunistic fishers. USVI commercial fishers reported earning an average of 64.5% of their income from fishing. Individual fishers earned 0% to 100% of their income from fishing depending on whether they fished primarily for personal consumption or their only income was from fishing.

Most commercial fishers owned a boat with a single outboard motor that they fueled with gasoline (Kojis 2004). The average boat length in the USVI was 21 feet. Most fishers owned boats ranging in length from 16 to 25 feet. Boats were constructed primarily of fiberglass and wood. Over half of fishers in the USVI carried a cell phone when they fished and a quarter owned a GPS. Echo sounders were installed on over a third of the fishing boats in the USVI. Winches were installed on 25% of the boats in St. Thomas/St. John District while electric reels were installed on about 10% of fishing boats in St. Croix District and 5% in St. Thomas/St. John District.

USVI commercial fishers, together and individually, targeted a variety of fish and shellfish (Table IV-1, see Kojis 2004). The most commonly targeted categories of fish were reef fish and coastal pelagic fish. They caught a wide range of species using a variety of fishing gear that included traps, lines, nets and scuba. There were distinct differences in the gears used in each district. About 50 St. Thomas/St. John District commercial fishers used more than 7,500 fish traps, modified lobster traps, and plastic lobster traps to target fish and lobster. In St. Croix District, traps were not as commonly used. Instead fishers diversified into other gears such as multi-hook vertical setlines, gill and trammel nets, and scuba. These gears were used by fishers in St. Thomas/St. John District as well, but not as commonly. Line fishing using hand lines or less commonly rods and reels was done by most fishers in the USVI.

Fishing in the USVI was generally a day operation (Kojis 2004). Approximately 80% of fishing trips were under nine hours. The average USVI fisher fished 3.1 times a week for 7.2 hours with one helper and occasionally a second helper. Each week, USVI fishers spent an average of 8 hours selling fish, 3.1 hours fixing their boats and 4.9 hours fixing gear.

Fishers in St. John generally landed their fish in one of 5 locations, most commonly Cruz Bay or Coral Bay (Kojis 2004). Fishers on St. Thomas landed their fish at one of 19 different locations on the island, most commonly Frenchtown, Hull Bay, and Benner Bay. Fishers on St. Croix landed their fish at 18 different sites on St. Croix and one fisher landed his fish on St. John. The most commonly used landing sites on St. Croix were Altona Lagoon, Molasses Pier and Frederiksted Fisherman's Pier. One-third of St. Croix fishers landed their fish at more than one site.

Fish were primarily marketed whole, gutted, scaled, and or iced (Kojis 2004). They were commonly sold at the fisher's landing site but also sold along the road, at fish markets, to restaurants, and to retail stores.

Table IV-1. Number and Percentage of Commercial Fishers Targeting Various Categories of Fish, Molluscs, and Crustaceans in the US Virgin Islands (from Kojis 2004).

	St. Thomas/St. John District		St. Croix District		USVI	
Categories of fish	**N[*1]**	**Percent**	**N[*1]**	**Percent**	**N[*1]**	**Percent**
Reef fish	**87**	**77.7%**	**182**	**84.7%**	**269**	**82.3%**
Coastal pelagic	60	53.6%	80	37.2%	140	42.8%
Deep pelagic	11	9.8%	71	33.0%	82	25.1%
Deepwater snapper	5	4.5%	91	42.3%	96	29.4%
Bait fish	33	29.5%	31	14.4%	64	19.6%
Conch	10	8.9%	84	39.1%	94	28.7%
Whelk	16	14.3%	10	4.7%	26	8.0%
Lobster	40	35.7%	87	40.5%	127	38.8%
Total # responses	262		636		898	
Total # respondents	112	234.0%[*2]	215	295.9%[*2]	327	274.7%

*notes:
1. N= total number of fishers who responded to this question.
2. Percent totals more than 100% because fishers frequently fished more than one category.

Over half the fishers in St. Thomas/St. John District felt that fishing was the same as ten years ago (Kojis 2004). The one third who felt it was worse gave less fish, area closures and too many traps as the primary reasons for the decline. In contrast, almost 70% of St. Croix fishers thought fishing was worse today than ten years ago. Nearly 40% of fishers felt the decline was due to net fishing and a third felt that too many fishers also contributed to the decline. Only 5% of fishers in the USVI felt that fishing was better than 10 years ago.

This 2003 census (Kojis 2004) was compared to surveys of the US Virgin Islands fisheries done in 1930 by Fiedler and Jarvis (1932) and 1968 (as described in Swingle et al. 1970). While the population of the US Virgin Islands increased from 22,012 in 1930 (Fiedler and Jarvis 1932) to 108,612 in 2000, the number of fishers stayed nearly the same (Kojis 2004). Therefore, as a percentage of the total USVI population, the number of fishers declined from 1.8% in 1930 to 0.3% in 2000 (Table IV-2, see Kojis 2004). The ethnic composition of fishers also changed. The percentage of fishers who were black and white declined between 1930 (Fiedler and Jarvis 1932) and 2003 (Kojis 2004). There were no Hispanic fishers reported in 1930 (Fiedler and Jarvis 1932). However, by 2003, Hispanic fishers comprised 38.5% of commercial fisher population (Kojis 2004).

While boat size did not change significantly between 1930 and 2003, the materials used to build boats, the methods of propulsion, and the equipment installed on the boats changed dramatically (Kojis 2004). In 1930 most boats were constructed of wood (Fiedler and Jarvis 1932). By 2003, wooden boats were uncommon and most boats were constructed of either fiberglass or wood and fiberglass (Kojis 2004). In 1930, fishers either sailed or rowed to their fishing grounds (Fiedler and Jarvis 1932). By 1968, most boats were outfitted with outboard engines (Swingle et al.

1970). In 2003, boats not only had engines, many boats had a variety of mechanical and electronic equipment (Kojis 2004). A number of fishers had installed winches, reels to haul in lines set in deep water, marine radios, and/or echo sounders. A high percentage of fishers carried cell phones when they fished; few carried EPIRBs.

Pots (traps) have been an important fishing gear since 1930 and in 2003 they were still an important component of the fishery, especially in St. Thomas/St. John District (Kojis 2004). However, other gears such as nets and vertical setlines were more commonly reported in 2003 than in 1930 or 1968 (Fiedler and Jarvis 1932; Swingle et al. 1970; and Kojis 2004).

Table IV-2. Comparison of the number of commercial fishers in the US Virgin Islands between 1930 and 2004 (from Kojis 2004)

Survey year	**# and percent of commercial of fishers who are full time (FT) or part time (PT)**				**Total # of Commercial Fishers**	**USVI Population**	**% of population commercially fishing**
	FT	**%**	**PT**	**%**			
1930[*1]	n/a		n/a		405	22,012	1.8%
1968[*2]	120	30%	280	70%	400	55,000	0.73%
2003-4[*3]	215	67%	108	33%	383	108,612[*4]	0.3%

*sources:
1. Fiedler and Jarvis, 1932
2. Swingle et al., 1970
3. Kojis 2004
4. 2000 US Census – www.census.gov/prod/cen2000/island/viprofile.pdf - July 17, 2004.

(2) Condition of USVI Commercial Fisheries

In the 2003 census (Kojis, 2004), fishers were asked if fishing was "better", the "same" or "worse" than 10 years ago. Most fishers in St. Thomas/St. John District responded that fishing was the same with 36% responding that fishing was worse (Table IV-3). In St. Croix District, 68% of fishers responded that fishing was worse (Table IV-3). The decline in fishing in St. Croix District had been noted since 1967 when Swingle et al. (1970) reported that St. Croix fisheries had suffered from the dredging operations on the south shore. In 1967, fishers on St. Thomas caught more fish than on either St. Croix or in the BVI and catch per unit effort and annual catch per man was lower on St. Croix than on St. Thomas (Swingle et al. 1970).

Respondents who believed that fishing was "worse" in 2003 were asked the reason why (Kojis 2004). In St. Croix, the main reasons given for fishing being worse were that net fishers were taking too many fish, there were too many fishers, there was less fish, and there was overfishing (Table IV-4). These reasons supported the request in 2001 by St. Croix fishers to the Commissioner of DPNR to limit the number of commercial fishers on St. Croix because of the limited fishing grounds in that district. The main reasons given by fishers in the St. Thomas/St. John District, who responded that fishing was worse, were that they caught less fish, area closures had been implemented, there were too many traps, and overfishing was occurring (Table

IV-5). Almost 20% of St. Thomas/St. John District fishers felt that area closures were making fishing worse. The recently declared Coral Reef National Monument closed a substantial area of the shelf south of St. John to anchoring and almost all fishing (Executive Proclamation, 2001). This is in addition to other closures such as the Red Hind Marine Conservation District Closure and the St. James and Cas Cay/Mangrove Lagoon Marine Reserves and Wildlife Sanctuaries (USVI Code, Title 12) (described in DFW/DEE 2004), and the fishing restrictions in the St. John National Park (Kojis 2004).

Table IV-3. US Virgin Islands Commercial Fisher's Opinions on Whether Fishing is Better, the Same, or Worse than 10 Years Ago (from Kojis 2004)

Fisher Opinions	**St. Thomas/St. John District**		**St. Croix District**		**USVI**	
	N*1	**%**	**N*1**	**%**	**N*1**	**%**
Better	11	11%	4	1.9%	15	4.9%
Same	**53**	**53%**	63	30.3%	116	37.7%
Worse	36	36%	**141**	**67.8%**	**177**	**57.4%**
Total	100	100.00%	208	100.00%	308	100.00%

*note: N = number of fishers who responded to this question.

Many of the concerns expressed in 2003 by fishers who stated that fishing was worse (Kojis 2004), were the same ones that had been expressed for over 15 years (USVI Government 1987). They included declining fish stocks, too many traps, and the loss of fish and shellfish nursery habitat to development and pollution. However, in 2003 new concerns arose (Kojis 2004), including the concern that there were too many fishers for the size of the fishing grounds. This concern was compounded by the loss of fishing grounds that came with the closure to fishing of large areas of the shelf with the Presidential Proclamations of January 17, 2001 establishing the Virgin Islands Coral Reef National Monument and enlarging the boundary of Buck Island National Monument (US Government, Federal Register, Vol. 66, No. 14, Proclamations 7399 and 7392, respectively). Resolution of these concerns will not be easy (Kojis 2004).

Table IV-4. Reasons fishers gave for fishing being worse in St. Croix District (from Kojis 2004)

Fisher Responses	N[*1]	Percent of fishers[*2]
Net fishers take too many fish ▪ Too many fishermen with nets, they dump (throw away) the small fish ▪ Too much new equipment like nets ▪ Too many net fishers taking most of the fish ▪ Over fishing by gill nets ▪ Too many gill and trammel nets ▪ Gill nets catching too many fish ▪ Gill nets need to be regulated or eliminated ▪ Over fishing due to gill nets ▪ Haul seines remove too many fish, fish spoiled on shore ▪ Gill nets need to be monitored on a daily basis ▪ Gill nets kill juvenile fish ▪ Gill nets abusing fisheries ▪ Gill nets doing a lot of damage ▪ Divers with gill nets ▪ Change in fishing methods (example: trap fishers now use gillnets) ▪ Larger jack nets have taken all the fish ▪ Too many gill nets catch everything	55	**38.9%**
Too many fishers ▪ Too many fishers, need closed season ▪ Too many trap fishers ▪ Too many divers and fishers now ▪ Greater number of fishers ▪ Too many fishers fishing out the fishery ▪ More trap fishers ▪ Fish are scarce because of too many fishermen	46	32.9%
Less fish ▪ Same in deepwater but worse inshore ▪ Less baitfish available ▪ Decrease in lobsters and pelagic fish ▪ Dredging of Altona Lagoon caused decrease catch ▪ Catch not as good but doesn't know why	37	25.9%
Overfishing	15	10.5%
Pollution ▪ Pollution on south side of island ▪ Poor water quality ▪ Pollution in general	15	10.5%

Table IV-4. Reasons fishers gave for fishing being worse in St. Croix District (from Kojis 2004) (continued)

Fisher Responses	N[*1]	Percent of fishers[*2]
Hurricane damage to reefs ▪ Reefs aren't healthy – no staghorn corals ▪ Bottom of sea is different now ▪ Reef destroyed by nature, not many caves now	9	6.3%
Area closure ▪ Too much area closed ▪ Buck Island closure ▪ New regulations limiting our fishing	14	9.8%
Longliners ▪ Longliners are hammering offshore stocks before they get into USVI waters ▪ Foreign longliners	7	4.9%
Difficulty selling fish ▪ Can't sell fish, people don't want to buy, no money ▪ Too much competition from other fishers, reduced prices to sell fish ▪ Market selling different prices, too much competition ▪ Difficult to sell fish at market – can take 2-3 days to sell catch ▪ More difficult to sell ▪ Too many fishers, sales were better 10 years ago	6	4.2%
Competition with other fishers or with foreign vessels	5	3.5%
Illegal fishing	5	3.5%
Fish trap theft and illegal hauling of traps	4	2.8%
Not enough FADs	3	2.1%
More gear being used today	2	1.4%
Reef unhealthy	1	0.7%
Not enough shelf area	1	0.7%
Net fishers on St. Martin	1	0.7%
Ghost traps	1	0.7%
Fuel costs	1	0.7%
More boat ramps needed	1	0.7%
Total number of respondents	141	161.40%
Total number of responses	229	

*notes:
1. N = number of respondents. Most respondents gave more than one reason.
2. The number of responses in each category was divided by the number of respondents who indicated that fishing was worse, therefore, the total adds up to more than 100%.

Table IV-5. Reasons fishers gave for fishing being worse in St. Thomas/St. John District (from Kojis 2004)

Fisher Responses	N*1	Percent of fishers*2
Less fish ▪ Less baitfish available ▪ Less fish ▪ Catching less	**12**	**33.3%**
Area closure ▪ Less fishing ground, have to go out further ▪ National Park ▪ Taking away best fishing grounds	7	19.4%
Too many traps	5	13.9%
Overfishing ▪ Overfishing ▪ Too much fishing pressure ▪ Area overfished	4	11.1%
Too many fishers	3	8.3%
Difficulty selling fish ▪ Sales down ▪ Fewer sales	3	8.3%
Pollution ▪ Pollution from development kills reef ▪ Pollution in general	3	8.3%
Hurricane damage to reefs ▪ Natural disasters ▪ Weather	3	8.3%
Fish trap theft and tampering	2	5.6%
Longliners	2	5.6%
Habitat Destruction	1	2.8%
More regulations	1	2.8%
BVI rules	1	2.8%
Larger mesh required on traps	1	2.8%
Higher fuel costs	1	2.8%
No. of respondents	36	136.10%
No. or responses	49	

*notes:
1. N = number of respondents. Most respondents gave more than one reason.
2. The number of responses in each category was divided by the number of fishers who indicated that fishing was worse, therefore, the total adds up to more than 100%.

(3) Number of Licensed Commercial Fishers

There are several estimates available regarding the number of licensed commercial fishers in the USVI over the last 30 years (see Holt and Uwate 2004a). In addition, there were several ways to estimate the numbers of licensed commercial fishers in the USVI (such as minimum reported, maximum reported, average of number reported, mode of number reported for each fishing year and each district). These were all examined by Holt and Uwate (2004a). The best estimate of the number of licensed commercial fishers for each district and each fishing year were then determined (see Figure IV-1).

Based on the above, it appeared that the numbers of licensed commercial fishers on St. Thomas/St. John have declined almost 50 percent over the last almost 20 years (see Figure IV-2, and Holt and Uwate 2004a). However, the number of licensed commercial fishers on St. Croix has remained relatively stable over this same period of time.

Figure IV-1. USVI Total Number of Licensed Commercial Fishers Per Year For 1973/74 to 2002/03 Fishing Years (from Holt and Uwate 2004a)

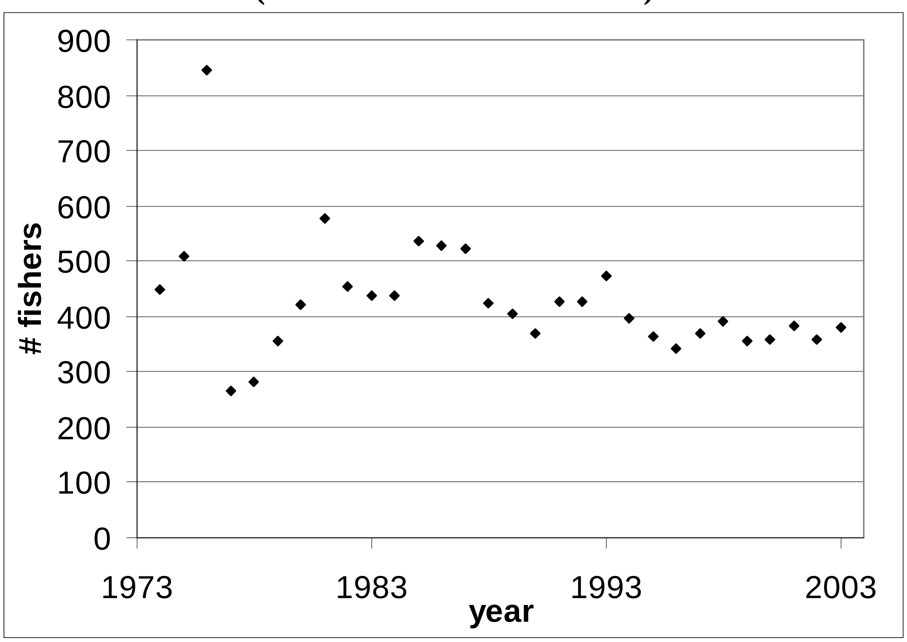
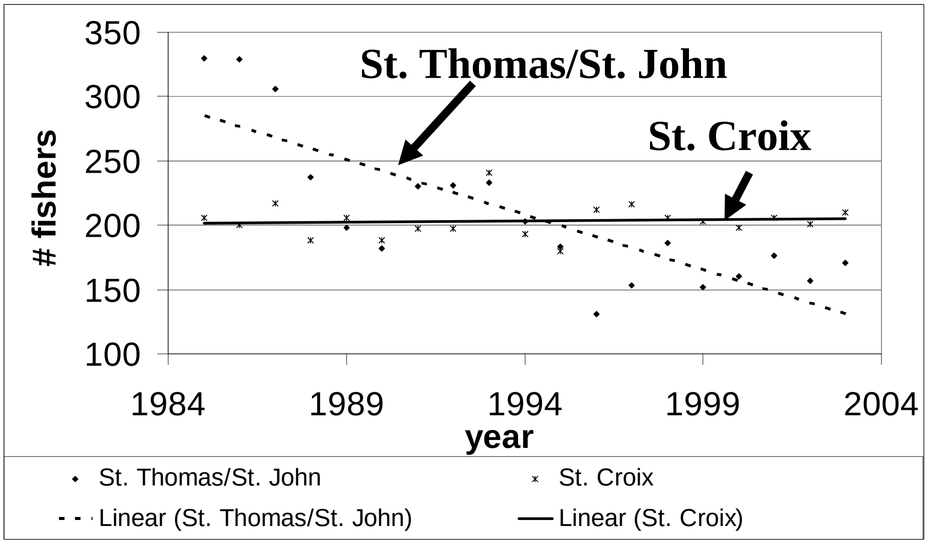


Figure IV-2. St. Thomas/St. John and St. Croix Number of Licensed Commercial Fishers Per Year For 1984/85 to 2002/03 Fishing Years with Linear Trend Lines (from Holt and Uwate 2004a)



*notes: For St. Thomas/St. John, the linear regression is Y = 8.5509X + 17258, with r^2 = 0.6625.
For St. Croix, the linear regression is Y = 0.193X – 181.39, with r^2 = 0.0067.

(4) Commercial Landings

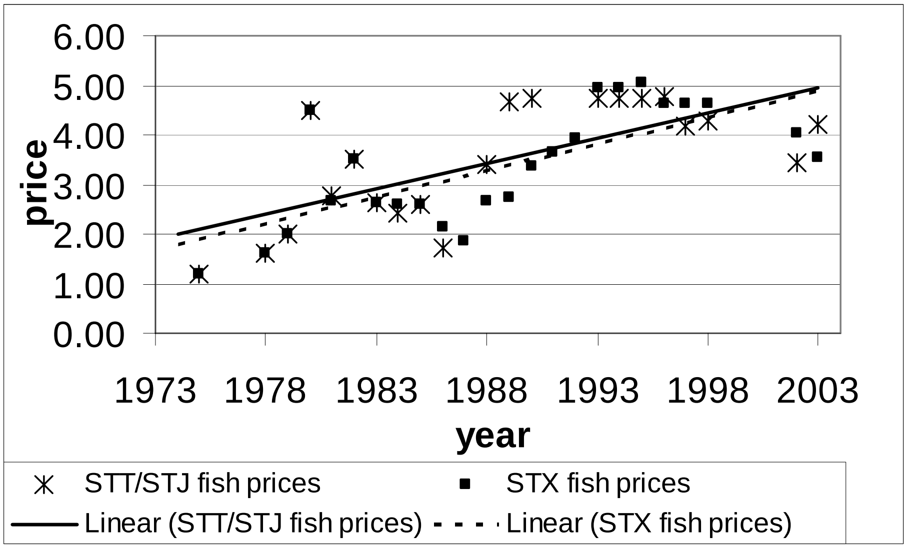
Commercial catch reports have been required since about 1974 (DFW internal data files). Prior to 2002, these files were not organized and readily available. By 2003, all available 1974 to 1985 commercial catch reports had been entered into computer data files (NOAA/NMFS grant no. 40GENF100212). In addition, by 2004 all available 1992 to 2002 commercial catch reports had been entered into computer data files (NOAA/NMFS grant no. 40GENF100212). In late 2004, DFW received a small grant (NOAA/NMFS grant no. GA133F04SE1539) to support data entry of 1985 to 1992 commercial catch report data. Data entry and proofing of these data were completed in early 2005.

(5) Historic Ex-vessel Fish Prices

In general, overall ex-vessel fish prices were similar in St. Thomas/St. John compared with those in St. Croix and have increased gradually over the last 30 years (see Figure IV-3, and Holt and Uwate 2004b).

At the gear or species group level, for St. Thomas/St. John most gear and species group prices showed similar trends of increase over time (see Holt and Uwate 2004b). However, there were exceptions. For example, baitfish ex-vessel prices appear rather flat. Angelfish, barracuda, goatfish, jack, grunt, parrotfish, shellfish, triggerfish, and surgeonfish ex-vessel prices have declined. This is also reflected in the linear regression with a negative sign on the slope of the line (see appendix 3 in Holt and Uwate 2004b).

Figure IV-3. Scatter Plot of Average St. Thomas/St. John and St. Croix Fish Prices per Pound for 1974 to 2003 Fishing Years (see Holt and Uwate 2004b)



For St. Croix, most gear and species group prices also showed a gradual increase over the years (Holt and Uwate 2004b). There were a few exceptions. Baitfish, angelfish, barracuda, goatfish, jack, grunt, mackerel, parrotfish, shellfish, triggerfish, and surgeonfish ex-vessel prices showed a general decline.

In general, St. Thomas/St. John ex-vessel prices were very similar to those of St. Croix (Holt and Uwate 2004b). Many ex-vessel prices that were initially different between districts, but became more similar in recent years. In one case, historical ex-vessel prices have remained different (see shellfish (i.e., lobster, conch) figure 36 in Holt and Uwate 2004b).

(6) Priority Issues for USVI Commercial Fisheries

MRAG Americas, Inc. obtained a Cooperative Research Program grant from NOAA Fisheries to help determine fishers' opinions of fishing capacity and effort reduction programs. The purpose of this project was to assess the potential for using capacity and/or effort reduction as a component of the fisheries management strategy for fishing in the waters of the U.S. Caribbean. During a series of workshops held on St. Thomas and St. Croix, fishers in the USVI expressed suspicion of and/or unhappiness with government agencies (MRAG Americas, Inc. 2004). Fishers felt overwhelmed by the myriad of Territorial and Federal agencies with some control over fishing activities. Many expressed reluctance to cooperate with the agencies because of a perceived ineffectiveness of cooperation or dishonesty on the part of the agencies, giving examples as imposition of parks and monuments, inactivity on resolving the USVI-BVI conflict, and inactivity addressing foreign fishing near and possibly in the U.S. Caribbean. The USVI fishers have a FAC with which to develop and transmit ideas to management. However, it has not been entirely successful, due in part to lack of funding and expertise, and in part to lack of participation by fishers. Fishers commented that members who participate in unpopular decisions may be the target of retaliation in the form of gear destruction. Some USVI fishers spoke of a need for more organization among fishermen. St. Croix fishers desired a fishery liaison position with local government to assist fishers in dealing with the government.

License and capacity limitation issues

From the results of these workshops, fishers generally preferred a system that limited entry to "full time" or genuine fishers (MRAG Americas, Inc. 2004). Fishers commonly stated that small boats used in the U.S. Caribbean do not have enough fishing power to cause a resource problem. USVI fishers supported limits on the number of traps. Fishers face many socio-economic obstacles, have few economic opportunities other than fishing, and felt that management restrictions directly reduced their standard of living. Fishers consistently brought up the idea of compensation by the government for present and especially future fishery restrictions.

Fishers from all areas reached similar conclusions on several key concepts related to license limitation but often did not agree on the details of the concepts (MRAG Americas, Inc. 2004). In general, fishers wanted to limit commercial fishing licenses to genuine fishers—those who made a substantial part of their income from fishing. A preference for license limitation, used in this sense, was virtually universal. USVI fishers wanted to make the current moratorium permanent. In most cases, fishers preferred a tiered license system that designated full-time fishers and other categories, although some did not want any separation among fishers. Those who wanted a tiered system had various ideas for the details. Virgin Island fishers were receptive to licenses or endorsements for species or gear. Fishers preferred a management system that reduces the administrative difficulties in dealing with government, including a single license for State and Federal waters, at least several years duration for licenses, and a single location for renewing licenses. Fishers in both areas felt that enforcement was inadequate to prevent illegal fishing. USVI fishers further felt that lack of enforcement could jeopardize future management actions, including license limitation, but felt that moving forward with program development was worthwhile, in part to raise the profile of the enforcement inadequacies.

Priority Issues as Expressed Through Opinion Surveys

Priority issues concerning USVI's fisheries as expressed by commercial and recreational fishers, and various other user and interest groups are contained in the Table IV-6 below (detailed discussions of these opinion surveys and results are provided in Chapter V).

Table IV-6. Summary of the Most Common Responses Identifying Problems with the Fisheries in the USVI.

Rank	STT/STJ	STX	USVI
1	Enforcement (lack of)	Gillnets	Overfishing
2	Pollution	Overfishing	Enforcement (lack of)
3	Overfishing	Fish traps (too many)	Pollution
4	Fish traps (too many)	Enforcement (lack of)	Fish traps (too many)
5	Longlining	Longlining	Longlining
6	Habitat degradation	Pollution	Gillnets

*note: Rankings are a rough approximation arrived at by averaging the percentage responses from ECC (2002), Gordon and Uwate (2003), Kojis (2004), Messineo and Uwate (2004), and Messineo et al. (2004), and Uwate et al. (2001).

(7) Current Management Measures

Federal and territorial management measures that are applicable to USVI commercial fishers are presented in Appendix 3. These are summarized in DFW/DEE (2004). Federal regulations apply to waters from 3 miles offshore to 200 miles offshore (the US Exclusive Economic Zone). Territorial waters extend from shore to 3 nautical miles offshore.

(8) Current Projects and Research

Division of Fish and Wildlife/Department of Planning and Natural Resources

1) Caribbean/NMFS Cooperative SEAMAP Project - This three year project will address three different issues:

   a) The state of whelk stocks in the U.S. Virgin Islands – The field portion of this work was completed. The draft report is now being finalized (Toller and Gordon draft).

   b) Fishery-independent collection of data from trap and line fishing – The field portion of this work should begin in 2005. This is limited to St. Thomas/St. John. The St. Croix portion of this work will begin in 2005.

   c) Fishery-independent collection of data from anchored line fishing – This is funded through SEAMAP-C FY04 Supplemental Funding. The field portion of this work should begin in 2005. This is limited to St. Thomas/St. John.

d) Conch data analysis – Data on conch density in St. Croix back embayments was previously collected, but never analyzed or summarized. Under this project, funded by SEAMAP-C FY04 Supplemental Funding, these data will be analyzed and a report summarizing findings will be completed.

e) Fishery-independent historic trap and line fishing data – Trap and line fishing data have been collected for about 15 years. In an inventory of data hard copies and the actual NOAA Fisheries data file, more than 60 percent of data was not in the computer data file. Under this project, these missing data were entered into the SEAMAP database.

2) USVI/NOAA-Fisheries Cooperative Fisheries Statistics Program - The objective of this project is to develop a cooperative program to determine the monthly commercial harvest in pounds and the ex-vessel and processed value in dollars of all marine commercial fishing resources landed in the U.S. Virgin Islands. Under this continuing program, commercial catch reports are collected, catch report data are entered into a computer data file and proofed, commercial fishers are licensed annually, and price information is periodically collected.

3) USVI/NOAA-Fisheries Inter-jurisdictional Fisheries Program - The objective of this program is to collect bio-statistical data from commercial fisheries when they land their catches. This is a small grant, so efforts are limited to St. Croix and include only 1 to 2 catch samples per month.

4) USVI/NOAA-Fisheries Historical Catch Report Project - The objective of this program is to enter and proof commercial catch report data from the 1985 to 1992 period. These catch reports were previously entered into computer data files, but the data files only contained about one-third to one-half of the information on commercial catch reports. This work was completed in early 2005.

5) USVI/NOAA-Fisheries Trap Survey - The objective of this project is to assess benthic damage from fish traps on St. Thomas and St. Croix. This is a continuation of earlier efforts on this subject.

6) USVI/NOAA-Fisheries St. Croix By-Catch Survey (with MRAG Americas, Inc) - The objective of this project is to obtain baseline information on by-catch from commercial fishers in St. Croix.

7) St. Croix Trammel and Gill Net Buy-back Program - This one-time trammel and gill net buy-back program is intended to reduce gear impacts to the coral reefs and associated habitats within St. Croix waters. Specific implementation recommendations have been provided by both the St. Thomas/St. John and St. Croix Fisheries Advisory Committees. A draft of the regulations was completed

and is now being considered by the Commissioner of Planning and Natural Resources.

8) Grammanik Bank Study - DFW also funded a recently completed study of grouper and snapper breeding aggregations and spawning habitat on the Grammanik Bank (Nemeth et al. 2004).

MMSC/UVI

Current research being conducted by the MacLean Marine Science Center (MMSC) at the University of the Virgin Islands (UVI) includes:

1) Patterns of Larval Fish Supply and Settlement - This study is designed to help understand the patterns of larval fish distribution and settlement, which is the primary mechanism for replenishing local fish populations.

2) Quantitative Assessment of Nursery Habitats for Fishery Stock Enhancement - This study is designed to demonstrate the importance of seagrass and mangrove habitats (believed to serve as nurseries for reef fish) to reef fisheries production.

3) Evaluating the Effect of a Marine Protected Area on a Red Hind Breeding Aggregation - This study is an effort to determine whether the Red Hind Bank Marine Conservation District (MCD), which was permanently closed to protect red hind spawning aggregations, has improved the red hind population (Nemeth 2005).

4) Evaluating the Effect of Seasonal Closure on Red Hind Spawning Aggregations at Lang Bank, St. Croix (Nemeth. in press).

5) Assessment of Grouper and Snapper Spawning Aggregations at the Grammanik Bank, St. Thomas (Nemeth et al. 2004).

For more information on UVI/MMSC research refer to their website at: http://marsci.uvi.edu/research.htm

National Park Service

The National Park Service is conducting a fish inventory program in the Caribbean national parks, which will help pave the way for development of an integrated fish monitoring program throughout the South Florida/Caribbean Monitoring Network. The inventory is being conducted cooperatively by staff of the Virgin Islands National Park, the recently authorized (2001) Virgin Islands Coral Reef National Monument, Buck Island Reef National Monument, the NOAA Biogeography Program, and the Caribbean Field Station of the USGS Biological Resources Division.

2. RECREATIONAL FISHING

(1) Description of USVI Recreational Fishing

Saltwater recreational fishing is one of the most important outdoors activities in the U.S. Virgin Islands (DFW 1996a; Friedlander 1995; Friedlander and Contillo 1994; Griffith et al. 1988; and Hinkey et al. 1994). In the 1990s, a recreational fishing study showed that recreational fishing activities contributed $25 million annually to the USVI territorial economy (Hinkey et al. 1994). In 1999, it was estimated that 11 percent of USVI residents participated in recreational fishing activities (Mateo 1999). The actual number of recreational fishers in the USVI is unknown. There is no requirement by the local or federal governments for a recreational fishing license.

Recreational fishing in the U.S. Virgin Islands can be divided into a number of different categories (e.g., inshore and offshore fishing, charter boat and non-charter boat fishing, etc.). In addition, several types of gear are used to catch fish. The most popular methods include rod and reel, hand line, spear fishing, free diving, scuba diving, and cast netting (Jennings 1992; and Mateo 1999). In a 1986 study by Jennings (1992), non-charter boat anglers from both St. Thomas and St. Croix harvested more fish than did shore-based fishers.

In the 1990's and early 2000's, the Division of Fish and Wildlife distributed logbooks to key recreational fishers. These anglers were then contacted by phone at least once a month to obtain the trip information from the logbooks. This was part of the USFWS F-8 Recreational Fishing Assessment Grant. In about 2002 logbooks were discontinued due to a reduction of funds available for this project. Summaries of these data were included in the annual progress report for the F-8 Grant for the period identified above (DFW 1994, 1996a, and 1996b; Mateo 2001; and Mateo et al. 2000).

(2) Inshore Recreational Fishery

The USVI marine inshore recreational fishery is a multi-species fishery (DFW 1996a, and 1996b). USVI fishermen harvest more than 80 different fish species. These include bonefish (*Albula vulpes*), tarpon (*Megalops atlanticus*), snook (*Centropomus parallelus*), and permit (*Trachinotus falcatus*), which can often be found on shallow-water "flats", and reef fish species (usually snappers and groupers). According to Bohnsack (1987), the recreational fishery in the Virgin Islands includes some 65 species which are recognized as being economically important. Many members of the snapper and grouper families are among this total. Snappers were the most frequently harvested species from both St. Thomas and St. Croix (Jennings 1992). Yellowtail snapper (*Ocyurus chrysurus*) probably constituted most of the snapper landings. This species is known to form large pelagic schools and can be caught in large numbers using handlines drifted in the current during certain lunar phases. Groupers were among the most harvested species, after snappers, in the St. Thomas/St. John area (Jennings 1992). Red hind (*Epinephelus guttatus*) probably constituted most of the grouper landings. This species has been abundant in the past and is known to form large spawning aggregations during which they are extremely vulnerable to angling.

In a survey of activity and harvest patterns from 1995 to 2000 (Mateo et al. 2000), small fish species commonly used as bait (such as *Jenkisia laeproetania*, *Anchoa lyolepsis*, and *Harengula humeralis*) made up a major component of the recreational angler catches. Large catches of baitfish were occasionally recorded for small numbers of anglers.

Effort and harvest patterns suggested a depletion of near-shore fish stocks in the St. Thomas/St. John stratum that may be related to overharvest and to extensive coastal development (Jennings 1992). A recreational port sampling program to determine the harvest and effort for the various marine sport fishes in the USVI was initiated in 1981 (Brandon 1985, and 1986; Friedlander 1990; Mateo et al. 2000; and Tobias 1982, 1985, and 1991).

Inshore fishing can be broken down further into shore fishing or inshore fishing by boat. Shore fishing is a form of recreation practiced by thousands of USVI residents annually despite low catches and lack of facilities (DFW 1996a; Jennings 1992; and Mateo 1999). Shore fishing effort appears to be related to two major factors: (1) the proximity to populated areas, and (2) the accessibility of the fishing site. The shore fishery for both St. Thomas and St. Croix is a multi-species fishery, with the species composition of recreational landings similar for both islands (Jennings 1992; and Mateo 1999).

The results of a telephone survey, conducted by the Eastern Caribbean Center (ECC) of boat-based marine recreational fishers in the USVI indicated a large amount of fishing activity and economic impact from boat-based recreational fishing (ECC 2002). Estimates from this study indicate that these resident recreational fishers spent a total of 320,204 hours fishing and supplemented the USVI economy with $5.9 million in recreational fishing related expenditures. This is equivalent to $18.54 per hour of fishing for each fisher.

For the USVI as a whole, resident boat-based recreational fishers were roughly split in terms of where they fished (ECC 2002). Respondents indicated that 53.3 percent usually fished within 3 miles of shore (in USVI territorial waters) and 46.7 percent usually fished beyond three miles of shore (in Federal waters). The results were similar for St. Croix and St. Thomas/St. John.

The results of this survey also indicated that the most targeted fish family was the snappers, Lutjanidae (ECC 2002). Snapper popularity was also noted by Jennings (1992) for 1986. In the ECC study, several pelagic species (fished more offshore) were also quite popular such as dolphin, tuna, and kingfish (ECC 2002).

(3) Offshore Recreational Fishery

The fishing grounds around St. Thomas are world famous for big game sportfishing (DFW 1996a; Friedlander 1995; and Friedlander and Contillo 1994). According to Friedlander (1995), it is one of the most important locations in the world for fishing the blue marlin, *Makaira nigricans*.

The offshore recreational fishery in St. Thomas and St. Croix are very different. The St. Thomas offshore fleet consists of large charter boats and a small fleet of local vessels (DFW 1996a; Griffith et al. 1988; and Hinkey et al. 1994). Much of the offshore recreational fishery in St. Thomas occurs on the North Drop, 30 km (about 18 miles) north of St. Thomas in British Virgin Islands (BVI) waters (Friedlander 1995). Recreational charter fishing on the North Drop will be affected by new fees and regulations recently instituted in the BVIs. Almost 95% of the fishing effort for pelagic species is concentrated on the North Drop (Mateo et. al. 2000). Some offshore recreational fishing also occurs at the South Drop, located 13 km (about 8 miles) south of St. Thomas (Friedlander 1995).

A total of 1,493 fishes comprising 12 different species were recorded for 1995 to 1999 from a total of 36 fishing tournaments held on St. Thomas (Mateo et. al. 2000). The total recreational catch from private and charter boats, based on all sampling methods combined, during this period was 274,133 pounds, or 20.1 pounds of fish per boat-hour. Numerically, the blue marlin was the most commonly caught fish (1,045 individuals) followed by dolphin (80 individuals) and wahoo (71 individuals). Likewise, by weight, the blue marlin dominated followed by dolphin (Mateo et al. 2000). Billfish tournaments in the V.I. employ catch and release rather than landings as the preferred scoring method for fishing competitions.

The St. Thomas offshore recreational fishing fleet is composed of about 150 vessels including some 40 vessels from the mainland U.S. that visit and fish during the marlin season which is from June to October (Mateo et al. 2000).

The St. Croix offshore recreational fishery is much smaller than that of St. Thomas. St. Croix's offshore recreational fishing fleet is composed of less than 30 boats (DFW 1996a). St. Croix offshore recreational fishing is primarily in the north and east sides of that island. The St. Croix offshore fleet is composed of small, private resident vessels and few charter boats (Griffith et al. 1988; and Hinkey et al. 1994). Much of the fishing effort targets species for food consumption and recreation (Mateo 1999). The primary sought after species are pelagics (tunas, dolphin, and wahoo).

Most of the emphasis of the offshore recreational fishery is on the blue marlin (DFW 1996a; Brandon 1989; and Friedlander 1995). Other offshore pelagic species are also caught in the USVI offshore recreational fishery such as sailfish (*Istiophorus albicans)*, white marlin (*Tetrapturus albidus)*, dolphin (*Coryphaena hippurus)*, wahoo (*Acanthocybium solandri)*, different species of tunas, as well as coastal pelagic species such as the king mackerel (*Scomberomorus cavalla)* (DFW 1996a; Brandon 1989; and Friedlander 1995).

In the 1995 to 2000 survey (Mateo et al. 2000), seasonal trends for the St. Thomas offshore recreational fishery were evident for certain species such as the blue marlin, dolphin, and wahoo. Wahoo catches peaked in the fall and dolphin catch was highest from March to May. Peak catches of billfish and blue marlin occurred during the summer months. Pounds per unit effort (PPUE) for offshore fish species fluctuated between 1995 to 2000, but showed no pronounced upward or declining trend (Mateo et al. 2000).

Annual harvest rates for the most commonly caught fish, from the St. Thomas offshore recreational fishery, varied throughout the 1995 to 2000 study period (Mateo et al. 2000). Blue marlin pounds per unit effort (PPUE) ranged from 14.27 to 24.31 pounds per boat-hour. The annual dolphin PPUE ranged from 0.07 to 0.58 pounds per boat-hour. Wahoo PPUE peaked in 1995-1996 with 0.24 pounds per boat-hour. Likewise, yellowfin tuna PPUE peaked in 1995-1996 with 0.25 pounds per boat-hour. The annual mean fish weight (pounds/fish) for offshore pelagic species in St. Thomas either remained relatively stable or fluctuated throughout the entire period (Mateo et al. 2000).

(4) Fishing Tournaments

Data on catch and effort has been collected for decades by the Division of Fish and Wildlife under the USFWS F-8 Recreational Fishing Grant. Annual summaries of total catches and, in many cases, total effort are completed for each tournament. However, to-date, there has never been a summary made of these data covering the entire period of data collection. Nothing is available besides short annual summaries. There are several different types of tournaments each year. St. Thomas has offshore pelagic, general off and inshore, and onshore tournaments. There are about 10 tournaments held annually on St. Thomas. St. Croix also has about 5 or 6 tournaments each year. These target pelagic species, except for an annual shoreline tournament for kids.

Fishing tournaments are opportunities to collect recreational fishing data (DFW 1996a, and 1996b; DFW 1995; Mateo 2001; and Toller 2003). Each tournament is different (Mateo et al. 2000). In St. Thomas, offshore fishing tournaments are dominated by blue marlin catches, however there are also dolphin and wahoo tournaments. St. Croix offshore fishing tournaments target other pelagic species such as wahoo, dolphin, and kingfish (Mateo et al. 2000). There are some inherent problems with tournaments. In some cases, fishermen do not bring their total catch to the weighing station. Therefore, total catches can be underestimated (Mateo et al. 2000).

Recreational fishing in the USVI provides a leisure activity for thousands of people (Jennings 1992; and Mateo 1999). Recreational fishing is a year-round activity practiced by all age groups and social strata (Griffith et al. 1988; and Hinkey et al. 1994). And recreational fishing in the Virgin Islands is promoted as a tourist activity and contributes to the local economy (Griffith et al. 1988; and Hinkey et al. 1994). The high quality of USVI big game fishing is a plus for marketing the USVI as a global game fish fishing destination.

The USVI recreational fishing industry has direct and indirect impacts on the local economy (Ditton and Stoll 2000; and Olsen 1979). Billfish anglers spend a great deal of money to go fishing (Mateo et al. 2000). Major local expenditures include charter and guide fees, lodging, and food and drink. Indirect impacts include the additional purchases of goods and services resulting from wages paid directly or indirectly by affected businesses.

(5) Status of Fish Targeted by Recreational Fishers

Target species of offshore recreational fishers are, generally speaking, relatively large fish which can be considered high level predators, if not top predators, in their respective ecosystems (e.g., tarpon - mangroves; snappers/groupers - coral reefs; tunas, billfish, dolphins - oceanic pelagic waters). As such, a decline in their populations would have an impact on community structure in their particular ecosystem, though exactly how that impact would manifest itself is hard to predict, especially for the more poorly understood highly migratory species (Hixon and Beets 1993). The life histories of species, such as snappers and groupers, are somewhat more amenable to study and their ecological roles have been addressed in previous sections (i.e., in overview of species of greatest conservation concern). Life history information on highly migratory species (HMS), such as billfish, tunas, and dolphin is relatively scarce, however, some generalities can be made about their ecological role.

Migratory species migrate for one or more of the following reasons: (1) to reach spawning grounds, (2) to follow a food supply, or (3) to keep within suitable temperature ranges for development (Ricklefs 1979). Large oceanic pelagic fishes generally have high metabolic rates and are fast-growing (Stevens and Dizon 1982). Many, if not all, of these highly migratory species (tunas and billfishes, in particular) are obligate swimmers (ram ventilators), that have to swim continuously in order to force water over their gills to supply enough oxygen to meet their metabolic demands (Magnuson 1973; and Roberts 1978). As species at or near the top trophic rung, and as the larger members of this particular guild (the oceanic habitat), large amounts of living space are required, by virtue of a dispersed food supply and high metabolic demand (Olson and Boggs 1986). A characteristic of many tropical pelagic predators, that grow rapidly in spite of high metabolic rates in an oligotrophic (low nutrient) habitat, is to put a higher proportion of energy into reproduction and maintain a smaller standing stock (Olson and Boggs 1986). This could make populations of highly migratory species more vulnerable to overfishing.

The 2003 HMS SAFE report (Highly Migratory Species Stock Assessment and Fisheries Evaluation) includes the latest stock assessment information through December 2002 (NMFS 2003a). Atlantic blue marlin and white marlin are overfished and overfishing continues internationally. The most recent stock assessment for Atlantic blue marlin was conducted in 2000, and is somewhat more optimistic than the previous 1998 assessment. It found that stock productivity (maximum sustainable yield (MSY) and stock's capacity to replenish) is higher than previous estimates. Overfishing of blue marlin has taken place for the last 10-15 years and is still occurring (NMFS 2003a).

Atlantic white marlin has also been overfished for many years (NMFS 2003a). The most recent stock assessment was conducted in May 2002 (NMFS 2003a). The previous two white marlin assessments, made in 1996 and 2000, indicate that the white marlin is also overfished and that overfishing continues to occur (NMFS 2003a).

Because of their oceanic nature, changes to the habitat of sufficient magnitude to directly impact HMS fisheries are relatively unlikely, however, oil spills, ocean dumping, and the general degradation of the ocean environment may impact the survival of larvae and possibly adults, either directly or through the food chain (SAFMC 1988). In addition, changes in UV irradiation, sea temperatures, and, perhaps more directly, the loss of sargassum mats could impact HMS fisheries. It is believed that the larvae of migratory fish species use sargassum mats as cover for a significant portion of their life cycle (Jason Vasques, USVI DFW fisheries biologist, personal communication). Research needs, in general, include understanding the life cycle of these migratory species and the ecological requirements of the various stages in these life cycles. Research needs, in particular for the USVI, include understanding what stage in this cycle is spent in USVI waters, and knowing the status of the habitat required by that stage.

(6) Priority Issues for USVI Recreational Fisheries

Priority USVI fisheries issues identified in the previous section included the following:

1) pollution,
2) lack of enforcement,
3) gillnets,
4) overfishing,
5) traps,
6) longlines,
7) habitat degradation, and
8) lack of moorings.

These are the key priority issues that need to be resolved. There are several ways to approach each of these priority issues (see Chapter VI). For solutions to these issues as suggested by various user groups see Chapter VI, section 2. Also refer to ECC (2002), Gordon and Uwate (2003), Kojis (2004), Messineo and Uwate (2004), Messineo et al. (2004), and Uwate et al. (2001).

(7) Current Management Measures for Recreationally Caught Fish

In the USVI a recreational fishing license is not required if fishing with hand lines, troll lines, cast nets, snares, or spears. A summary of territorial fishing regulations (DFW/DEE 2004) that apply to recreational fishers in territorial waters (from shore to 3 nautical miles offshore) is provided in Appendix 3A. A summary of the fishing regulations (DFW/DEE 2004) that apply to recreational fishers in federal waters (from 3 to 200 nautical miles offshore) is provided in Appendix 3B.

(8) Current Projects and Research Overview

The USVI Division of Fish and Wildlife is currently involved in a recreational fishery assessment project (F-8 grant through the USFWS). Under this grant, DFW staff serve on the weigh-in committees and collect catch and effort data from most recreational fishing contests in the USVI. In FY05, due to budget cuts, the level of effort to collect this data will be reduced by 50 percent. This year, only one person is budgeted for each fishing contest.

In addition to assessment of recreational fishing in the USVI, DFW is involved in various projects to enhance recreational fishing here. These include the following:

1. Boating Access (USFWS F-9) – Over the years DFW has developed and maintained various boat ramps and boating facilities around the USVI. These include: (1) Krum Bay boat ramp (St. Thomas), (2) Hull Bay boat ramp (St. Thomas, (3) Altona Lagoon Boat Access Facility (St. Croix), (4) Frederiksted Boat Access Facility (St. Croix), and (5) Gallows Bay Boat Access Facility (St. Croix). These sites are available to recreational fishers. In FY05, additional work will be completed as follows: (1) repairs to Altona Lagoon and Gallows Bay facilities (St. Croix), (2) completion of repairs to Frederiksted boating access facility (St. Croix), (3) planning of site development at Molasses Dock (St. Croix), (4) planning of site development at Water Island (St. Thomas), and (5) planning of site development at Benner Bay, St. Thomas.

2. Artificial Reefs (USFWS F-10) – DFW had permitted artificial reef sites on St. Thomas, St. John, and St. Croix. These sites are periodically monitored (Tobias and Uwate 2001). Additional materials are periodically deployed at these sites. Artificial reefs provide alternative fishing sites for recreational fishers. In FY05, monitoring of artificial reef sites will continue. In FY05, the US Army Corps of Engineers issued a permit for the artificial reef sites south of St. Thomas and St. John. The permit application for a new artificial reef site off St. Croix was submitted and is being reviewed by the US Army Corps of Engineers.

3. Fish Aggregating Devices (FADs) (USFWS F-10) – DFW has an ongoing FAD program. FADs aggregate pelagic fish species, reducing the time and effort to catch them. FADs provide offshore fishing opportunities for recreational fishers (Friedlander et al. 1994). In FY05, FAD maintenance and replacement of lost FADs will continue. See *overfishing conservation strategies* in Chapter 6, p. 198.

4. Day-Use Mooring Buoys (USFWS F-9 and BIG) – DFW provides support for two non-profit organizations for the deployment and maintenance of day-use mooring buoys around St. Thomas and St. Croix. At this time, about 50 day-use mooring buoys are permitted on each island and the same number of day-use mooring buoys have been deployed. These day-use mooring buoys reduce anchor damage to sensitive marine habitats therefore enhance the boating and recreational fishing experience at these popular sites. In FY05, maintenance of day-use mooring buoys will continue.

3. MARINE RECREATION

(1) Description of USVI Marine Recreation

Residents and non-residents of the U.S. Virgin Islands depend heavily upon the coral reefs that surround them (Gardner 2003). The reefs shelter the shoreline of these islands in "hurricane alley". They are largely responsible for the white sandy beaches; when corals die, the white calcium carbonate the animals use to make their structures erodes and washes ashore. The reefs also provide habitat for many types of fish - a critical food source since the islands were first settled. But most of all, the reefs bring tourists such as cruise ship passengers, divers, boaters, and beachcombers, who, in turn, bring income to the islands.

Tourism is the engine that drives the economy of the U.S. Virgin Islands (Gardner 2003). In 2001, the 122,211 inhabitants of these islands hosted 2.1 million cruise ship passengers alone. Tourism accounts for more than 70 percent of both employment and the gross domestic product. With few employment alternatives, attracting more tourists and vacationers, and building the ship facilities, hotels, and resorts to house them, is critical to the Virgin Islands. Yet while tourism and development bring jobs, they also put pressure on the local environment, particularly the coral reefs, which attract much of the tourism in the first place. Virgin Islanders are caught in a vicious cycle experienced by many Caribbean nations and territories. They want to preserve the natural environment because that's what attracts visitors. Yet more visitors to the islands mean more pressure is exerted on fragile coastal areas and reefs.

Marine recreation is an integral component of what attracts visitors to the Virgin Islands. The main marine recreational activities in the USVI include recreational boating, sailing, kayaking, jet skiing, surfing, wind surfing, recreational fishing, swimming, snorkeling, scuba diving, para-sailing, and going to the beach.

Recreational boating

Recreational boating in the USVI occurs in two categories: (1) residents and tourists who own and use their own boats, and (2) residents and tourists who rent or charter yachts/boats for fishing, pleasure cruises, sailing, diving, or other marine or pleasure-related activities (Hinds Unlimited 2003). The infrastructure necessary to support pleasure boating - the marinas, charter agencies, marine hardware stores, repair facilities, boat sales firms, etc., has grown to where it probably ranks next to cruise ship tourism in producing revenue and employment on St. Thomas. St. Croix, separated by 40 miles of open ocean from the most favorable small boat cruising area located around St. Thomas/ St. John and the British Virgin Islands, has its own cruising areas, marinas, and support infrastructures.

Private recreational boats reportedly total 1,183 registered boats (Mateo et al. 2000). In early 2000, there were 2,462 registered boats in the USVI (Uwate et al. 2001). This figure included private and commercial boats. In 1978, the Department of Conservation and Cultural Affairs reported a total of 1,789 registered boats, 75% were registered as recreational (Olsen 1979).

Using these figures, recreational boats are down from 75% of the total number of registered boats in 1978, to less than 50% (1,183/2,462) of the registered boats in 2000/2001.

Sailing

The waters surrounding the Virgin Islands are one of the most desirable sailing areas to be found anywhere. Sailors throughout the world are attracted to it and a substantial recreational boat service industry has developed here to cater to their needs. Numerous bays and harbors are designated as mooring and anchoring areas by the Department of Planning and Natural Resources. VIRR (1992) includes detailed rules and regulations regarding the mooring and anchoring of vessels in the USVI.

Kayaking

In addition to the privately owned kayaks, there are approximately one-half dozen kayak rental businesses in the U.S. Virgin Islands (Gordon and Uwate 2003). There are also some eco-tour operators in the USVI (exact number not available) that provide kayaking tours.

Jet Skiing

In addition to privately owned jet skis, there are 22 watersports rental businesses licensed on St. Thomas/St. John, and six watersports businesses on St. Croix (Hinds Unlimited 2003). VIRR (1994a) has detailed regulations on the use and restrictions of jet skis. The category of data called “recreation” collected by the Bureau of Economic Research does not differentiate between types of watersports such as kayaking, parasailing, mini subs, jet skis, etc. The Department of Consumer Affairs and Licensing also does not issue licenses that are specific to the above-named watersports. It would be helpful if an agency of government were charged with collection of watersports data in a format that could be used for economic and descriptive analysis of marine resource and other purposes (Hinds Unlimited 2003).

Wind surfing

There are 22 watersport rental businesses licensed on St. Thomas/St. John, and six watersport businesses on St. Croix (Hinds Unlimited 2003). However, specific information on wind surfing is not available. VIRR (1994b) specifies regulations on public shoreline access.

Recreational Fishing

Covered in section 2 of this chapter.

Swimming

There is no data on this form of marine recreation. VIRR (1994b) details regulations on public shoreline access.

Snorkeling

According to Hinds Unlimited (2003), 45,000 snorkelers use the Buck Island Reef National Monument (BIRNM) underwater trails annually. In addition, thousands of snorkelers, and other recreational users, also visit the many other park and recreational areas located in the U.S. Virgin Islands. Recreational activities in reef environments, including snorkeling, swimming, scuba diving, etc., can have a negative impact (Marion and Rogers 1994). Predominant reef impacts include physical damage to the reef, harassment and artificial feeding of fish, collection of reef organisms, and pollution of reef waters from boat oil and gas residues (Marion and Rogers 1994). See comments above for swimming.

SCUBA Diving

Recreational scuba divers impact marine resources, directly by touching and removing coral (habitat) and indirectly by removing fish (Garcia-Moliner et al. 2001). No information is available documenting the changes in the scuba diving activity in the U.S. Caribbean (Garcia-Moliner et al. 2001). The 'sport' became popular in the 1970s and its popularity has increased ever since. In 2001, there were thirty dive shop businesses/schools licensed on St. Thomas and St. John, and six on St. Croix (Hinds Unlimited 2003).

In the USVI, 79% of the diving operations were exclusively of a passive nature, not allowing any removal of fish or coral (Garcia-Moliner et al. 2001). Among the species that are being harvested by recreational divers are spiny lobster, queen conch, hogfish, and snappers (Garcia-Moliner et al., 2001). In the USVI, the number of visitors totaled 2,138,900 in 1998 (Garcia-Moliner et al. 2001). The number of potential divers was estimated at 169,156 which could account for 8% of the total visitors. USVI dive operators cater to the tourist industry, and, more specifically, the cruise ship tourist. Since most of the cruise ships stop at St. Thomas, the areas around that island could be receiving more of a direct impact from divers than St. John and St. Croix (Garcia-Moliner et al. 2001). Marine recreation-related environmental stresses and threats were further documented in Hinds Unlimited (2003) and Marion and Rogers (1994).

Para-Sailing

Para-sailing is offered in the USVI by several watersports businesses and resorts. However, little information is available on this type of marine recreation.

Going to the Beach

Of course, one of the most popular tourist and local activity is just going to the beach. This may be for relaxing on the beach and reading a book to playing various sports on the beach such as volleyball, throwing a frisbee, catch, or flying a kite. All or any of the above mentioned water related activities can be done at most beaches around the USVI, especially at the beaches of major resorts.

Recreational uses of the waters and beaches of the Virgin Islands National Park have increased dramatically from less than 100,000 people in 1967, to more than 750,000 in 1968, to 802,000 in 2000 (VINP 2001). The recent reports include such specific present uses as day trips, camping, and water-based sports and activities (Hinds Unlimited 2003).

(2) Priority Issues for USVI Marine Recreation

Recreational activities have direct and indirect impacts over marine resources (Hinds Unlimited 2003; Roberts 1995; Rogers and Needham 1991; Rogers et al. 1988a, 1988b; and MerrellKatsouros, LLC 2003). These impacts can also take a variety of forms and severity. There are numerous examples of severe, localized damage to marine ecosystems attributable to recreation (Hinds Unlimited 2003). In a survey of stresses affecting Caribbean reefs, many resource managers and scientists reported damage from anchors (e.g., from cruise ships and dive boats), from boat groundings, and from people walking on reef flats and removing corals as souvenirs (Rogers 1985).

A Virgin Islands Resource Management Cooperative (VIRMC) report on recreational uses in the national park observed that one consequence of the popularity of the Virgin Islands National Park (VINP) and Biosphere reserves on St. John has been “degradation of the park’s marine resources, particularly some of the coral reefs and seagrass beds along the north shore of the island … anchor damage and damage from boats striking or grounding on reefs is evident … seagrass beds in popular bays have deteriorated.” (Rogers et al. 1988a).

Pollution

Public Service campaigns of conservation groups, Earth Day celebrations, and the Anti-Litter and Beautification Commissions have long focused attention on the garbage problems that plague many of the Territory’s beaches (Hinds Unlimited 2003). In the community briefings and focus groups, stakeholders also complained that negative impacts from camping and picnicking during resident’s and visitor’s treks on nature trails and beaches include improper disposal of trash, damage to nearby trees and plant life, noise pollution, smoke, and waste oil pollution from generators (Hinds Unlimited 2003).

It was estimated that tourists (in general) generate twice as much solid waste per capita as local residents, a substantial amount of liquid waste, place a high demand on potable water energy, and spend their time in tourism facilities that are, for the most part, built within 800 meters (0.5 miles) of the high water mark in environmentally-sensitive areas (Dixon et al. 2001).

In the USVI, energy and potable water are produced from fossil fuels (Hinds Unlimited 2003). A higher usage of water and energy by tourists, coupled with traffic congestion, and the related emissions, constitute environmental stresses (Hinds Unlimited 2003). These stresses need to be understood and, therefore, warrant research and analysis (Hinds Unlimited 2003).

On St. Croix, immediate and long-term threats to the existing nursery habitats in Salt River and Altona Lagoon include point and non-point source pollution, coastal development, permitted water-dependent and land-based recreational activities (Tobias 1998).

In theory and in practice, "spot zoning" often permits a use and/or construction that may not give adequate consideration to nearby environmentally sensitive areas (Hinds Unlimited 2003). Coupled with the absence of a comprehensive land and water use plan, spot zoning can be a contributor to habitat degradation (Hinds Unlimited 2003).

While boats are on railways during repair and maintenance, oil, grease, paint chips, and other scrapings and materials fall directly into the water (IRF 1993b).

Erosion and Runoff

Probably the most serious threat facing the Virgin Islands' marine resources comes from the accelerating pace of coastal and upland development where land is being cleared and bulldozed to make way for hotels, condominiums, and home sites (Rogers and Needham 1991). Construction of marinas and boatyards to support recreational boating has had serious environmental consequences, particularly in mangrove areas (Rogers et al. 1988a). Erosion and runoff of sediment from these sites can result in reduction of light available for photosynthesis by marine organisms and smothering of organisms, leading to deterioration of water quality and degradation of nearshore ecosystems (Rogers and Needham 1991). A good deal of this development is undoubtedly due, directly or indirectly, to the tourism industry, with marine recreation being a primary factor in that industry's sustainability and growth.

Habitat/Coral Damage

Habitat degradation can result from a variety of tourism and marine recreation related activities, including (Hinds Unlimited 2003):

1) Upland development without proper sediment control measures resulting in unintentional filling in or even loss of a salt pond.

2) Cutting, or anchoring to, mangroves damages or destroys mangroves which can eliminate nature's filtering mechanism.

3) Extended camping and cookout activities have resulted in gradual destruction of mangrove habitat. Particularly at Salt River on St. Croix, mangroves have been cleared for campground areas and burned for firewood (Tobias 1998).

4) Dredging, sand extraction, groin construction, and sewage effluent have affected reefs on St. Thomas and St. Croix (Goenaga and Boulon 1992). A dredging project on St. Croix in the early 1990s removed 122,000 cubic yards of bottom material and destroyed approximately 5 acres of seagrass meadows (IRF 1993b).

In the past ten years, there have been several studies that examined the effects of snorkeling and diving activities on coral reef systems. Divers are known to damage corals and other marine organisms through direct physical contact with their hands, body, equipment, and fins (Rouphael and Inglis 1995, 1997; and Talge 1990, and 1992). The cumulative effects of such damage can cause substantial localized damage to reef communities (Garabou et al. 1998; Hawkins et al. 1999; and Plathong et al. 2000).

Beyond the physical damage that inexperienced divers may cause, the direct take of marine organisms (i.e., lobsters, conch, shells, and corals) adds to the negative impacts humans can have as underwater spectators (Hinds Unlimited 2003).

Habitat damage can also be from boat propellers which also often disturb and suspend silt (Hinds Unlimited 2003). A U.S. Environmental Protection Agency “Fact Sheet” describes the way in which snorkelers and divers kick up sediment that lands on the coral, blocks needed sunlight, thereby destroying living coral (U.S. EPA undated).

Generation of wave energy by use of personal motor craft at high speeds in an embayment can accelerate shoreline erosion and adversely affect the behavior of juvenile fishes (Tobias 1998).

Degradation of habitats (such as salt ponds, mangroves, coral, and seagrass), whether by natural or anthropogenic influences, negatively impacts the marine resource (Hinds Unlimited 2003). The concept of an “ecosystem” makes it clear that loss or degradation of any of these habitats is critical for the overall health of the marine resources. These areas also serve as nurseries or home to many species, including endangered species. Studies of mangroves have determined that these areas are of principal importance to the marine resource health (IRF 1993a).

According to Turgeon et al. (2002), little is known about the interactions among coral reefs, mangroves, and seagrass beds, and how deterioration of mangroves and seagrass beds contributes to the degradation of coral reefs. Degradation of benthic habitats has undoubtedly contributed to the significant changes in reef fish assemblages as gleaned from qualitative observations and quantitative research (Turgeon et al. 2002).

Coral Diseases

Entry of pathogens into the waters from discharge of sewage from boats can cause disease and scarring in many coral species (Rogers et al. 1988a).

White band disease and other coral diseases have not been directly correlated with human activities although Peters (1984) suggests that injuries to corals from snorkelers, divers, and adverse environmental conditions, such as high turbidity and sediment, could increase the frequency of occurrence. However, it is not known if the dramatic increase in visitation to Caribbean coral reef areas and damage resulting from recreational activities have been accompanied by increases in coral diseases.

Anchor Damage

Small boat impacts on benthic habitats include anchor damage (TNC 2002). A lack of knowledge and experience increases the likelihood for damage to the marine communities of concern by recreational boaters (TNC 2002). Recent surveys make it clear that anchoring gear has damaged critical benthic resources. Garrison (1993) and Link (1997) report that breakage occurs from occasional ship groundings of large commercial vessels and smaller recreational boats and anchoring.

Anchors and their attached chains can severely damage seagrasses and coral communities (Rogers and Needham 1991). In many cases, the chain is more detrimental than the anchor itself because it scours the bottom as the vessel shifts in the wind and currents, or else moves up and down, bouncing off the bottom. A single anchor drop can destroy reef areas, which support a high diversity of living organisms, and which took centuries to develop (Rogers and Needham 1991). The anchor from a large vessel can weigh several tons and is capable of doing far more serious damage than the lighter anchors of smaller boats. Large anchors can actually fracture the framework of a reef (Rogers and Needham 1991).

In a study conducted by the Virgin Islands Resource Management Cooperative (VIRMC) in the Virgin Islands National Park (VINP) from 1984 to 1987, 186 boats inside park boundaries were surveyed (Rogers et al. 1988b). Of these, 32% were anchored in seagrasses and 14% in coral communities, with the remainder on sand, mud, or pavement. Many sites which now have barren sand or pavement could previously have had seagrass beds or coral communities which deteriorated with an increase in anchor damage. Of the 26 anchors found on coral bottoms, 7 were causing minor damage and 3 were causing moderate or severe damage, with the rest causing no apparent damage (Rogers et al. 1988b). Of 60 anchors in seagrasses, 18 were causing minor damage, and 17 were causing moderate or severe damage, with the rest causing no apparent damage (Rogers et al. 1988b).

A dramatic incident on October 8, 1988 made it clear that the greatest threat to the marine resources in the park, the destruction by cruise ship anchors, was not being adequately addressed (Rogers and Needham 1991). On that day, a 440 foot cruise ship dropped its anchor on a coral reef, dragging the anchor along the reef slope which rises from a depth of 75 feet to 25 feet in waters west of Francis Bay, St. John. It left a distinct scar about 420 feet long and 6-10 feet wide (Rogers and Needham 1991). Corals and other reef organisms were pulverized, overturned, and ripped from their bases. An area of 340 sq. yards was virtually destroyed (Rogers and Needham 1991).

Sport fishermen anchor or moor vessels in protected back reef embayments, which are known to be important nursery grounds for recreational sport fishes (Mateo and Tobias 2001). Subsequently, these essential fish habitat areas, which include mangrove wetlands, seagrass beds, and coral reefs, become degraded by damage caused by anchoring (Mateo and Tobias 2001). Sailboats and liveaboards also anchor long-term in these same areas and cause damage not only from anchors but discharge as well. Tropical storms and hurricanes magnify the damage caused by anchored vessels to the benthic community and prolong recovery (Rogers and Needham 1991).

Recovery of seagrass beds and reefs is a slow process (Rogers and Needham 1991). Corals grow a maximum of a few centimeters a year. In cases where corals have been pulverized or displaced, recovery depends on successful recruitment of live coral fragments and settlement of coral planulae (larvae). These larvae require hard substrate for colonization. Often the anchor scar contains loose sediment and rubble which do not provide a suitable substrate. Recovery may be prevented or delayed if anchoring continues or if storms or heavy seas prevent the cementation and stabilization of detached coral colonies or coral rubble. Seagrass beds take decades to recover if the rhizomes have been severed (Rogers and Needham 1991). In addition, the root and rhizome systems of seagrass plants stabilize sand, and their destruction can increase sedimentation in nearby areas (Rogers and Needham 1991; Rogers et al. 1988a, and 1988b; Short and Wyllie-Echeverria 1996; and Thayer et al. 1975).

Destruction from boat anchors and from boats running aground have ranged from a 283 cubic meter (~10,000 sq. ft) section of reef destroyed by a cruise ship on St. John in 1988 (with no significant recovery 10 years later) to an average of four boats per week running aground and destroying coral, particularly elkhorn coral (prior to the installation of moorings) (Rogers et al. 1988b).

Body Lotions

Suntan oil used by swimmers and snorkelers has been postulated to harm or even kill sensitive coral (US EPA undated), though no studies have been conducted to support this contention.

Boat discharges/pollution

Small boat impacts on benthic habitats include septic and oil discharge, fuel spills during refueling, pollution from pumping a bilge, or from discharging untreated sewage in the water (Hinds Unlimited 2003). A lack of knowledge and experience in small boat handling increases the likelihood for damage to the marine communities of concern by recreational boaters (TNC 2002). The entry of pathogens into the waters, from discharge of sewage from boats, can cause disease and scarring in many coral species (Rogers et al. 1988a). Sewage pump-out facilities are woefully lacking or inadequate throughout the territory in marinas and harbors, especially where "liveaboards" are moored (IRF 1993b).

Studies highlighting the high levels of pollutants in boatyards and marinas, and measures addressing these problems can be found in NPS (2001) and Hutchins (2004). Although the use of tributyltin (TBT) is prohibited in the U.S., it is not prohibited in many countries (Hinds Unlimited 2003). Foreign ships or recreational boats entering USVI harbors may utilize bottom paint containing TBT (IRF 1993b). TBT could then leach into USVI waters from these sources.

Vessel groundings

Recent surveys make it clear that anchoring gear has damaged critical benthic resources. Garrison (1993) and Link (1997) report that environmental damage occurs from occasional ship groundings of large commercial vessels and smaller recreational boats, anchoring, and deployment of fish traps on coral reefs. Small boat impacts on benthic habitats also include prop scars and groundings (Hinds Unlimited 2003). Some grounded vessels are abandoned and left on the reef or shoreline causing extensive damage over extended periods. Some are abandoned after hurricanes. Inexperienced tourists rent boats and run into shallow water areas where groundings cause impacts on corals and benthic habitat.

Disturbing Wildlife

Small boat impacts on benthic habitats include wildlife disturbance (TNC 2002). A lack of knowledge and experience increases the likelihood for damage to the marine communities (TNC 2002).

Excessive Use

Dixon et al. (2001) suggests that even with good management practices, the presence of large numbers of divers or snorkelers in the water is often damaging to coral reef systems.

According to Hinds Unlimited (2003), a United Nations Environmental Program report on coastal tourism impacts addresses the links between a pristine environment and tourism, stating that “The issues of overuse of resources, damage to natural resources and ecosystems, increased conversion of coastal zone space to more stressful uses, and increased social tensions, all create major imbalance”.

(3) Current Management Measures

Some regulations that apply to marine recreation in general are as follows.

1) Marine turtles and eggs - It is unlawful to take, kill, molest, harass, or remove turtles or eggs in the United States or territorial waters (VIRR 1990). All species are protected by the Federal Endangered Species Act of 1973.

2) Coral - It is unlawful to remove, injure, break, or destroy any living coral within the territorial waters or National Park waters of the U.S. Virgin Islands (VIRR 1990). Black coral is protected under the U.S. Endangered Species Act of 1973 and the V.I. Endangered and Indigenous Species Act of 1990 (VIRR 1990). For more information on black coral in the USVI, refer to Olsen and Wood (undated).

3) Spearfishing - The use or possession of spearfishing equipment is prohibited within NPS boundaries. It is unlawful to spear lobsters in territorial waters (DFW/DEE 2004).

4) Removal of tropical fishes for aquarium purposes - Collection of tropical fish for aquarium purposes requires a special permit (DFW/DEE 2004).

Mooring and anchoring in the U.S. Virgin Islands is only allowed in bays or harbors that are designated as mooring and anchoring areas by the V.I. Department of Planning and Natural Resources (VIRR 1992). In addition, the following are punishable by up to $1,000 for the first offense or $5,000 for each subsequent offense:

1) Discharge of pollutants (garbage, sewage, heat, etc.) into the water in the mooring area or any waters of the Virgin Islands;

2) Activities that create excessive or unreasonable noise or that interfere with the comfortable enjoyment of the mooring area;

3) Houseboats are prohibited in designated mooring and anchoring areas;

4) Operating a vessel in excess of 6 mph or creating excessive wakes in a mooring or anchoring area; and

5) Spearfishing in a mooring or anchoring area.

Provisions in an international law referred to as MARPOL prohibit the discharge of plastic garbage anywhere in the ocean (DPNR 2004). They also restrict the disposal of other types of garbage within specified distances form shore and mandate that ports and terminals have reception facilities capable of receiving garbage from ships.

The Federal Water Pollution Control Act prohibits the discharge of oil or oily waste into or upon the navigable waters of the United States or the waters of the contiguous zone if such discharge causes a film or sheen upon, or discoloration of, the surface of the water, or causes a sludge or emulsion beneath the surface of the water (DPNR 2004).

In the Virgin Islands National Park (VINP) under the National Park Service (NPS) has taken a number of actions in an attempt to balance use of the park with protection of the marine resources for which the park was established (Rogers and Needham 1991). These include:

1) Designated anchorages;

2) Provision of moorings;

3) Enforcement;

4) Communications with user groups;

5) Environmental education efforts;

6) Research programs;

7) Regional cooperation; and

8) Specific resource management actions.

Specific resource management actions which have been taken in VINP have been based on research on the coral reefs and seagrass beds and careful documentation of resource degradation (Rogers and Needham 1991). For example, the documentation of damage from the cruise ship that dropped its anchor in Francis Bay, mentioned above, and other similar incidents, prompted the establishment of regulations which prohibit boats over 225 feet long from anchoring in the park, and which require boats from 125 to 225 feet long to anchor in Francis Bay (Rogers and Needham 1991). Francis Bay was selected as a designated anchorage for these larger vessels because it has a predominantly sandy bottom with few coral or seagrass communities. In addition, some nearshore areas have been designated off limits to boats to allow recovery of shallow seagrass beds and coral communities (Rogers et al. 1988b).

(4) Current Projects and Research Overview

The USVI Division of Fish and Wildlife is currently involved in two projects related to marine recreation (DFW 2004a and 2004b): (1) to improve boating access for recreational boaters and (2) to provide better day-use mooring facilities for recreational boaters.

Presently, only limited public boat access facilities are available to the recreational boating community (DFW 2004a). Expansive sections of coastlines remain inaccessible to recreational fishermen who trailer their boats due to the lack of access facilities or inaccessible coastal terrain (DFW 2004a). Recreational boaters are forced to trailer their vessels relatively long distances to reach existing facilities. The lack of public boat ramp facilities also requires sport fishermen to leave their vessels in the water for extended periods of time. Existing facilities are small and overcrowded. Recent hurricanes affecting the Virgin Islands have rendered several boat access facilities, which were previously in need of repair, either unusable or hazardous to recreational fishermen and boaters (DFW 2004a). By upgrading and constructing new boat access facilities, sport fishermen will have improved and safer access to offshore waters, which will enhance their overall recreational boating experience (DFW 2004a). Environmental impact to inshore nursery areas will be reduced, which will promote the conservation of recreationally important fish species.

The second project is the deployment and maintenance of day-use mooring buoys around St. Thomas and St. Croix (DFW 2004b). Additional day-use mooring buoys will also be deployed and maintained around the newly designated St. Croix East End Marine Park (DFW 2004b). These provide increased opportunities for recreational boating and fishing, in designated areas, and reduce anchor damage to critical marine habitats such as coral and seagrass beds (DFW 2004b).

The National Park Service (NPS) has shown a substantial commitment to increasing our knowledge of the marine resources in Virgin Islands National Park (VINP) and Biosphere Reserve, and Buck Island Reef National Monument in St. Croix (Rogers and Needham 1991). Beginning in 1983, NPS provided funds to support a series of research projects by members of the Virgin Islands Resource Management Cooperative (VIRMC) (Rogers and Needham 1991). Between 1983 and 1988, VIRMC members completed 30 research projects which emphasized baseline studies of marine systems (seagrass beds, coral reefs, reef fishes), monitoring, and synthesis of information (Rogers and Teytaud 1988). Much of the information from these VIRMC projects has provided an essential basis for research management in the park.

The results of these studies (Rogers and Teytaud 1988) and additional observations by park biologists led to concerns over the environmental consequences of the increasing level of tourism in the park (Rogers and Needham 1991). In 1988, the NPS provided further funding to support the Coral Reef Assessment Program for 3-5 years (Rogers and Needham 1991). The overall goal of this program was to establish effective long-term research and monitoring sites at NPS units in the USVI. The value of research as a basis for management has been demonstrated (Rogers and Needham 1991). The deleterious results of marine-based tourism have been superimposed on marine resources which have been subjected to a variety of stresses from natural processes and various human activities (Rogers and Needham 1991).

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CHAPTER V
IDENTIFICATION OF PRIORITY ISSUES AND SPECIES OF CONCERN

1. IDENTIFICATION OF PRIORITY ISSUES

(1) Background

Over the last few years, a variety of groups were approached for their opinions regarding the marine resources and fisheries in the U.S. Virgin Islands. A list of these surveys that solicited opinions on these resources is as follows:

1) In 2000, a telephone survey of registered boaters, and thus targeting only boat-based fishers, was conducted by the Eastern Caribbean Center (ECC) at the University of the Virgin Islands (see ECC 2002).

2) In 2001, at the request of the St. Thomas/St. John Fisheries Advisory Committee (FAC), the USVI Division of Fish and Wildlife (DFW) conducted an opinion survey of USVI commercial fishers (Uwate et al 2001).

3) In 2002, DFW conducted surveys of two user groups in the USVI (see Gordon and Uwate 2003). The first was an opinion survey of commercial fishers. The second was an opinion survey of marine recreational industry.

4) In 2003, DFW conducted a survey of V.I. recreational fishing club members (see Messineo and Uwate 2004). This involved members of the two existing recreational fishing clubs in the USVI: (1) the Virgin Islands Game Fishing Club on St. Thomas, and (2) the Golden Hook Fishing Club on St. Croix.

5) In late 2003, a census of the commercial fishers of the USVI was conducted (see Kojis 2004).

6) In 2004, DFW conducted a survey of V.I. marine researchers (see Messineo et al. 2004).

(2) Priority Issues in the USVI Fisheries

In the 2000 survey of registered boat owners (see ECC 2002), more than 75 percent of the respondents indicated that the government could do things to improve their recreational fishing experience in the USVI. These include issues such as enforcement of laws, fish aggregation devices (FADs), artificial reefs, pollution control, education, and public access. The responses were similar for St. Thomas/St. John and St. Croix.

In the 2001 commercial fisher opinion survey (Uwate et al 2001), the most commonly identified issues and problems regarding fisheries resources in St. Thomas/St. John included jet skis, overfishing, pollution, too many fish traps and fish traps lost or cut, and lack of enforcement. In St. Croix, respondents identified gillnets, overfishing, pollution, and stolen traps as the major fisheries problems.

In the 2002 opinion survey of commercial fishers (Gordon and Uwate 2003), respondents provided their opinions on the major issues and problems regarding fishing in the USVI. The top three areas of concern for St. Thomas/St. John included: overfishing, too many fish traps, and water pollution. Top issues for commercial fishers on St. Croix included: too many gillnets, over-fishing, and too many fishery area closures and stolen traps and/or trap catch.

The 2002 opinion survey of marine recreational industry (Gordon and Uwate 2003), respondent's opinions, as well as their view of their customers' opinions, identified fish traps (too many), lack of enforcement, and overfishing, in that order, as the main problems with fisheries on St. Thomas/St. John. On St. Croix, overfishing, lack of enforcement, and too many restrictions were identified as the main problems with fisheries.

In the 2003 recreational fishing club member opinion survey (Messineo et al 2004), respondents indicated that major fisheries problems included: overfishing, longliners, gillnets, fish traps, and enforcement (lack of). St. Croix respondents indicated that long-liners, gillnets, and fish traps were problems. These were not commonly identified problems for St. Thomas/St. John respondents.

In the 2003/04 commercial fisher census (see Kojis 2004), over half of the fishers in St. Thomas/St. John District felt that fishing was the same as ten years ago. The one third who felt it was worse gave less fish, area closures, and too many traps as the primary reasons for the decline. In contrast, almost 70% of St. Croix fishers thought fishing was worse today than ten years ago. St. Croix District fishers who thought fishing was worse today than 10 years ago provided twenty reasons for the decline. Over half (53.4%) stated that it was due to four factors: net fishing, too many fishers, less fish, and overfishing. Only 5% of the fishers in the USVI felt that fishing was better than 10 years ago.

In the 2004 USVI marine researcher survey (Messineo et al. 2004), respondents identified a variety of problems with the local fishery. Major responses fell into the following categories: over-fishing/stock depletion, lack of enforcement, habitat loss/destruction, inappropriate gear types (e.g., trap mesh too small), and pollution. Again, in the V.I. marine researcher opinion survey (Messineo et al. 2004), respondents were asked about fishery problems in the USVI as a whole. Responses were not broken down between the St. Thomas/St. John and St. Croix districts.

A summary of perceived problems in the USVI fisheries is provided in Table V-1 below. These rankings are a rough approximation, which was arrived at by averaging the percentage responses from the six opinion surveys reviewed in this summary (see ECC 2002; Gordon and Uwate 2003; Kojis 2004; Messineo and Uwate 2004; Messineo et al. 2004; and Uwate et al 2001).

Table V-1. Summary of the Most Common Responses* Identifying **Problems** with the **Fisheries** in the USVI.

Rank	**STT/STJ**	**STX**	**USVI**
1	Pollution	Gillnets	Pollution
2	Enforcement (lack of)	Pollution	Enforcement (lack of)
3	Fish traps (too many)	Enforcement (lack of)	Overfishing
4	Overfishing	Fish traps (too many)	Fish traps (too many)
5	Longlining	Overfishing	Gillnets
6	Habitat degradation	Longlining	Longlining

*note: Rankings are a rough approximation arrived at by averaging the percentage responses from ECC (2002), Uwate et al. (2001), Gordon and Uwate (2003), Messineo and Uwate (2004), Kojis (2004), and Messineo et al. (2004).

As a side note, the St. Thomas Fishermen's Association (STFA) indicated that priority should be attached to the following issues (see comments and STFA letter in Appendix 4):

1) The failure of the local government to collect data and develop management actions based upon analytical results.
2) Lack of local fishermen input to the FAC and CFMC.
3) Absence of enhancement and habitat rehabilitation plans and projects for important fishery habitat and resources.
4) Failure of DPNR enforcement to enforce existing fishery regulations.
5) Failure of DPNR to enforce sediment control requirements of construction permits.
6) Failure of DPNR to address sewage and industrial pollution issues.

Some of these issues were identified in Table V-1 above.

(3) Priority Issues in USVI Marine Resources

In the 2002 commercial fisher opinion survey (Gordon and Uwate 2003), respondents identified priority areas for marine resources that need to be addressed. Of the fishers that responded to this, the main priority area to be addressed in St. Thomas/St. John was habitat destruction followed by coastal development, too many fishers, more jet ski regulations, overfishing, and pollution, all rating equally. On St. Croix, top priorities that need to be addressed were pollution, too many fishing area closures, and too many gillnets.

In the 2002 opinion survey of the marine recreational industry (Gordon and Uwate 2003), respondents identified the major diving/marine resource problems as they perceived them. St. Thomas/St. John respondents thought pollution, habitat destruction, and lack of moorings were major problems. On St. Croix, major resource issues included pollution, overfishing, and habitat destruction.

In the 2003 VI recreational fishing club member opinion survey (Messineo and Uwate 2004), respondents identified marine resource problems that were similar to those identified for fisheries. Enforcement, pollution, and reef damage were common USVI identified marine resource problems. Between districts, pollution (i.e., sewage, runoff) was identified by St. Thomas/St. John respondents as the main marine resource problem, followed by decreases in fishing area, overfishing, and the need for stock enhancement. St. Croix respondents identified lack of enforcement and overfishing as the primary marine resource problems.

In the 2004 USVI marine researcher opinion survey (Messineo et al. 2004), respondents identified major problems for marine resources that need to be addressed. Common problems included: pollution, sedimentation, overfishing (overexploitation), lack of enforcement, and habitat/ecosystem degradation. As before, the marine researcher responses in this opinion survey (Messineo et al. 2004) were not separated into responses for the St. Thomas/St. John and St. Croix districts, but applied to the USVI as a whole.

A summary of perceived problems with USVI marine resources is provided in Table V-2 below. These rankings are a rough approximation, which was arrived at by averaging the percentage responses from the six opinion surveys reviewed in this summary.

Table V-2. Summary of the Most Common Responses* Identifying **Problems** with the **Marine Resources** in the USVI.

Rank	**STT/STJ**	**STX**	**USVI**
1	Pollution	Pollution	Pollution
2	Enforcement (lack of)	Enforcement (lack of)	Enforcement (lack of)
3	Fish traps (too many)	Overfishing	Overfishing
4	Overfishing	Habitat degradation	Habitat degradation
5	Habitat degradation	Gillnets	Gillnets
6	Moorings (not enough)	Moorings (not enough)	Moorings (not enough)

*note: Rankings are a rough approximation arrived at by averaging the percentage responses from ECC (2002), Uwate et al. (2001), Gordon and Uwate (2003), Messineo and Uwate (2004), Kojis (2004), and Messineo et al. (2004).

(4) Overall USVI marine resources and fisheries priority issues

Reviewing Tables V-1 and V-2 above, it is obvious that the major fisheries priority issues are very similar to those faced by marine resources (at least from the view point of the different user groups interviewed). The priority issues perceived as problems with both marine resources and fisheries in the USVI included:

1) **Pollution,**
2) **Lack of enforcement,**
3) **Gillnets**, and
4) **Overfishing.**

According to Robert McAuliffe, Fishermen's United Services Co-op of St. Croix (personal communication), commercial fishermen feel that a ban on gill and trammel net fishing is unnecessary and should, instead, be well-regulated and managed/enforced better

The two other major issues perceived as problems in the USVI fishery included:

1) **Traps,** and
2) **Longlines.**

The two other major issues perceived as problems with USVI marine resources included:

1) **habitat degradation,** and
2) **lack of moorings.**

2. IDENTIFICATION OF SPECIES OF CONSERVATION CONCERN

(1) Comprehensive Species of Concern List

Table V-3 contains a comprehensive species of concern list for the USVI, which includes species that have been identified as threatened or endangered, or are currently under some type of restriction (see 'identification of species of greatest conservation concern' in section 2, below), as well as species that have not been identified as threatened or endangered. Accounts of these species can be found in Appendix 1.

Table V-3. Comprehensive species of concern list for the U.S. Virgin Islands. Accounts of these species can be found in Appendix 1 (page number indicated).			
Category/Family	**Species (common name)**	**Species (scientific name)**	**Account (page no.)**
<u>Harvestable Caribbean Reef Fish Species</u>			273
Surgeonfishes, Acanthuridae			274
	ocean surgeonfish	*Acanthurus bahianus*	274
	doctorfish	*Acanthurus chirurgus*	275
	blue tang	*Acanthurus coeruleus*	276
Frogfishes, Antennariidae			276
Cardinalfishes, Apogonidae			277
	flamefish	*Apogon maculates*	277
	conchfish	*Astrapogen stellatus*	278
Trumpetfishes, Aulostomidae			278
	trumpetfish	*Aulostomus maculates*	278
Triggerfish, Balistidae			279
	queen triggerfish	*Balistes vetula*	279
	ocean triggerfish	*Canthidermis sufflamen*	280
	black durgon	*Melichthys niger*	281
	sargassum triggerfish	*Xanthichthys ringens*	282
Filefishes, Monacanthidae			282
	scrawled filefish	*Aluterus scriptus*	283
	whitespotted filefish	*Cantherhinesw macrocerus*	283
Combtooth blennies, Blenniidae			284
	redlip blenny	*Ophioblennius atlanticus*	284
Lefteye flounders, Bothidae			284
	peacock flounder	*Bothus lunatus*	285
Jacks, Carangidae			285
	yellow jack	*Caranx bartholomaei*	285
	blue runner	*Caranx crysos*	286
	horse-eye jack	*Caranx latus*	287
	black jack	*Caranx lugubris*	288
	bar jack	*Caranx rubber*	288
	greater amberjack	*Seriola dumerili*	289
	almaco jack	*Seriola rivoliana*	290
Butterflyfishes, Chaetodontidae			291
	longsnout butterflyfish	*Chaetodon aculeatus*	291
	foureye butterflyfish	*Chaetodon capistratus*	292
	spotfin butterflyfish	*Chaetodon ocellatus*	293
	banded butterflyfish	*Chaetodon striatus*	293
Hawkfishes, Cirrhitidae			294
	redspotted hawkfish	*Amblycirrhitus pinos*	294

Table V-3 (continued). Comprehensive species of concern list for the U.S. Virgin Islands. Accounts of these species can be found in Appendix 1 (page number indicated).			
Category/Family	**Species (common name)**	**Species (scientific name)**	**Account (page no.)**
Flying gurnards, Dactylopteridae			
	flying gurnard	*Dactylopterus volitans*	295
Spadefishes, Ephippidae			296
	Atlantic spadefish	*Chaetodipterus faber*	296
Gobies, Gobiidae			297
	neon goby	*Gobiosoma oceanops*	297
	rusty goby	*Priolepis hipoliti*	297
Basslets, Grammatidae			298
	royal gramma	*Gramma loreto*	298
Grunts, Haemulidae			298
	porkfish	*Anisotremus virginicus*	299
	margate	*Haemulon album*	299
	tomtate	*Haemulon aurolineatum*	200
	french grunt	*Haemulon flavolineatum*	301
	white grunt	*Haemulon plumieri*	302
	bluestriped grunt	*Haemulon sciurus*	302
Squirrelfishes and Soldierfishes, Holocentridae			303
	squirrelfish	*Holocentrus adscensionis*	303
	longspine squirrelfish	*Holocentrus rufus*	304
	blackbar soldierfish	*Myripristis jacobus*	305
	cardinal soldierfish	*Plectrypops retrospinis*	306
Wrasses and Hogfish, Labridae			306
	spanish hogfish	*Bodianus rufus*	306
	creole wrasse	*Clepticus parrae*	307
	yellowcheek wrasse	*Halichoeres cyanocephalus*	307
	yellowhead wrasse	*Halichoeres garnoti*	308
	clown wrasse	*Halichoeres maculipinna*	308
	puddingwife	*Halichoeres radiatus*	309
	pearly razorfish	*Hemipteronotus novacula*	310
	green razorfish	*Hemipteronotus splendens*	310
	hogfish	*Lachnolaimus maximus*	311
	bluehead wrasse	*Thalassoma bifasciatum*	311
Snappers, Lutjanidae			312
	black snapper	*Apsilus dentatus*	313
	queen snapper	*Etelis oculatus*	314
	mutton snapper	*Lutjanus analis*	314
	schoolmaster snapper	*Lutjanus apodus*	316
	blackfin snapper	*Lutjanus buccanella*	316
	gray snapper	*Lutjanus griseus*	317
	dog snapper	*Lutjanus jocu*	318

Table V-3 (continued). Comprehensive species of concern list for the U.S. Virgin Islands. Accounts of these species can be found in Appendix 1 (page number indicated).

Category/Family	Species (common name)	Species (scientific name)	Account (page no.)
	mahogany snapper	*Lutjanus mahogoni*	319
	lane snapper	*Lutjanus synagris*	319
	silk snapper	*Lutjanus vivanus*	320
	yellowtail snapper	*Ocyurus chrysurus*	322
	wenchman	*Pristipomoides aquilonaris*	323
	vermilion snapper	*Rhomboplites aurorubens*	323
Tilefishes, Malacanthidae			324
	blackline tilefish	*Caulolatilus cyanops*	324
	sand tilefish	*Malacanthus plumieri*	325
Goatfishes, Mullidae			325
	yellow goatfish	*Mulloidichthys martinicus*	325
	spotted goatfish	*Pseudupeneus maculates*	326
Morays, Muraenidae			327
	chain moray	*Echidna catenata*	327
	green moray	*Gymnothorax funebris*	328
	goldentail moray	*Gymnothorax miliaris*	328
Batfishes, Ogcocephalidae			329
Snake eels, Ophichthidae			329
	goldspotted eel	*Myrichthys ocellatus*	329
Jawfishes, Opistognathidae			330
	yellowhead jawfish	*Opistognathus aurifrons*	330
	dusky jawfish	*Opistognathus whitehursti*	330
Boxfishes, Ostraciidae			331
	spotted trunkfish	*Lactophrys bicaudalis*	331
	honeycomb cowfish	*Lactophrys polygonia*	332
	scrawled cowfish	*Lactophrys quadricornis*	332
	trunkfish	*Lactophrys trigonus*	333
	smooth trunkfish	*Lactophrys triqueter*	333
Angelfishes, Pomacanthidae			334
	cherubfish	*Centropyge argi*	334
	queen angelfish	*Holacanthus ciliaris*	334
	rock beauty	*Holacanthus tricolor*	335
	gray angelfish	*Pomacanthus arcuatus*	336
	french angelfish	*Pomacanthus paru*	336

Table V-3 (continued). Comprehensive species of concern list for the U.S. Virgin Islands. Accounts of these species can be found in Appendix 1 (page number indicated).			
Category/Family	**Species (common name)**	**Species (scientific name)**	**Account (page no.)**
Damselfishes, Pomacentridae			337
	sergeant major	*Abudefduf saxatilis*	337
	blue chromis	*Chromis cyanea*	338
	sunshinefish	*Chromis insolata*	338
	yellowtail damselfish	*Microspathodon chrysurus*	339
	dusky damselfish	*Pomacentrus fuscus*	339
	beaugregory	*Pomacentrus leucostictus*	340
	bicolor damselfish	*Pomacentrus partitus*	340
	threespot damselfish	*Pomacentrus planifrons*	341
Bigeyes, Priacanthidae			341
	bigeye	*Priacanthus arenatus*	342
	glasseye snapper	*Priacanthus cruentatus*	342
Parrotfishes, Scaridae			343
	midnight parrotfish	*Scarus coelestinus*	344
	blue parrotfish	*Scarus coeruleus*	344
	striped parrotfish	*Scarus croicensis*	345
	rainbow parrotfish	*Scarus guacamaia*	345
	princess parrotfish	*Scarus taeniopterus*	346
	queen parrotfish	*Scarus vetula*	347
	redband parrotfish	*Sparisoma aurofrenatum*	347
	redtail parrotfish	*Sparisoma chrysopterum*	348
	redfin parrotfish	*Sparisoma rubripinne*	348
	stoplight parrotfish	*Sparisoma viride*	349
Drums, Sciaenidae			350
	high-hat	*Equetus acuminatus*	350
	jackknife-fish	*Equetus lanceolatus*	350
	spotted drum	*Equetus punctatus*	351
Scorpionfishes, Scorpaenidae			351
Groupers, Hinds, and Sea Basses, Serranidae			352
	rock hind	*Epinephelus adscensionis*	352
	graysby	*Epinephelus cruentatus*	353
	yellowedge grouper	*Epinephelus flavolimbatus*	354
	coney	*Epinephelus fulvus*	354
	red hind	*Epinephelus guttatus*	355
	goliath grouper	*Epinephelus itajara*	356
	red grouper	*Epinephelus morio*	357
	misty grouper	*Epinephelus mystacinus*	358

Table V-3 (continued). Comprehensive species of concern list for the U.S. Virgin Islands. Accounts of these species can be found in Appendix 1 (page number indicated).			
Category/Family	**Species (common name)**	**Species (scientific name)**	**Account (page no.)**
	nassau grouper	*Epinephelus striatus*	359
	butter hamlet	*Hypoplectrus unicolor*	360
	swissguard basslet	*Liopropoma rubre*	361
	yellowfin grouper	*Mycteroperca venenosa*	361
	tiger grouper	*Mycteroperca tigris*	362
	creole-fish	*Paranthias furcifer*	353
	greater soapfish	*Rypticus saponaceus*	364
	orangeback bass	*Serranus annularis*	364
	lantern bass	*Serranus baldwini*	365
	tobaccofish	*Serranus tabacarius*	365
	harlequin bass	*Serranus tigrinus*	366
	chalk bass	*Serranus tortugarum*	366
Soles, Soleidae			367
	Caribbean tonguefish	*Symphurus arawak*	367
Porgies, Sparidae			367
	sea bream	*Archosargus rhomboidalis*	368
	jolthead porgy	*Calamus bajonado*	368
	sheepshead porgy	*Calamus penna*	369
	pluma	*Calamus pennatula*	370
Seahorses and Pipefishes, Syngnathidae			370
Lizardfishes, Synodontidae			371
	sand diver	*Synodus intermedius*	371
Puffers, Tetraodontidae			371
	sharpnose puffer	*Canthigaster rostrata*	371
	porcupinefish	*Diodon hystrix*	372
Harvestable Invertebrate Species			373
	Caribbean spiny lobster	*Panulirus argus*	373
	queen conch	*Strombus gigas*	377
	Atlantic triton's trumpet	*Charonia variegata*	380
	cameo helmet	*Cassis madagascarensis*	380
	Caribbean helmet	*Cassis tuberosa*	381
	flame helmet	*Cassis flammea*	381
	Caribbean vase	*Vasum muricatum*	381
	green star shell	*Astrea tuber*	381
	hawkwing conch	*Strombus raninus*	381
	true tulip	*Fasciolaria tulipa*	382
	milk conch	*Strombus costatus*	382
	roostertail conch	*Strombus gallus*	382
	West Indian fighting conch	*Strombus pugilis*	382

Table V-3 (continued). Comprehensive species of concern list for the U.S. Virgin Islands. Accounts of these species can be found in Appendix 1 (page number indicated).			
Category/Family	**Species (common name)**	**Species (scientific name)**	**Account (page no.)**
	whelk (West Indian top shell)	*Cittarium pica*	383
Non-Harvestable Species			386
Sponges, Phylum Porifera			386
Coelenterates or Cnidaria, Phylum Coelenterata			388
Hydrocorals, Class Hydrozoa			388
Anthozoans, Class Anthozoa			389
Octocorals, Orders Alcyonacea and Gorgonacea			390
Anemones, Orders Actiniaria and Zoanthidea			392
Hard or Stony Corals, Order Scleractinia			392
Black Corals, Order Antipatharia			397
False Corals, Order Corallimorpharia			398
Bryozoans			398
Aquarium Trade Species			399
Annelid Worms, Phylum Annelida			399
Molluscs			399
Crustaceans			400
Echinoderms			401
Tunicates, Class Ascidiacea			402
Marine Plants			402
Algae			402
Seagrasses			403
Marine Mammals			404
	humpback whales	*Megaptera noveangliae*	405
	sperm whales	*Physeter macrocephalus*	408
	fin whale	*Balaenoptera physalus*	410
	sei whale	*Balaenoptera borealis*	411
	West Indian manatee	*Trichechus manatus*	412
Sea Turtles			413
	leatherback turtle	*Dermochelys coriacea*	414
	hawksbill turtle	*Eretmochelys imbricata*	416
	green turtle	*Chelonia mydas*	417

(2) Selection Process of Species of Greatest Concern

There are hundreds of species of marine organisms and fishes in the waters around the USVI. In order to focus on species with the greatest conservation concerns, the following process was followed:

1) Species currently under territorial management were first identified;

2) Species currently under federal management were then identified;

3) Species currently under National Park Service management were then identified;

4) Finally, species of possible concern that may occur in USVI waters that have been identified by other agencies were identified and listed.

(3) Species Currently Under Territorial Management

Territorial regulations apply to waters extending from the shoreline to 3 miles out (DFW/DEE 2004). For regulations concerning these species, refer to Appendix 3A. Species currently under territorial management include:

1) whelk (*Cittarium pica*),
2) queen conch (*Strombus gigas*),
3) spiny lobster (*Panulirus argus*),
4) pink shrimp (*Penaeus spp.*),
5) goliath grouper (*Epinephelus itajara*),
6) mutton snapper (*Lutjanus analis*),
7) sea turtles,
8) marine aquarium fish,
9) black coral (order: Antipatharia),
10) tarpon (*Megalops atlanticus*), and
11) bonefish (*Albula vulpes*).

In addition, reef fish are collectively managed in the territory by specific regulations on traps and nets.

(4) Species Currently Under Federal Management

In the USVI, Federal waters extend from 3 miles to 200 miles offshore (DFW/DEE 2004). For regulations concerning these species, refer to Appendix 3B. Species currently under Federal management include:

1) red hind (*Epinephelus guttatus*),

2) mutton snapper (*Lutjanus analis*),
3) yellowtail snapper (*Ocyurus chrysurus*),
4) Nassau grouper(*Epinephelus striatus*),
5) goliath grouper(*Epinephelus itajara*),
6) seahorses (*Hippocampus spp.*),
7) foureyed, banded, and longsnout butterflyfishes (family: Chaetodontidae),
8) queen conch (*Strombus gigas*),
9) marine aquarium fish,
10) billfish (regulations extend to the shore),
11) tuna (regulations extend to the shore) (family: Scombridae),
12) shark (regulations extend to the shore) (family: Carcharhinidae),
13) sea turtles (CFMC 2004),
14) spiny lobster (*Panulirus argus*)(CFMC 2004) ,
15) black coral (order: Antipatharia)(CFMC 2004), and
16) cetaceans (CFMC 2004).

In addition, reef fish are collectively managed through federal regulations on trap and net fishing.

(5) Species Currently Under National Park Service Management

Species specified in these regulations (NPS 2004) include:

1) queen conch (*Stombus gigas*),
2) whelk (*Cittarium pica*), and
3) spiny lobster (*Panulirus argus*).

No extractive uses are permitted in the Buck Island Reef National Monument (BIRNM) on St. Croix and the Coral Reef National Monument on St. John. The National Park Service also manages harvest of species in the Virgin Islands National Park (NPS 2004). NPS regulations include:

1) Fishing is allowed outside of swim areas, but not in Trunk Bay and Jumbie Bay.

2) Spear guns are prohibited anywhere in Park waters.

3) Caribbean spiny lobster catch is limited to two per person per day and the carapace (area between head and tail) must be at least 3.5".

4) Whelk season is October 1-March 30. Whelk must be larger than 2.5" in diameter and take is limited to 1 gallon of whelks (in the shell) per person per day.

5) Conch season is October 1- June 30. Conch must be 9" long and take is limited to two per person per day.

6) Collecting plants and animals - dead or alive - or inanimate objects, including cultural artifacts, coral, shells, and sand is prohibited.

7) Feeding marine and terrestrial wildlife is prohibited and may be dangerous to the individual.

(6) Other Species of Possible Concern

At larger geographic scales, seventeen species that occur in the USVI have been identified for possible management actions. These are listed in Table V-4. Depending on the source of information, the designated status can be different. The point here is that these species have been identified at the regional or global level as having problems.

Table V-4. List of Species of Possible Concern that May Occur in the USVI that have been Identified by Various Sources

species	status	source
queen trigger fish, *Balistes vetula*	1. threatened; 2. vulnerable, a high risk of extinction in the wild in the medium term future	Froese and Pauly (2002); IUCN (2002)
hogfish, *Lachnolaimus maximus*	1. threatened; 2. vulnerable, a high risk of extinction in the wild in the medium term future	Froese and Pauly (2002); IUCN (2002)
cubera snapper, *Lutjanus cyanopterus*	1. threatened	Froese and Pauly (2002)
mutton snapper, *Lutjanus analis*	1. threatened; 2. vulnerable, a high risk of extinction in the wild in the medium term future	Froese and Pauly (2002); IUCN (2002)
rainbow parrotfish, *Scarus guacamaia*	1. threatened 2. vulnerable, a high risk of extinction in the wild in the medium term future	Froese and Pauly (2002); IUCN (2002)
marbled grouper, *Dermatolepis inermis*	1. threatened	Froese and Pauly (2002);
goliath grouper, *Epinephelus itajara*	1. critically endangered; 2. threatened; 3. U.S. Caribbean stock is overfished, but not experiencing overfishing	IUCN (2002); Froese and Pauly (2002); NMFS (2002)
Nassau grouper, *Epinephelus striatus*	1. threatened; 2. severely overfished in 1990; 3. endangered; 4. U.S. Caribbean stock is overfished, but not experiencing overfishing	Froese and Pauly (2002); NMFS (2002); IUCN (2002); NMFS (2002)
bigeye tuna, *Thunnus obesus*	1. threatened	Froese and Pauly (2002);

Table V-4. List of Species of Possible Concern that May Occur in the USVI that have been Identified by Various Sources (continued)

species	status	source
longsnout seahorse, *Hippocampus reidi*	1. threatened	Froese and Pauly (2002);
blacktip shark, *Carcharhinus limbatus*	1. threatened	Froese and Pauly (2002);
whale shark, *Rhincodon typus*	1. threatened	Froese and Pauly (2002);
elkhorn coral, *Acropora palmata*	1. NOAA Fisheries determination of ESA status pending	CFMC (2004)
staghorn coral, *Acropora cervicornis*	1. NOAA Fisheries determination of ESA status pending	CFMC (2004)
fused-staghorn coral, *Acropora prolifera*	1. NOAA Fisheries determination of ESA status pending	CFMC (2004)
black coral, order: Antipatharia	1. listed in CITES Appendix II, species not necessarily now threatened with extinction, but may become so unless trade is closely controlled.	CITES
queen conch, *Strombus gigas*	1. US Caribbean stock is overfished and undergoing overfishing; 2. listed in CITES Appendix II, species not necessarily now threatened with extinction, but may become so unless trade is closely controlled.	NMFS (2002); CITES

(7) Species of Greatest Concern

Many species that have been identified as threatened or overfished in the U.S. Caribbean (see Table V-4) are not protected by territorial or federal regulations (see sections above). Also, some species managed by the territory are not covered under existing federal regulations. Conversely, some species managed by federal regulations are not covered under territorial regulations. As an initial starting point, it would be appropriate to combine the list of all species currently under management and the list of species that have been identified for conservation. This will be the initial list of species of greatest conservation concern. A combined list is provided below in Table V-5. As a side note, there was a recent CFMC meeting and agreement to harmonize V.I. and Federal regulations.

Table V-5. List of Species of Greatest Concern

Fish Species	**Invertebrate Species**
queen trigger fish, *Balistes vetula*	elkhorn coral, *Acropora palmata*
hogfish, *Lachnolaimus maximus*	staghorn coral, *Acropora cervicornis*
cubera snapper, *Lutjanus cyanopterus*	fused-staghorn coral, *Acropora prolifera*
mutton snapper, *Lutjanus analis*	black coral (Order Antipatharia)
yellowtail snapper, *Ocyurus chrysurus*	spiny lobster, *Panulirus argus*
rainbow parrotfish, *Scarus guacamaia*	queen conch, *Strombus gigas*
red hind, *Epinephelus guttatus*	whelk, *Cittarium pica*
marbled grouper, *Dermatolepis inermis*	shrimp (*Penaeus spp.*)
goliath grouper, *Epinephelus itajara*	
Nassau grouper, *Epinephelus striatus*	
bigeye tuna, *Thunnus obesus*	
longsnout seahorse, *Hippocampus reidi* (and seahorses in general)	**Turtle Species**
blacktip shark, *Carcharhinus limbatus*	Leatherback,*Dermochelys coriacea*
tarpon, *Megalops atlanticus*	Hawksbill, *Eretmochelys imbricata*
bonefish, *Albula vulpes*	Green, *Chelonia mydas*
foureyed butterflyfish, *Chaetodon capistratus*	
banded butterflyfish, *C. striatus*	
longsnout butterflyfishes, *C. aculeatus*	**Marine Mammals**
billfish (various species)	humpback whale, *Megaptera noveangliae*
marine aquarium fish (various species)	fin whale, *Balaenoptera physalus*
reef fish (various species)	sei whale, *Balaenoptera borealis*
tuna (various species)	sperm whale, *Physeter macrocephalus*
whale shark, *Rhincodon typus* (and various other species of sharks)	West Indian manatee, *Trichechus manatus*

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CHAPTER VI
CONSERVATION STRATEGIES

1. STRATEGIES FOR ADDRESSING PRIORITY ISSUES

(1) Introduction

Priority USVI marine resource and fisheries issues identified in the previous section included the following:

1) Pollution,
2) Lack of enforcement,
3) Gillnets,
4) Overfishing,
5) Traps,
6) Longlines,
7) Habitat degradation, and
8) Lack of moorings.

These are the key priority issues that need to be resolved. There are several ways to approach each of these priority issues (see below). Also see to ECC (2002), Gordon and Uwate (2003), Kojis (2004), Messineo and Uwate (2004), Messineo et al. (2004), and Uwate et al. (2001).

(2) Public/User Group Suggestions for Improving USVI Marine Resources and Fisheries

Fisheries Suggestions - In the 2000 survey of registered boat owners conducted by ECC, most respondents indicated that government could improve the fishing by enforcement of laws, FADs, public access, education, and controlling pollution (ECC 2002).

Respondents in the 2001 commercial fisher opinion survey (Uwate et al. 2001) made various suggestions on how to make fishing better in the USVI. The most common suggestions included improving enforcement, controlling pollution and overfishing (gear limits, limited entry, banning gillnets, etc), and deploying additional FADs. Respondent's suggestions on how to improve the fishery differed somewhat between St. Thomas/St. John and St. Croix. Respondents from St. Thomas/St. John believed that better enforcement, limits on the number of traps, limited entry (limiting the number of fishers), and controlling pollution, in that order, were the best solutions. Respondents from St. Croix believed that banning gillnets, better enforcement, deploying more FADs (fish aggregating devices), better access (more boat ramps), and limited entry would improve the fishery.

In the 2002 opinion survey of commercial fishers (Gordon and Uwate 2003), respondents thought that the best way to improve the fishery was to improve enforcement (19% on St. Thomas/St. John; and 16% on St. Croix). Common suggestions were to hire additional enforcement officials, increase patrols, and increase site inspections. As in 2001 (see Uwate et al

2001), many St. Croix respondents (12%) also suggested that gillnets be banned or regulated (Gordon and Uwate 2003).

In the 2002 opinion survey of the USVI marine recreational industry (Gordon and Uwate 2003), respondents indicated that, in general, better enforcement and tougher regulations restricting bag and size limits would fix major fisheries problems. Between districts, marine recreation industry respondents from St. Thomas/St. John, for the most part (70%), had no comment on how to improve USVI's fisheries. Beyond that, fewer traps with larger mesh sizes and better fishing regulations were the leading suggestions. St. Croix marine recreational industry respondents suggested bag and size limits (19%), better enforcement (19%), and educational programs (10%) as ways to fix major fisheries problems. Workshops, advertising, and public announcements are some of the suggested educational options. There was also a 38% call for education within the additional comments provided by the St. Croix maritime businesses.

In the 2003 survey of recreational fishing club members (Messineo and Uwate 2004), there was little difference between suggestions on how to fix problems with fisheries and marine resources. Banning gillnets, fish traps, and increasing enforcement were common suggestions to fix the fishery resource, while instituting fish size limits and cleaning up pollution were common suggestions for fixing the marine resources (Messineo and Uwate 2004).

In the 2003 commercial fisher census (Kojis 2004), respondents were not specifically asked for their opinions on solutions to problems, however, solutions could be viewed as a reflection of their responses on fisheries problems. For example, commonly stated problems in St. Thomas/St. John District included overfishing, area closures, too many fishers, too many traps, pollution, etc., while St. Croix District respondents named gillnets, overfishing, too many fishers, pollution, etc. as problems with the fishery resources. Solutions to these problems could include gear limits, entry limits, pollution control, better management, enforcement, and education, etc.

In the 2004 survey of USVI marine researchers (Messineo et al. 2004), respondents made various suggestions on how to improve the fisheries. Common suggestions for improving fisheries included: enforcement of regulations, increasing enforcement, education, and gear reduction.

Other less common responses concerning problems/solutions for fisheries and marine resources identified by respondents from all six surveys, include: the need for better regulations and management, better cooperation with the BVI, fish trap mesh sizes, controlling coastal and upland development, closures (both for and against), marine protected areas, theft, fish market co-ops, more research, more fisher involvement, and a stronger FAC.

A summary of suggestions on how to improve the USVI fisheries is presented in Table VI-1. These rankings are a rough approximation, which were arrived at by averaging the percentage responses from the six opinion surveys reviewed in this summary (ECC 2002; Gordon and Uwate 2003; Kojis 2004; Messineo and Uwate 2004; Messineo et al. 2004; Uwate et al. 2001).

Table VI-1. Summary of the Most Common Responses* Identifying Solutions to USVI Fisheries Problems

Rank	STT/STJ	STX	USVI
1	Pollution control	Enforcement (improve)	Enforcement (improve)
2	Education	FADs (deploy more)	Pollution control
3	Enforcement (improve)	Pollution control	Education
4	FADs (deploy more)	Education	FADs (deploy more)
5	Artificial reefs	Boat/public access	Artificial reefs
6	Boat/public access	Artificial reefs	Boat/public access

*note: Rankings are a rough approximation arrived at by averaging the percentage responses from ECC (2002), Gordon and Uwate (2003), Kojis (2004), Messineo and Uwate (2004), Messineo et al. (2004), and Uwate et al. (2001).

As a side note, the St. Thomas Fishermen's Association (STFA), in disagreement with current and/or proposed management measures, has set up management committees for lobster, trap, line, and seine net fishing which will develop management recommendations (David Olsen, St. Thomas Fishermen's Association, personal communication, also refer to review comments and STFA open letter in Appendix 4).

David Olsen has also provided the following suggestions (David Olsen, St. Thomas Fishermen's Association, personal communication, also see David Olsen's comments in Appendix 4):

1) Work with major polluters to reduce their impacts over time.
2) Completely revamp your own enforcement department (i.e. DEE/DPNR) so that it actually enforces regulations.
3) Work harder at connecting with local interests which currently view DFW and DPNR as largely antagonistic and irrelevant.
4) Reactivate DFW so that it carries out research and activities which generate meaningful information required for management.
5) Address the lack of native-born participation in DFW's activities.

<u>Marine Resources Suggestions</u> - In the 2002 opinion survey of the USVI marine recreational industry (Gordon and Uwate 2003), respondents indicated that better enforcement, education, and pollution control would improve the marine resources in the USVI. As with their responses for solutions to fisheries problems, respondents from the St. Thomas/St. John marine recreation industry largely had no comment (70%) on how to fix marine resource problems. Leading suggestions included controlling pollution (10% of STT/STJ respondents), more commercial fishing regulations (4% of respondents), additional moorings (4% of respondents), and tougher regulations concerning fish traps (4% of respondents). St. Croix marine industry respondents

suggested better enforcement (22%), better education (17%), and pollution control (13%) as solutions to marine resource problems.

As indicated above, in the 2003 survey of recreational fishing club members (Messineo and Uwate 2004), the leading suggestions for improving the marine resources included instituting fish size limits, and cleaning up pollution (Messineo and Uwate 2004).

In the 2004 survey of USVI marine researchers (Messineo et al. 2004), respondents made various suggestions on how USVI marine resources could be improved. Common responses for improving marine resources included: more enforcement, education, better resource management, and restrictions on coastal development.

A summary of suggestions on how to improve the marine resources in the USVI is presented in Table VI-2. These rankings are a rough approximation, which were arrived at by averaging the percentage responses from the three opinion surveys reviewed in this summary (Gordon and Uwate 2003; Messineo and Uwate 2004; and Messineo et al. 2004).

Suggestions on how to improve the USVI marine resources and how to improve the USVI fisheries were the same (compare Table VI-1 above to Table VI-2 below). These suggestions were incorporated as much as possible into the proposed conservation strategies developed below for each of the previously identified USVI marine resources and fisheries priority issues.

Table VI-2. Summary of the Most Common Responses* Identifying Solutions to USVI Marine Resource Problems

Rank	STT/STJ	STX	USVI
1	Pollution control	Enforcement (improve)	Enforcement (improve)
2	Education	Pollution control	Education
3	Enforcement (improve)	Education	Pollution control
4	FADs (deploy more)	FADs (deploy more)	FADs (deploy more)
5	Artificial reefs	Boat/public access	Artificial reefs
6	Boat/public access	Artificial reefs	Boat/public access

*note: Rankings are a rough approximation arrived at by averaging the percentage responses from Gordon and Uwate (2003); Messineo and Uwate (2004); and Messineo et al. (2004).

(3) Pollution Priority Conservation Strategies

The general guidance provided by various user groups (see above) is to control pollution (see Tables VI-1 and VI-2 above). Their suggestion for more education can also be applied to this priority issue. This general guidance needs further development.

The pollution priority issue can be addressed by implementing the following conservation strategies:

1) Oil pollution and dispersants

a) Major Oil Spill Response and Preparedness - The existing emergency response teams should be maintained operationally ready to deal with major oil spills. Periodic training operations (*education*) should be held to ensure that staff and equipment are maintained in a state of readiness.

b) Minor Oil Spill Response and Preparedness - For minor oil spills, local marinas and fuel docks should have and use appropriate dispersants to control minor oil spills (*education*). Periodic inspections are needed to ensure compliance (*enforcement*). Resources to respond to public notifications of minor oil spill occurrences should be identified.

c) Boater Education - As suggested by user groups, programs should be developed to inform recreational boaters (*education*) about the damage caused by discharging oil and bilge wastes into the marine environment.

2) Siltation, groundwater contamination, and surface runoff

a) Control Siltation - Major sources of siltation into the marine environment need to be identified and assessed. Steps need to be taken to stop or control siltation into the marine environment (*enforcement)*.

b) Identify Sources of Groundwater Contamination - Sources of groundwater contamination need to be identified and assessed. Once an assessment is made as to the severity and any health risks of the source, the source can be isolated, neutralized, and/or removed (*enforcement*).

c) Control Surface Runoff - Sources of surface runoff need to be identified and assessed. Construction projects are supposed to use siltation barriers when cutting into earth for road access or construction site work. Existing rules on earthwork and the use of siltation barriers need to be enforced (*enforcement*).

3) Land use practices

a) Environmentally Friendly Use of Chemicals - Use of agricultural chemicals, fertilizers, and pesticides needs to be done in an environmentally friendly manner *(education)*.

b) Stop Excess Use of Chemicals - Excessive use of these chemicals should not be permitted *(enforcement)*.

c) Stop Runoff of Chemicals to the Sea - Steps should be identified and taken so that these chemicals do not get washed away into the marine environment *(enforcement)*.

4) Wastewater discharge

a) Monitor Sewage Plants - Public and private sewage treatment plants should have monitoring systems in place *(education)*.

b) Backup Storage Tanks - Backup storage tanks to store sewage during periods when the plant is down.

c) Backup Sewage Processing - If a plant is down for a significant amount of time (beyond the capacity of the backup storage tank), then alternative ways to process the raw sewage should be implemented (pump or haul to alternative treatment plant).

d) Containment/Prevention - Containment or prevention of sewage overflow and run-off during periods of heavy rainfall.

e) Stop Direct Discharge - Discharge of untreated sewage and industrial wastes to the marine environment should be illegal and stopped *(enforcement)*.

f) Boater Education - Recreational boaters should be educated about the damage caused by dumping raw sewage into the marine environment *(education)*.

5) Dredging

a) Use Siltation Curtains - All dredging operations should employ appropriate environmental safeguards such as siltation curtains *(enforcement)*.

b) Use Siltation Curtains Properly - These siltation curtains need to be properly deployed and maintained *(enforcement)*.

c) Inspect Siltation Curtains Regularly - Periodic inspections are needed to ensure that dredging operations are in compliance with siltation curtain requirements *(enforcement)*.

6) Toxic and thermal pollution

a) Identify Sources of Industrial Waste - Sources of industrial wastes should be identified and assessed, including, for example, desalination and generation plants.

b) Stop Discharge of Industrial Waste to the Sea - Steps should be taken to stop the discharge of industrial wastes discharged into the marine environment *(enforcement)*.

7) Recreational activities

a) Local and Visitor Education - Local residents and visitors need to be educated *(education)* about their impacts on the marine environment. This is especially true for snorkelers and divers who can kick up silt or otherwise come into physical contact with corals.

b) Boater Education - Recreational boaters should also be educated *(education)* about the collection of onboard rubbish and its disposal on appropriate land disposal sites.

8) Ship grounding-propeller scour

a) Fine Boaters for Damage to the Seabed - Boaters in general, and recreational boaters in particular, should be fined for destroying marine habitat *(enforcement)*.

b) Continue Assessments of Seabed Damage - An assessment is already made of marine habitat damage when boats run aground. These assessments should be continued for future vessel groundings. These reports should be the basis for the level of fine.

c) Public and Boater Education - In addition, a program *(education)* is needed to inform visitors and resident boat operators about the hazards and obstacles present when operating a boat in USVI waters.

(4) Lack of Enforcement Priority Conservation Strategies

The general guidance provided by various user groups (see above) is to increase enforcement (see Tables VI-1 and VI-2 above).

1) Increase Territorial Enforcement – Local enforcement of marine resources and fisheries regulations is the responsibility of the Division of Environmental Enforcement (DEE) within the Department of Planning and Natural Resources. Environmental enforcement officers need to successfully complete the police academy. DEE competes against local law enforcement for new recruits. Substantial supplemental recurrent funding is required by DEE to support

additional staff as well as to support them in terms of vehicles, vessels, and special equipment. Given the state of the local economy and local government revenues, additional local resources for this are highly unlikely. There may additional federal grants to support this. This needs to be investigated further.

2) Increase Federal Enforcement – Enforcement of federal fishing regulations falls within the mandate of NOAA Fisheries Enforcement Unit and the U.S. Coast Guard. With the recent demands on Coast Guard assets (after 9/11/01), these are now spread very thin and for the most part, not available for enforcement of federal fishing regulations. NOAA Fisheries Enforcement Unit had an officer based on St. Thomas. However, when this officer retired, he was not replaced. NOAA Fisheries has no plans to replace this officer. In 2003, CFMC requested that NOAA Fisheries replace this officer. However, no action has been taken on this request. Further efforts are required to motivate NOAA Fisheries to replace this enforcement officer.

(5) Gillnet Priority Conservation Strategies

One priority issue was the ban or regulation of gillnet fishing. Concern about gill and trammel nets was expressed by commercial fishers (Gordon and Uwate 2003; Kojis 2004; and Uwate et al. 2001). Basically, in order to achieve the objective of this priority issue, gill and trammel nets need to be banned or regulated. Steps have already been taken to address this priority issue. These steps include the following.

1) The issue of banning gill and trammel nets in the USVI was brought up by the St. Croix Fisheries Advisory Committee (FAC), and was also discussed with the St. Thomas and St. John FAC.

2) Various background and guidance papers were drafted by DFW (see Tobias 2004). These were provided to both FACs for their education and consideration.

3) After several FAC meetings and discussions, the FACs jointly developed specific recommendations on banning gill and trammel nets in the USVI. These were forwarded to the Commissioner of Planning and Natural Resources.

4) The Commissioner of Planning and Natural Resources has requested public hearings and is currently considering these recommendations and the formalization of management regulations concerning gill and trammel nets.

This issue needs to be monitored, followed up, and facilitated so that the proposed ban and regulations on gill and trammel nets are approved, and that there is compliance with the new rules and regulations *(education and enforcement)*.

As a side note, commercial fishermen feel that a ban on gill and trammel net fishing is unnecessary and should, instead, be well-regulated and managed/enforced better (Robert McAuliffe, Fishermen's United Services Co-op of St. Croix, personal communication).

(6) Overfishing Priority Conservation Strategies

A priority issue was overfishing. User group suggestions that address overfishing include deployment of more FADs and the creation of more artificial reefs (see Tables VI-1 and VI-2 above). Therefore, steps that can be taken to address the issue of overfishing, based on user group suggestions, include:

1) Deployment of additional fish aggregation devices (FADs) - This task also includes continued maintenance of existing FADs to prolong their usable life. FADs provide alternative fishing opportunities to local fishers. By having additional FADs, fishing pressure on inshore resources can be reduced and transferred to underutilized pelagic resources offshore. This should take some of the fishing pressure off of inshore resources and subsequently reduce overfishing in those inshore areas. At this time, pelagic fish resources may be underexploited. However, a stock assessment should be completed to determine the capacity of these offshore resources to support additional fishing pressure. Figures VI-1 and VI-2 show the locations of FADs currently deployed.

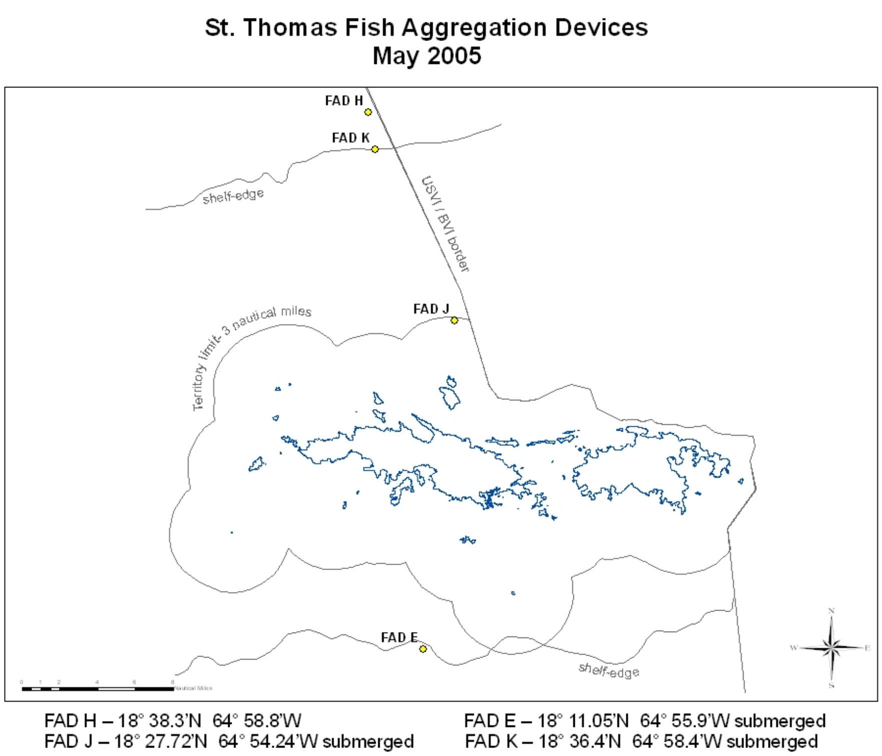
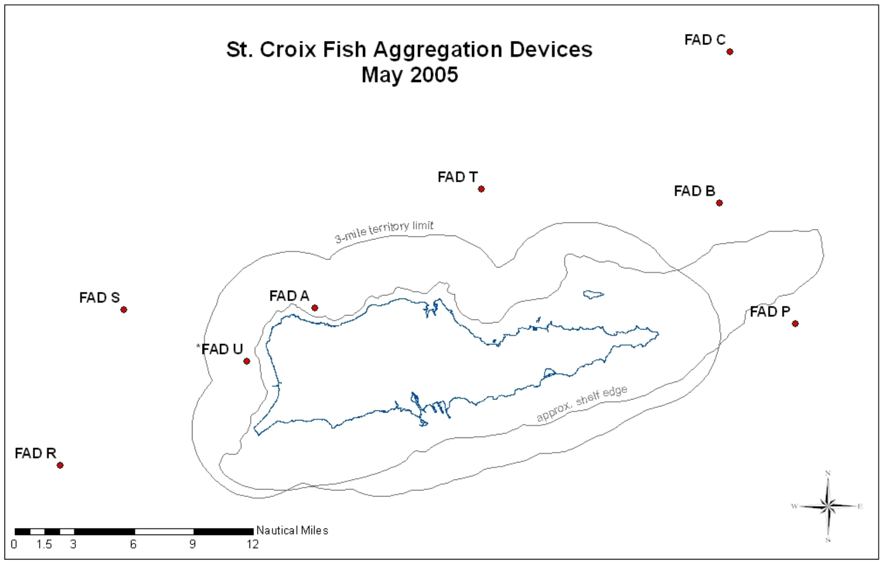


Figure VI-1. Current FAD deployment off St. Thomas and St. John.



FAD C – 17° 58.9'N 64° 30.3'W FAD S – 17° 46.5'N 65° 00.8'W FAD B – 17° 51.6'N 64° 30.8'W
FAD P – 17° 45.8'N 64° 27.0'W FAD A – 17° 46.573'N 64° 51.2'W FAD T – 17° 52.3'N 64° 42.8'W
FAD R – 17° 39.0'N 65° 04.0'W *FAD U – 17° 44.0'N 64° 54.6'W
*FAD U is a submerged navy buoy and is not part of the Division of Fish and Wildlife FAD program

Figure VI-2. Current FAD deployment off St. Croix.

2) Development of additional artificial reef sites – Artificial reefs attract fish (Pickering and Whitmarsh 1997). There is also some scientific literature which suggests that artificial reefs can also increase fish stocks, as opposed to just attracting and concentrating fish stocks (Pickering and Whitmarsh 1997). If artificial reefs concentrate fish, then they may only be accelerating the depletion of existing fish stocks. If they can increase fish stocks (by providing additional habitat in habitat-limited situations), then they can be a mechanism to provide additional resources for fishing. More fish production means more fish for fishers. It needs to be stated that, before artificial reefs can be considered as a contributing factor in the overall solution to the problem of overfishing, the question of whether artificial reefs really do increase fish stocks needs to be resolved, or at least addressed. Beyond the fish concentration versus fish production controversy, artificial reefs do provide alterative dive sights for tourist divers and snorkelers. These can only enhance the tourist dive experience here.

In addition to user group suggestions on how to address this priority issue, there are also other steps that can be taken to reduce fishing pressure. Some recent and current activities on this issue include the following.

1) Moratorium on the issuance of new commercial fishing licenses – At the request of St. Croix commercial fishers, in August 2001, the Commissioner of Planning and Natural Resources declared a moratorium on the issuance of new commercial fishing licenses. This moratorium is still in effect.

2) Closure of 30 percent of the Exclusive Economic Zone – The Caribbean Fisheries Management Council was considering the closure of about 30 percent of the EEZ around the U.S. Caribbean. Most of these closures were proposed for waters around St. Thomas. CFMC is now considering seasonal closures rather than area closures.

3) Fishing Effort Reduction - NOAA Fisheries sponsored a series of workshops in mid-2004 (MRAG 2004) focusing on alternative ways to reduce fishing effort. Input from local fishers, regarding which alternatives might be possible here in the USVI, was solicited. This may be a precursor for additional attempts by the Federal Government to reduce fishing effort (and overfishing) in the USVI. The St. Thomas Fishermen's Association (STFA) has also set up management committees for lobster, trap, line, and seine net fishing which will develop management recommendations.

4) Fishery Enhancement Activities - Other fishery enhancement activities such as lobster settlement devices and shelters (casitas) (Lozano-Alvarez et al. 1994; Arce et al. 1997; Sosa-Cordero et al. 1998; Briones-Fourzan and Lozano-Alvarez 2001), stock enhancement aquaculture, etc. should also be considered as a way to reduce the effects of fishing pressure (David Olsen, St. Thomas Fishermen's Association, personal communication**,** also see David Olsen's comments in Appendix 4).

5) Marine Protected Areas (MPA) - MPAs are defined as "areas of the ocean designated to enhance conservation of marine resources". The actual level of protection within MPAs varies considerably; most allow some extractive activities such as fishing, while prohibiting others such as drilling for oil or gas. Marine reserves, a special class of "marine protected areas", are defined as "areas of the ocean completely protected from all extractive and destructive activities" (Lubchenco et al. 2003). By protecting geographical areas, including both resident species and their biophysical environments, marine reserves offer an ecosystem-based approach to conservation or fisheries management, which is distinct from the traditional focus on single species conservation or management (NMFS 1999; and NRC 1999).

   Marine reserves may provide multiple benefits including: protection of habitat, conservation of biodiversity, recovery of depleted stocks of exploited species, export of individuals to fished areas, insurance against environmental or management uncertainty, and sites for scientific investigation, baseline information, education, and recreation (NRC 2000). Marine reserves can be powerful management and conservation tools, but they are not a panacea (Allison et al. 1998; and Lubchenco et al. 2003). They cannot alleviate all problems, such as pollution, climate change, or overfishing, that originate outside reserve boundaries. MPAs are thus emerging as a powerful tool, but one that should be complemented by other approaches.

Currently in the USVI, there are twelve MPAs (Figures VI-3 and VI-4), including the recently (January 9, 2003) designated East End Marine Park in St. Croix (TNC 2002) (also see Appendix 3A), Cas Cay/Mangrove Lagoon Reserve (Appendix 3A), Compass Point Marine Reserve and Wildlife Sanctuary (Appendix 3A), Salt River Marine and Wildlife Sanctuary (Appendix 3A), the Small Pond at Frank Bay Wildlife and Marine Sanctuary (Appendix 3A), all under territorial jurisdiction, two red hind spawning area closures (see Appendix 3B), Buck Island Reef National Monument (BIRNM), Coral Reef National Monument, and St John National Park waters, under Federal control, and a mutton snapper spawning area closure under joint Federal and Territorial control (see Appendix 3B). In addition, NMFS (NOAA Fisheries) has published an interim rule to implement the closure (to fishing) of an area on the Grammanik Bank, recommended by CFMC (Figure VI-3). The 23.57 square kilometer (6.88 square nautical miles) closure encompasses an area where a yellowfin grouper spawning aggregation is reported to occur (NMFS 2004). The interim measure calls for closure of this site from February 1, 2005 through April 30, 2005. More permanent measures are currently under discussion by CFMC which will may involve seasonal rather than area closures.

For more discussion on MPAs, their potential benefits, and use in the USVI, see Appeldoorn and Lindeman (2003), Appeldoorn and Recksiek (2000), Appeldoorn et al. (1997), Beets (1992, 1996a), Beets and Rogers (2000), Bernstein et al. (2004), Bohnsack (1992, 1993, 1998, 1999, 2000, 2003), Bohnsack et al. (2000), CANARI (1992), Clark et al. (1989), Garrison (1998), Impact Assessment (1997), Lubchenco et al. (2003), Pomeroy (2003), Roberts and Polunin (1993), Rogers and Beets (2001), Sale and Ludsin (2003), Sladek-Nowlis and Roberts (1997), and TNC (2002).

Virgin Islands National Park was designated as an International Biosphere Reserve by UNESCO in June, 1976. There has since been a series of Biosphere Reserve Research Reports generated from studies within the reserve (Anderson et al. 1986; Beets and Lewand 1986; Beets et al. 1986; Boulon 1986a, 1986b, 1987; Boulon and Clavijo 1986; Boulon et al. 1986; Dammann 1986; Davis et al. 1986; Gladfelter et al. 1987; Hubbard 1987; Hubbard et al. 1987; IRF 1996; Knausenberger et al. 1987; Koester 1986; Lund et al. 1986; Matuszak et al. 1987; Nichols and Brush 1988; Putney 1987a, 1987b; Ramos-Perez and Gines-Sanchez 1988; Rogers and Teytaud 1988; Rogers and Zullo 1987; Rogers et al. 1988; Tobias et al. 1988; Tyson 1987; and Williams 1988).

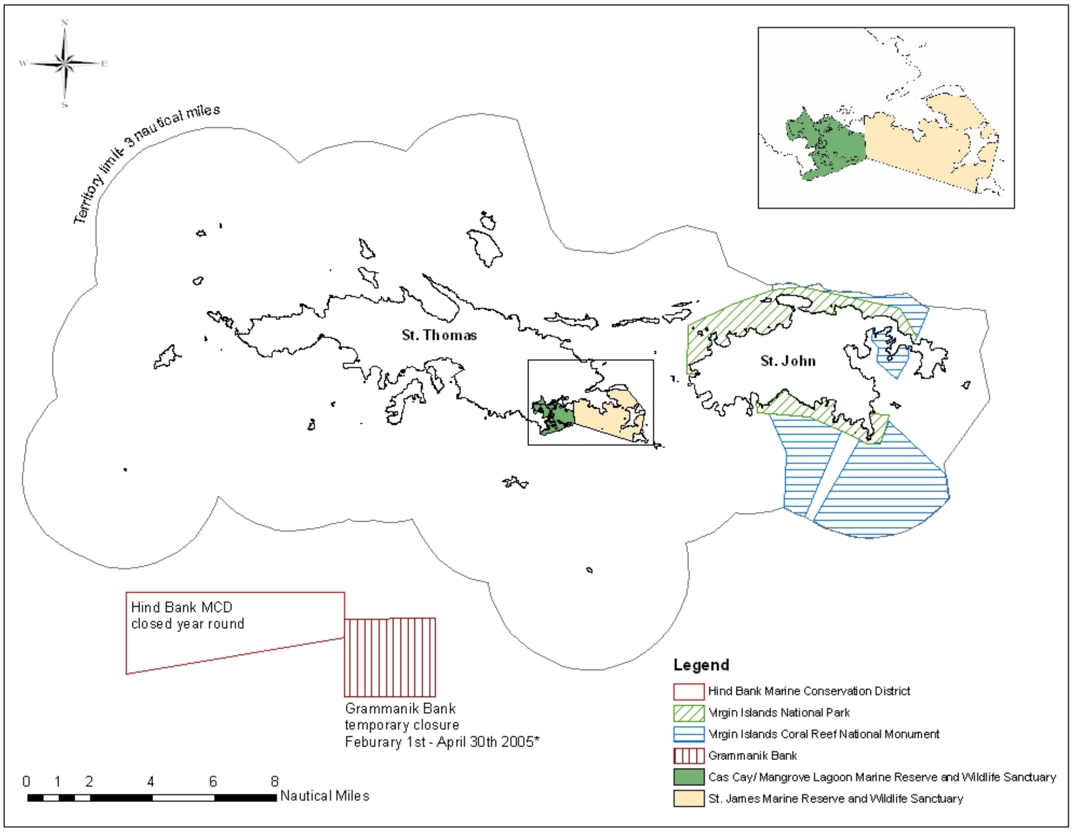


Figure VI-3. Marine protected areas (MPAs) for St. Thomas and St. John, and territorial limit (3 nautical miles). Note: Boundaries of the Grammanik Bank in this illustration do not represent actual boundary lines. An area of the Grammanik Bank known to contain spawning aggregation sites (6.88 sq. miles) is closed to fishing on an interim basis from February 1 to April 30, 2005. More permanent boundaries for future management measures will be determined.

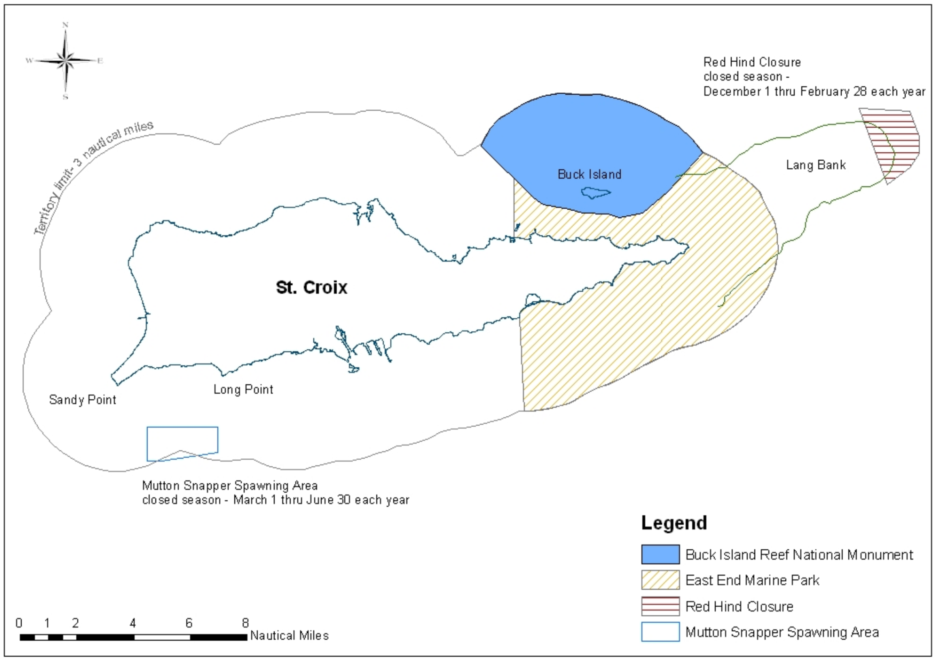


Figure VI-4. Marine protected areas (MPAs) for St. Croix, and territorial limit (3 nautical miles).

Linked with the question of overfishing, is the need to monitor and assess the condition of the local fishery. There are three long term fisheries data sets: (1) commercial catch reports; (2) bio-statistical catch surveys; and (3) SEAMAP-C trap and line data. These go back about 15 to 30 years. These ongoing projects are needed to monitor and assess the local fisheries so that overfishing can be detected and averted.

1) Fisheries Dependent Commercial Catch Reports – The fisheries dependent commercial catch report system needs to be continued.

2) Fisheries Dependent Bio-statistical Catch Surveys – The fisheries dependent bio-statistical surveys of commercial fisher landings needs to be continued.

3) Fisheries Independent SEAMAP-C trap and line surveys – Fisheries independent SEAMAP-C trap and line surveys need to be continued.

4) Recreational Fisheries Data – A simple, long term recreational fisheries data collection system needs to be developed and implemented. This may include a recreational licensing and catch reporting system.

5) Stock Assessment and Data Analyses – It is not enough just to collect data. Stock assessment data needs to be made available in electronic format, analyzed, and

summarized to support fisheries management decisions, with an emphasis on spawning stocks and spawning aggregations.

6) Research to Address Emerging Fisheries Issues – In addition to long term data collection and analysis efforts, new issues emerge periodically that need to be addressed. Recently, the issue of by-catch has emerged. Two pilot programs, one on St. Croix and one on St. Thomas, were developed to answer basic questions regarding by-catch in the USVI. The capacity to respond to and study emerging issues should be available.

(7) Trap Priority Conservation Strategies

User groups (see above) provided no guidance on the priority issue of trap fishing (see Tables VI-1 and VI-2 above). Trap fishing has some controversy associated with it (refer to the commercial fishing overview section in Chapter IV). For example, traps that are set on corals can cause physical damage, traps that are lost or abandoned (ghost traps) can continue to damage the environment and continue to catch fish if appropriate escape panels are not installed, the indiscriminate selection of catch, etc. (Sheridan et al. 2003). Possible considerations for the management of trap fishing include the following.

1) Regulating the number of traps – This can range from restricting the number of traps used in the USVI to banning trap use entirely.

2) Additional trap regulations – Restrictions can range from technical specifications to deployment regulations. There are some technical specifications already in place. Additional trap construction specifications might include specifications on mesh size, escape panel size, and construction material. There are also some regulations regarding trap deployment. Additional trap fishing requirements could include specific time, location, and buoying requirements.

Updating existing trap regulations is a matter for the Fisheries Advisory Committees to address. Once they have discussed these matters, they can make specific recommendations to the Commissioner of Planning and Natural Resources. The Commissioner is empowered to make specific regulations regarding fisheries and marine resources. For more information concerning trap fishing in the U.S. Virgin Islands, see Austin (1988), Beets (1993, 1996b), DFW (1993), Garrison (1997), Olsen et al. (undated), Sheridan et al. (2002), and Tobias (1992).

(8) Longline Fishing Priority Conservation Strategies

User groups (see above) provided no guidance on how to address the longline fishing priority issue (see Tables VI-1 and VI-2 above).

The longline fishing controversy centers on Asian fishing vessels operating in the Caribbean and within the Exclusive Economic Zones (EEZ) of certain Caribbean countries. The EEZ encompasses waters up to 200 miles offshore. At this time, there is no agreement between the U.S. Government and any Asian longline fishers regarding operation within the EEZ of the U.S. Caribbean. Therefore this controversy is outside the jurisdiction of the Government of the Virgin Islands, which has control over territorial waters from the shoreline to 3 miles offshore.

The proper mechanism to proceed is to enter into discussions at the Caribbean regional level with independent national governments. The Government of the U.S. Virgin Islands is not allowed to do this, since it is a territory of the U.S. Only the U.S. State Department can do this.

One alternative is to have informal discussions with other island governments in the Caribbean region. However, informal discussions have no legal weight. Another alternative is for CFMC to exert pressure through ICCAT.

(9) Habitat Degradation Priority Conservation Strategies

Five marine habitats were identified in Chapter III: coral reefs, seagrass beds, mangroves, salt ponds, and algal plains. User groups (see above) provided no guidance on how to address this priority issue (see Tables VI-1 and VI-2 above). At this time, the extent and distribution of these different marine habitats around the USVI are poorly documented. Habitat degradation can be measured if the past and present extent and condition of these five habitats are known. The following projects need to be implemented:

1) <u>Benthic Image Collection</u> – The deeper shelf areas (>60 ft.) of the USVI need to be surveyed using side scan sonar or multi-beam technology.

2) <u>Ground Truthing</u> – A sample of similar image profiles needs to be "ground truthed" to confirm the habitat type within similar image profiles.

3) <u>Benthic Maps</u> – Based on benthic images collected and the ground truthing observations, different habitats can be identified and mapped. These maps should identify the extent and distribution of key benthic habitats on the shelf of the USVI (Kendall et al. 2001).

There are on-going efforts to collect this information. However, these are piece-meal and only target specific, small areas.

Only three of the five habitats are subtidal. The other two (mangroves and salt ponds) will require a different approach that the three methodologies outlined above. Land survey techniques can be applied to these subtidal habitats.

<u>Coral Reef Habitat Conservation Strategy</u>

According to recent studies, both nearshore and offshore reefs are subjected to similar stresses (in regards to stress type and magnitude) associated with land-derived eutrophication and sedimentation (TNC 2002). As such, the same management strategies can be applied to both wave-protected and wave-exposed reefs. Five key factors that can be controlled by effective management are critical to the long-term preservation of coral reef (and for other marine habitats). These include:

1) Control sedimentation runoff due to construction/development - Runoff from terrestrial systems must be mitigated by best management practices (e.g., establishment of brush/tree buffer zones approximately 10 m wide at terrestrial borders of marine habitats, or sediment traps at construction sites) as both sediment and nutrient loads associated with increases in erosion result in coral reef decline (TNC 2002). Heavy sediment loads smother corals (i.e., decrease rates of gas exchange and ability of corals to feed) and block growth-limiting irradiance from reaching their symbiotic algae, while increased nutrients shift the balance of power from hard corals to ephemeral macrophytes (macroalgae), which overgrow, shade, and eventually kill-off the underlying coral colonies. Sedimentation rates must be limited to less than 5-8 $mg/cm^2/day$ (Nemeth and Sladek-Nowlis 2001).

2) Control nutrient runoff due to rainfall and sewage discharge - Nutrient loads from non-point sources such as storm-water runoff and point sources such as wastewater treatment plants must be curtailed as these high nitrogen and phosphorus inputs to the system will lead to rapid overgrowth of coral reefs by fast growing algae (TNC 2002).

3) Control nutrient/sediment runoff to seagrass and mangrove habitats which are linked to the health of coral reefs - Coral reefs are dependent on nearby marine communities for their overall health and well-being (TNC 2002). Likewise, seagrass beds and mangroves, as well, are dependent on other nearby marine habitats. See also the overview on habitats (Chapter III). Both mangroves and seagrasses filter out harmful sediments and nutrients which contribute to the deterioration of reef habitats dominated by corals. Without putting reef conservation into a landscape level context, i.e., linking its preservation with the conservation of nearby communities, its long-term preservation will be in jeopardy.

4) Improve fisheries management to maintain ecologically balanced herbivorous fish populations - According to TNC (2002), many recent studies have shown that coral growth and persistence are greatly enhanced by the presence of herbivorous fish, many of which are the focus of intense commercial fishing efforts (i.e., parrot and surgeon fish). These fish, by preferentially grazing down fast-growing epiphytic algae, indirectly facilitate reef growth by consuming coral's competitive dominant. Even in the face of increased nutrient loading, recent research has shown that consumers may compensate for increased algal growth with increased consumption and secondary growth. This suggests that herbivorous fish in coral reef communities will naturally mitigate, to some extent, the deleterious effects of increased nutrient input from anthropogenic sources. However, they must be

there to do so. Therefore, a key component to reef conservation is effective fisheries management. Understanding food web linkages and strength of consumer interactions should therefore not be ignored for the long-term management and conservation of coral reef communities.

Seagrass Bed Habitat Conservation Strategy

The conservation strategies for seagrass beds are essentially the same as those stated for coral reefs (see above coral section for more detailed discussion):

1) Control sedimentation runoff due to construction/development,

2) Control nutrient runoff due to rainfall and sewage discharge,

3) Control nutrient/sediment runoff to coral reef and mangrove habitats which are linked to the health of seagrass beds, and

4) Improve fisheries management to maintain ecologically balanced herbivorous fish populations.

Mangrove Habitat Conservation Strategy

The following are five key factors which can be controlled by effective management, and are critical to the long-term preservation of mangrove communities:

1) Conserve remaining mangroves - Since suitable mangrove habitat is becoming relatively rare (on St. Croix, about 10% of the shoreline is mangrove, TNC 2002), habitats currently occupied by mangroves, or that have the potential to be occupied by mangroves, should be conserved.

2) Accelerate re-colonization of restored or degraded habitats - Not only should a policy of “no net-loss of marine wetlands” be instituted, but an active policy of restoring wetlands that have deteriorated due to hurricane damage, garbage dumping, terrestrial runoff, and/or human development, should be initiated (TNC 2002). For example, the construction of the largest oil refinery in the Western Hemisphere, the Hovensa refinery on St. Croix, resulted in the loss of the largest mangrove complex on the island. A positive, proactive attempt should be made to coordinate an active restoration of an equivalent area of mangrove wetlands on other parts of the island which would involve joint cooperation (financial and man-hours) between industry (Hovensa, Alcoa Aluminum), conservation (TNC), the public (schools and volunteers), and governmental agencies (DPNR, EPA, and USFWS). Such an operation would bring positive publicity to everyone and result in broadening community support for marine conservation on St. Croix. Because mangrove restoration can be completed without having to be underwater,

efforts to restore mangroves (planting of seedlings, digging of new creeks, and removal of garbage) can involve a great many people of all ages. The opportunity to initiate such efforts should not be overlooked. Additional steps to conserve existing mangrove wetlands need to include:

a) removing garbage from wetland areas;

b) prohibiting dumping, with sign postings and legal enforcement;

c) establishing a network of creeks, required for healthy mangrove systems, that have been obstructed or closed by human-induced sedimentation; and

d) planting of mangrove propagules to accelerate re-colonization of restored and/or degraded habitats.

3) Increase or restore tidal flow where needed - Where possible, roads, bridges, culverts, etc., which partially, or completely, block flow in mangroves, should be removed or replaced to re-establish tidal flow (TNC 2002). Such efforts in the Bahamas on Andros Island were shown to immediately increase tidal flow and, over a few months to years, increase fish diversity and biomass as the deep-water habitats in the mangrove wetland expanded.

4) Create buffer zones between mangroves and developments - Although mangroves themselves likely benefit from increased sediment and nutrient loading, runoff from terrestrial systems must be mitigated by best management practices (i.e., buffer zones—tens of meters of terrestrial vegetation between mangroves and residential and/or agricultural development) as both increased sediment and nutrient loads result in die-offs of important flora and fauna that live in close association with mangroves (TNC 2002). Increased sediment loads block growth-limiting irradiance from penetrating to the benthos (killing seagrasses and other algae), while increased nutrients promote blooms of ephemeral algae (TNC 2002). As a result of these blooms, the increased respiration demand at night and during decay yields critically low dissolved oxygen concentrations (eutrophication), which kill off resident fish and invertebrate populations. Increased nutrient loads also shift the balance of power in the grass beds of mangrove creeks from rooted angiosperms to ephemeral algae, which overgrow, shade, and eventually kill-off the underlying seagrasses. This scenario seems to be occurring at the present time in the mangrove creeks of Great Pond, St. Croix, as excess nutrients, possibly from agricultural runoff, are leading to massive blooms of harmful algae on the mangrove benthos (TNC 2002).

5) Reduce runoff from rainfall and sewage - Nutrient loads from non-point sources, such as storm-water runoff, and point sources, such as municipal sewage overflow, must be curtailed, as these high nitrogen and phosphorus inputs create the same dire consequences for mangrove flora and fauna as they do for coral reefs (TNC 2002). Reductions in both point and non-point nutrient loads reaching

mangroves are critical to mangrove survival, yet is rarely addressed because mangrove trees actually benefit from increased nutrient inputs. Indeed, some managers even suggest that nutrient loads are not a threat to mangrove communities because of these reasons. However, conservation of these habitats requires not only policies that facilitate and promote growth of the foundation tree species, but also those which enhance production and persistence of associated fauna. Eutrophication and increased sediment loads do not meet both criteria.

Salt Pond Habitat Conservation Strategy

The conservation strategies for salt pond habitats are essentially the same as those stated for mangroves (see above mangrove section for more detailed discussions):

1) Conserve remaining salt ponds;

2) Accelerate re-colonization of restored or degraded habitats;

3) Increase or restore tidal flow where needed;

4) Create buffer zones between salt ponds and developments; and

5) Reduce storm-water and sewage runoff.

Algal Plain Habitat Conservation Strategy

The conservation strategies for algal plan habitats are essentially the same as those stated for coral reefs (see above coral section for more detailed discussion) and seagrass:

1) Control sedimentation runoff due to construction/development,

2) Control nutrient runoff due to storm-water/sewage,

3) Control nutrient/sediment runoff to coral reef, seagrass, and mangrove habitats, and

4) Improve fisheries management to maintain ecologically balanced herbivorous fish populations.

(10) Lack of Mooring Priority Conservation Strategies

User groups (see above) provided no guidance on how to solve this priority issue (see Tables VI-1 and VI-2 above). Steps that are needed to address this priority issue include the following.

1) Identify sites that require day-use mooring buoys.

2) Obtain appropriate permits for day-use mooring buoys.

3) Install day-use mooring buoys.

4) Maintain day-use mooring buoys.

Over the last few years, DFW has supported day-use mooring buoy programs under the Reef Ecology Foundation in St. Thomas and Island Conservation Efforts in St. Croix. These organizations are non-governmental organizations that have the permits for installation and maintenance of day-use mooring buoys. Additional support has been secured by DFW through the USFWS Boat Infrastructure Grant (BIG) program. These funds are available to the end of FY 2006. Support for day-use mooring buoys should be continued.

2. STRATEGIES FOR ADDRESSING SPECIES OF GREATEST CONCERN

Species of greatest concern were identified in the previous chapter. These are listed here in Table VI-3 below.

Table VI-3. List of species of greatest concern

Fish Species	**Invertebrate Species**
queen triggerfish, *Balistes vetula*	elkhorn coral, *Acropora palmate*
hogfish, *Lachnolaimus maximus*	staghorn coral, *Acropora cervicornis*
cubera snapper, *Lutjanus cyanopterus*	fused-staghorn coral, *Acropora prolifera*
mutton snapper, *Lutjanus analis*	black coral (Order Antipatharia)
yellowtail snapper, *Ocyurus chrysurus*	spiny lobster, *Panulirus argus*
rainbow parrotfish, *Scarus guacamaia*	queen conch, *Strombus gigas*
red hind, *Epinephelus guttatus*	whelk, *Cittarium pica*
marbled grouper, *Dermatolepis inermis*	pink shrimp (*Penaeus duorarum*)
goliath grouper, *Epinephelus itajara*	
Nassau grouper, *Epinephelus striatus*	
bigeye tuna, *Thunnus obesus*	
longsnout seahorse, *Hippocampus reidi* (and seahorses in general)	**Turtle Species**
blacktip shark, *Carcharhinus limbatus*	Leatherback,*Dermochelys coriacea*
tarpon, *Megalops atlanticus*	Hawksbill, *Eretmochelys imbricata*
bonefish, *Albula vulpes*	Green, *Chelonia mydas*
foureyed butterflyfish, *Chaetodon capistratus*	
banded butterflyfish, *C. striatus*	
longsnout butterflyfish, *C. aculeatus*	**Marine Mammals**
billfish (various species)	humpback whale, *Megaptera noveangliae*
marine aquarium fish (various species)	fin whale, *Balaenoptera physalus*
reef fish (various species)	sei whale, *Balaenoptera borealis*

tuna (various species)	sperm whale, *Physeter macrocephalus*
whale shark, *Rhincodon typus* (and various other species of sharks)	West Indian manatee, *Trichechus manatus*

(1) Fish Species of Concern (see Appendix 1A)

Queen Triggerfish, *Balistes vetula*

Information on this species in the USVI is limited (Manooch and Drennon 1987). Data presented by the STFA to CFMC indicates this species is being fished in an optimal manner. The conservation strategy is as follows:

1) Literature - Review available literature on this species.

2) Identify all available data – Review commercial and recreational landings data for this species.

3) Analyze available data – Compile, summarize, and analyze all available data on this species.

4) Propose conservation suggestions for this species – Based on a review of the literature, data available, and analysis of these data, propose conservation strategies for this species. If additional data are needed, recommend that additional data be collected. If data analysis indicates problems with this species, then make recommendations for stock management.

5) Formalize conservation strategies – If this species is facing overfishing, forward recommendations to the Fisheries Advisory Committees for their review and discussions. If the FACs deem necessary, they will recommend or endorse proposed management strategies to the Commissioner of Planning and Natural Resources. DFW can also make recommendations to the Commissioner. The Commissioner has the capacity to issue management regulations.

Other Fish Species of Concern

The above conservation strategy for queen triggerfish should also be applied to the following species:

1) Hogfish (*Lachnolaimus maximus*);
2) Cubera snapper (*Lutjanus cyanopterus*);
3) Mutton snapper (*Lutjanus analis*);
4) Yellowtail snapper (*Ocyurus chrysurus*);
5) Rainbow parrotfish (*Scarus guacamaia*);
6) Red hind (*Epinephelus striatus*);

7) Marbled grouper (*Epinephelus inermis*);
8) Blacktip shark (*Carcharhinus limbatus*)(this species is not currently covered under Federal Highly Migratory Species (HMS) regulations); and
9) Other species of sharks not covered under HMS regulations.

Goliath grouper, *Epinephelus itajara*

Goliath grouper are already protected from the shore to the 200 mile limit of the U.S. Exclusive Economic Zone. They are a federally protected species. No additional conservation strategy is proposed for this species. However, compliance with existing Federal and territorial regulations banning catch of this species may be limited and additional enforcement may be needed.

Nassau grouper, *Epinephelus striatus*

Nassau grouper are already protected in federal waters (3 to 200 mile limit of the US Exclusive Economic Zone). They are a federally protected species. The following conservation strategies are proposed for this species:

1) Compliance with the Federal Ban - Compliance with existing Federal and territorial regulations banning catch of this species may be limited and additional enforcement may be needed.

2) Territorial Ban - Recently, the St. Croix Fisheries Advisory Committee recommended that the ban on harvest of this species be extended into territorial waters. The St. Thomas/St. John FAC needs to consider this matter. If appropriate, these FACs will recommend to the Commissioner of DPNR that the ban on harvest of this species be extended into territorial waters. The Commissioner can then issue a regulation on the issue.

3) Seasonal Closures of Spawning Aggregation Areas - This could require a four-step process: 1) find spawning aggregation sites, 2) determine times of aggregations, 3) determine area covered by the aggregation, and 4) close the aggregation site to fishing, at least during peak aggregation periods.

Conventional management is based on management of individual species (AFS 2004). A ban on fishing for Goliath or Nassau groupers is not a stand alone conservation strategy. Reef species are part of a complex. Restrictions that are placed on individual species are ineffective because these “protected” species continue to be caught and suffer mortality when fishers target co-existing species that are not restricted. The management strategy with the greatest promise is the use of marine reserves or marine protected areas (MPAs)—spatially restricted absolute no-take zones (AFS 2004). In addition, preserving the habitats required by these species’ various life cycle stages would contribute to their recovery (e.g., the recent closure of the Grammanik Bank to protect spawning aggregations of Nassau, yellowfin, tiger, and yellow-mouth groupers).

Preserving these habitats (coral reefs, mangroves, seagrass beds, etc.) would involve alleviating the stresses addressed in the habitats section (chapter 3).

Billfish, Tunas, and Sharks (Highly Migratory Species)

The term highly migratory species includes certain species of billfishes, tunas, and sharks. These species are under Federal control. These regulations extend from the shoreline to the 200 mile limit of the US Exclusive Economic Zone. No additional conservation strategy is proposed for these species. However, compliance with existing Federal and territorial regulations on the catch of these species may be limited and additional enforcement may be needed.

Tarpon, *Megalops atlanticus*

In 2004, the Commissioner of DPNR issued a new regulation regarding tarpon. This species is restricted to catch and release using hook and line only. No take is allowed. As such, no additional conservation strategy is proposed for this species.

Bonefish, *Albula vulpes*

The new regulations regarding tarpon (see above) also apply to bonefish. Therefore, no additional conservation strategy is proposed for this species.

Marine aquarium fish (including the longsnout seahorse, foureyed, banded, and longsnout butterflyfishes)

Under Federal regulations, harvest and possession of the longsnout seahorse and foureyed, banded, and longsnout butterflyfishes are not allowed in Federal waters. Other marine aquarium fish may be harvested in Federal waters only by a hand-held dip net or a hand-held slurp gun. In territorial waters, collection of aquarium fish requires a permit from the Department of Planning and Natural Resources, Division of Fish and Wildlife. At this time, permits are approved for private collection and for educational purposes (for such establishments as Coral World on St. Thomas). No permits are issued for commercial exploitation of marine aquarium fish. No additional conservation strategy is proposed for these species.

Reef fish (various species)

There are hundreds of species that fit within this classification (Appendix 1A). This category includes the queen triggerfish (see above) and many species listed under the section above titled, “Other Fish Species of Concern”. The following conservation strategy is proposed for this group of fishes.

1) Review existing databases – Review the fishery dependent bio-statistical catch and the fishery independent SEAMAP-C trap and line data bases. Data included in these databases is at the species level and includes length and weight, as well as catch and effort information. The bio-statistical catch database includes about 15 years of data, as does the SEAMAP-C database.

2) Screen existing databases – Screen each of these databases. Determine the number of datum for each species in the database per year. Sort species by the number of datum per year and over the entire database.

3) Analysis for key species - For species with adequate amounts of data, complete time series length frequency, catch, catch per effort, and other appropriate analyses. For those species without adequate data, determine if at risk, whether targeted by commercial or recreational fishers, etc.

4) Management recommendations – Based on the above analyses, formulate species management recommendations. These should be submitted to the FACs for review and endorsement to the Commissioner of DPNR. The Commissioner can formalize regulations as necessary.

(2) Invertebrate Species of Concern (see Appendix 1B and 1C)

Elkhorn coral, Staghorn coral, and Fused-staghorn coral

At the request of the Center for Biological Diversity, NOAA Fisheries is currently considering listing these three species as endangered or threatened. To-date, no final determination has been made.

At the territorial level, indigenous species (such as these three coral species) are already protected in the V.I. Code from take, catch, possession, injury, harassment, and killing, except if a valid permit for such activities is obtained. As such, no additional conservation strategy is proposed for these species.

Black coral (Order Antipatharia)

Taking or possession of black coral is prohibited by Federal regulations. At the territorial level, indigenous species (such as black coral) are already protected in the V.I. Code from take, catch, possession, injury, harassment, and killing, except if a valid permit for such activities is obtained. As such, no additional conservation strategy is proposed for black coral.

Queen conch, *Strombus gigas*

The most recent field surveys of USVI conch populations were completed in 2002 (see Gordon 2002). The conservation strategy is as follows:

1) Propose conservation suggestions for this species – Based on a review of the literature, data available, and analysis of these data, propose conservation strategies for this species. If additional data are needed, recommend that additional data be collected. If data analysis indicates problems with this species, then make recommendations for stock management.

2) Formalize conservation strategies – If this species is facing overfishing, forward recommendations to the Fisheries Advisory Committees for their review and discussions. If the FACs deem necessary, they can recommend or endorse proposed management strategies to the Commissioner of Planning and Natural Resources. DFW can also make recommendations to the Commissioner. The Commissioner has the capacity to issue management regulations.

Whelk, *Cittarium pica*

The most recent field surveys were completed in 2004 (Toller and Gordon 2005). The conservation strategy is as follows:

1) Propose conservation suggestions for this species – Based on a review of the literature, data available, and analysis of these data, propose conservation strategies for this species. If additional data are needed, recommend that addition data be collected. If data analysis indicates problems with this species, then make recommendations for stock management.

2) Formalize conservation strategies – If this species is facing overfishing, forward recommendations to the Fisheries Advisory Committees for their review and discussions. If the FACs deem necessary, they can recommend or endorse proposed management strategies to the Commissioner of Planning and Natural Resources. DFW can also make recommendations to the Commissioner. The Commissioner has the capacity to issue management regulations.

Spiny lobster, *Panulirus argus*

The above conservation strategy for queen conch and whelk should also be applied to spiny lobster.

Pink Shrimp (*Penaeus duorarum*)

Sale of southern pink shrimp from Altona Lagoon and Great Pond is prohibited by territorial regulations. These are the only restrictions on its harvest and sale. The above conservation strategy for queen triggerfish should also be applied to pink shrimp.

(3) Marine Turtles (see Appendix 1C)

The three species of marine turtles listed in Table VI-3 include the leatherback turtle, the hawksbill turtle, and the green turtle. These marine turtles are all listed and protected under the U.S. Endangered Species Act. The V.I. Bureau of Wildlife is formulating the management strategies for marine turtles (see the wildlife component of this plan). No further consideration is required for these species.

(4) Marine Mammals (see Appendix 1C)

The four species of whales listed in Table VI-3 include the Humpback whale, Fin whale, Sei whale, and Sperm whale. These whales are all listed and protected under the U.S. Endangered Species Act. No further consideration is required for these species.

Also listed in Table VI-3 is the West Indian manatee. This species is also listed and protected under the U.S. Endangered Species Act. No further consideration is required for this species.

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CHAPTER VII
PLAN IMPLEMENTATION

1. IMPLEMENTATION OF PRIORITY ISSUE CONSERVATION STRATEGIES

Plans implementing priority issue strategies are provided in Table VII-1 below. It should be noted that for many of the conservation strategies for each priority issue, DFW is not the primary or lead agency. It is inappropriate for DFW to dictate to other agencies what their job is, what to do, or how to do it. Therefore, the plan for implementation of each conservation strategy must be left to the primary agency, however, DFW can offer recommendations. The primary agencies and cooperating agencies are also identified in Table VII-1 below. In cases where DFW is the primary agency, more specific plans to implement conservation strategies are indicated.

It should also be noted that these implementation activities, especially those in which DFW is the primary agency, are subject to the availability of funds and resources. As funding opportunities for stated strategies come up, DFW can write proposals and solicit funding to support implementation of these conservation strategies that target priority issues.

2. IMPLEMENTATION OF SPECIES OF CONCERN CONSERVATION STRATEGIES

Plans implementing species of greatest concern strategies are provided in Table VII-2 below. It should be noted that for many of the conservation strategies for each species of greatest concern, DFW is not the primary or lead agency. It is inappropriate for DFW to dictate to other agencies what their job is, what to do, or how to do it. Therefore, the plan for implementation of each conservation strategy is left to the primary agency, however, DFW can offer recommendations. The primary agencies and cooperating agencies are also identified in Table VII-2 below. In cases where DFW is the primary agency, more specific plans to implement conservation strategies are indicated.

It should also be noted that these implementation activities, especially those in which DFW is the primary agency, are subject to the availability of funds and resources. As funding opportunities for stated strategies come up, DFW can write proposals and solicit funding to support implementation of these conservation strategies that target species of concern.

Table VII-1. Priority Issue Conservation Strategies, Primary Agency, Cooperating Agency, and Plans for Implementing Conservation Strategies

PRIORITY ISSUES	Primary Agency	Cooperating Agencies	Implementing Identified Strategies
Pollution Priority Conservation Strategies			
1. Oil pollution and dispersants			
a) Major Oil Spill Response and Preparedness	DEP	DFW, DCZM, DEE, USEPA, USCG, Port Authority, CRRT	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
b) Minor Oil Spill Response and Preparedness	DEP	DFW, DCZM, DEE	
c) Boater Education	DEE	DFW, DCZM, DEP	
2. Siltation, groundwater contamination, and surface runoff			
a) Control Siltation	DEP	DCZM, DEE	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
b) Identify Sources of Groundwater Contamination	DEP	DCZM, DEE	
c) Control Surface Runoff	DEP	DCZM, DEE	
3. Land use practices			
a) Environmentally Friendly Use of Chemicals	Dept of Agriculture	DEP	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
b) Stop Excess Use of Chemicals	Dept of Agriculture	DEP, DEE	
c) Stop Runoff of Chemicals to the Sea	DEP	DEE	

Table VII-1. Priority Issue Conservation Strategies, Primary Agency, Cooperating Agency, and Plans for Implementing Conservation Strategies (continued)

PRIORITY ISSUES	Primary Agency	Cooperating Agencies	Implementing Identified Strategies
Pollution Priority Conservation Strategies			
4. Wastewater discharge			
a) Monitor Sewage Plants	DEP	DEE, DCZM	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
b) Backup Storage Tanks	DEP	DEE, DCZM	
c) Backup Sewage Processing	DEP	DEE, DCZM	
d) Stop Direct Discharge	DEP	DEE, DCZM	
e) Boater Education	DEE	DCZM, DFW	
5. Dredging			
a) Use Siltation Curtains	DCZM	DEE, DEP, ACOE	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
b) Use Siltation Curtains Properly	DCZM	DEE, DEP, ACOE	
c) Inspect and Maintain Siltation Curtains Regularly	DCZM	DEE, DEP, ACOE	
6. Toxic and thermal pollution			
a) Identify Sources of Industrial Waste	DEP	DCZM, EPA	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
b) Stop Discharge of Industrial Waste to the Sea	DEP	DCZM, DEE, EPA	

Table VII-1. Priority Issue Conservation Strategies, Primary Agency, Cooperating Agency, and Plans for Implementing Conservation Strategies (continued)

PRIORITY ISSUES	Primary Agency	Cooperating Agencies	Implementing Identified Strategies
Lack of Enforcement Priority Conservation Strategies			
1. Increase Territorial Enforcement	DEE	VIPD	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
2. Increase Federal Enforcement	NOAA Fisheries	U.S. Coast Guard, NPS	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
Gillnet Priority Conservation Strategies			
1. Follow-up on Proposed Ban	DFW	DEE, FACs	At this time, draft rules and regulations are going to public hearings on St. Thomas and St. Croix. Implementation is awaiting outcome of the public hearings and final approval by the Commissioner of Planning and Natural Resources. If this process becomes stalled, DFW, in coordination with the two local FACs, will take steps to facilitate finalization of these new regulations.
2. Enforce Final Ban	DEE	VIPD	Implementation of the rules and regulations is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies to enforce the rules and regulations.

Table VII-1. Priority Issue Conservation Strategies, Primary Agency, Cooperating Agency, and Plans for Implementing Conservation Strategies (continued)

PRIORITY ISSUES	Primary Agency	Cooperating Agencies	Implementing Identified Strategies
Overfishing Priority Conservation Strategies			
1. Deployment of additional fish aggregation devices (FADs) [1]	DFW	FACs, DCZM, ACOE	Subject to the availability of funds and resources, DFW will replace and maintain FADs.
2. Development of additional artificial reef sites[1]	DFW	ACOE	Subject to the availability of funds and resources, DFW will obtain permits for artificial reefs sites, monitor existing sites, and coordinate deployment of additional artificial reef materials.
3. Grammanik Bank seasonal spawning area closure	CFMC	NOAA Fisheries, DFW, DEE	This Grammanik Bank seasonal closure is supported by the V.I. Govt. and is being implemented (Feb.-Apr.) by CFMC in 2005.
4. Compatible fishing regulations between Federal and Territorial Governments.	DFW, CFMC	DFW, CFMC, NOAA Fisheries, DEE	At a recent CFMC meeting, an agreement was reached that would harmonize territorial and federal regulations.
[1] These strategies were suggested by public input through user group opinion surveys (Chapter 6). It should be stated that some issues concerning these strategies need to be addressed, such as whether they actually increase fish stocks or just attract existing stocks, in which case we may just be increasing the rate of depletion (Chapter 6, section 6).			

Table VII-1. Priority Issue Conservation Strategies, Primary Agency, Cooperating Agency, and Plans for Implementing Conservation Strategies (continued)			
PRIORITY ISSUES	**Primary Agency**	**Cooperating Agencies**	**Implementing Identified Strategies**
Overfishing Priority Conservation Strategies			
5. Moratorium on the issuance of new commercial fishing licenses	DPNR	DFW, FAC	The FACs will periodically assess whether the moratorium should be continued. When it deems that the moratorium should be lifted, it will so recommend to the Commissioner of Planning and Natural Resources.
6. 30 percent reduction in fishing mortality in the Exclusive Economic Zone	CFMC	DFW, NOAA Fisheries	CFMC will bring its various closure proposals to public meetings. Based on input from the public and from other agencies, CFMC will make a decision on whether to proceed with suggested closures. DFW provides review comments to CFMC and the Commissioner of DPNR. CFMC is no longer considering permanent area closures, but may still implement seasonal closures.
7. Fisheries Dependent Commercial Catch Reports	DFW	Commercial fishers NOAA Fisheries	Subject to the availability of funds and resources, DFW will continue to produce commercial catch report forms, collect the forms from fishers, enter data in database, prepare a descriptive summary of the data, and submit data and reports to NOAA Fisheries.
8. Fisheries Dependent Bio-statistical Catch Surveys	DFW	Commercial fishers, NOAA Fisheries	Subject to the availability of funds and resources, DFW will continue to collect bio-statistical data on commercial fisher landings, from both St. Croix and St. Thomas/St. John, and enter into TIP online database program.

Table VII-1. Priority Issue Conservation Strategies, Primary Agency, Cooperating Agency, and Plans for Implementing Conservation Strategies (continued)

PRIORITY ISSUES	Primary Agency	Cooperating Agencies	Implementing Identified Strategies
Overfishing Priority Conservation Strategies			
9. Fisheries Independent SEAMAP-C surveys	DFW	SEAMAP-C Committee, NOAA Fisheries	Subject to the availability of funds and resources, DFW will continue SEAMAP-C surveys and to collect fisheries independent data on conch, spiny lobster, reef fish, whelk, and other species as appropriate.
10. Recreational Fisheries Data	DFW	VIGFC, Golden Hook Fishing Club	Subject to the availability of funds and resources, DFW will continue to collect information on recreational fishing in the USVI.
11. Stock Assessment and Data Analyses	DFW	NOAA Fisheries, CFMC	Subject to the availability of funds and resources, DFW will continue to analyze and summarize fisheries data.
12. Research to Address Emerging Fisheries Issues	DFW	FACs, commercial fishers, concerned citizens, recreational fishers	Concerned citizens, local fishers, the local FACs periodically bring to the attention of DFW emerging fisheries issues. Subject to the availability of funds and resources, DFW will develop projects to address these new emerging issues.

Table VII-1. Priority Issue Conservation Strategies, Primary Agency, Cooperating Agency, and Plans for Implementing Conservation Strategies (continued)

PRIORITY ISSUES	Primary Agency	Cooperating Agencies	Implementing Identified Strategies
Trap Priority Conservation Strategies			
1. Regulating the number of traps	DPNR (Terr. waters), CFMC (Fed. waters)	DFW, FACs, NOAA Fisheries	The two local FACs or CFMC may decide to take up this issue. The FACs can provide recommendations to the Commissioner of Planning and Natural Resources. The CFMC may decide to regulate the number of traps in Federal waters. Subject to the availability of funds and resources, DFW will review progress and provide recommendations as appropriate.
2. Additional trap regulations	DPNR (Terr. waters), CFMC (Fed. waters)	DFW, FACs, NOAA Fisheries	The two local FACs or CFMC may decide to take up this issue. The FACs can provide recommendations to the Commissioner of Planning and Natural Resources. The CFMC may decide to implement additional trap regulations in Federal waters. Subject to the availability of funds and resources, DFW will review progress and provide recommendations as appropriate.
Longline Fishing Priority Conservation Strategies			
1. Hold bilateral and multilateral discussions	U.S. Dept. of State	CFMC, NOAA Fisheries, Government of the Virgin Islands	Subject to the availability of funds and resources, DFW will continue to review activities on this issue and provide up-dates to the local FACs and the Commissioner of Planning and Natural Resources.
Habitat Degradation Priority Conservation Strategies			
1. Benthic Image Collection	DFW	NOAA NOS (National Ocean Service), EPA, CFMC	Subject to the availability of funds and resources, DFW will continue to coordinate the collection of benthic images of the USVI shelf area by itself and by various external agencies.

Table VII-1. Priority Issue Conservation Strategies, Primary Agency, Cooperating Agency, and Plans for Implementing Conservation Strategies (continued)

PRIORITY ISSUES	Primary Agency	Cooperating Agencies	Implementing Identified Strategies
Habitat Degradation Priority Conservation Strategies			
2. Ground Truthing	DFW	NOAA NOS (National Ocean Service), UVI, CFMC	Subject to the availability of funds and resources, DFW will continue to coordinate ground truthing of the USVI shelf area by itself and by various external agencies.
3. Benthic Maps	DFW	NOAA NOS (National Ocean Service), EPA, CFMC	Subject to the availability of funds and resources, DFW will continue coordinate develop of benthic maps of the USVI shelf area by itself and by various external agencies.
7. <u>Recreational activities</u> a) Local and Visitor Education b) Boater Education	 DCZM, DEE DEE	 DFW, DEP DFW, DCZM, DEP	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
8. <u>Ship grounding-propeller scour</u> a) Fine Boaters for Damage to the Seabed b) Continue Assessments of Seabed Damage c) Public and Boater Education	 DEE DFW DEE	 none. DCZM, DEP DFW, DCZM	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.

Table VII-1. Priority Issue Conservation Strategies, Primary Agency, Cooperating Agency, and Plans for Implementing Conservation Strategies (continued)

PRIORITY ISSUES	Primary Agency	Cooperating Agencies	Implementing Identified Strategies
Coral Reef Habitat Conservation Strategy			
1. Control sedimentation runoff due to construction/development	DCZM (1st tier), DEP (2nd tier)	DEE	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
2. Control nutrient runoff due to storm-water/sewage	DEP	DCZM, DEE, EPA	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
3. Control nutrient/sediment runoff to seagrass and mangrove habitats which are linked to the health of coral reefs	DEP	DCZM, DEE	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
4. Improve fisheries management to maintain ecologically balanced fish populations	DPNR, CFMC	DFW, CFMC, FACs, NOAA Fisheries	Subject to the availability of funds and resources, DFW will advise the FACs, Commissioner of DPNR, and CFMC on management measures to maintain the ecological balance in the marine environment.
Seagrass Bed Habitat Conservation Strategy - see *Coral Reef Habitat Conservation Strategy* above			
Algal Plain Habitat Conservation Strategy - see *Coral Reef Habitat Conservation Strategy* above.			

Table VII-1. Priority Issue Conservation Strategies, Primary Agency, Cooperating Agency, and Plans for Implementing Conservation Strategies (continued)

PRIORITY ISSUES	Primary Agency	Cooperating Agencies	Implementing Identified Strategies
Mangrove Habitat Conservation Strategy			
1. Conserve remaining mangroves	DFW	DCZM, DEE, DEP	Subject to the availability of funds and resources, DFW will review and assess activities that may damage or kill mangroves, and submit grants to purchase land containing wetland habitat (also refer to Bureau of Wildlife component of management plan).
2. Accelerate re-colonization of restored or degraded habitats			
a) removal of all garbage from wetland areas;	DPW	DFW	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
b) prohibition of future dumping, with sign postings and legal enforcement;	DEE	DFW, DCZM, VIPD, DPW	
c) establishment of a greater network of channels, using construction equipment, to restore water flow to areas filled in by human-induced sedimentation; and	DCZM	DFW, DPW	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
d) active planting of mangrove propagules to accelerate re-colonization of restored and degraded habitats.	DFW	NGOs, Volunteers	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.

Table VII-1. Priority Issue Conservation Strategies, Primary Agency, Cooperating Agency, and Plans for Implementing Conservation Strategies (continued)				
PRIORITY ISSUES		**Primary Agency**	**Cooperating Agencies**	**Implementing Identified Strategies**
Mangrove Habitat Conservationy Strategy				
3. Increase or restore tidal flow where needed		DCZM	DFW, DPW	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
4. Create buffer zones between mangroves and developments		DCZM	DFW	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
5. Reduce storm-water and sewage runoff		DEP	DCZM, DEE	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.

Table VII-1. Priority Issue Conservation Strategies, Primary Agency, Cooperating Agency, and Plans for Implementing Conservation Strategies (continued)

PRIORITY ISSUES	Primary Agency	Cooperating Agencies	Implementing Identified Strategies
Salt Pond Habitat Conservation Strategy			
1. Conserve remaining salt ponds;	DCZM	DEE, DFW	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
2. Accelerate re-colonization of restored or degraded habitats;	DFW	DCZM, NGOs, volunteers	Subject to the availability of funds and resources, DFW will organize projects and efforts to restore degraded habitats.
3. Increase or restore tidal flow where needed;	DCZM	DFW, DPW	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
4. Create buffer zones between salt ponds and developments; and	DCZM	DFW	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.
5. Reduce storm-water and sewage runoff.	DEP	DCZM, DEE	Implementation of the strategy is the responsibility of the primary agency. Subject to the availability of funds and resources, they will implement strategies that they are responsible for.

Table VII-1. Priority Issue Conservation Strategies, Primary Agency, Cooperating Agency, and Plans for Implementing Conservation Strategies (continued)			
PRIORITY ISSUES	**Primary Agency**	**Cooperating Agencies**	**Implementing Identified Strategies**
Lack of Mooring Priority Conservation Strategies			
1. Identify sites that require day-use mooring buoys.	REF, ICE	DFW, DCZM	Subject to availability of funds, REF and ICE will continue to identify day-use mooring buoy sites.
2. Obtain appropriate permits for day-use mooring buoys.	REF, ICE	DFW, DCZM	Subject to availability of funds, REF and ICE will continue to keep current DCZM and ACOE permits for day-use mooring buoy sites.
3. Install day-use mooring buoys.	REF, ICE	DFW, DCZM	Subject to availability of funds, REF and ICE will continue to install day-use mooring buoys. DFW will apply for grants available through USFWS Federal Assistance and any other sources, and make funds available to organizations that hold appropriate permits.
4. Maintain day-use mooring buoys.	REF, ICE	DFW, DCZM	Subject to availability of funds, REF and ICE will continue to maintain day-use mooring buoys.

Table VII-2. Species of Greatest Concern Conservation Strategies, Primary Agency, Cooperating Agency, and Plans for Implementing Conservation Strategies

Species of Concern	Primary Agency	Cooperating Agencies	Implementing Strategies
FISH SPECIES			
queen triggerfish, *Balistes vetula*	DFW, NOAA Fisheries, CFMC	FACs	Subject to the availability of funds and resources, DFW will implement the detailed strategy stated in the previous chapter for these species. In addition, NOAA Fisheries will also assess the status of these species as requested to by the CFMC.
hogfish, *Lachnolaimus maximus*			
cubera snapper, *Lutjanus cyanopterus*			
mutton snapper, *Lutjanus analis*			
yellowtail snapper, *Ocyurus chrysurus*			
rainbow parrotfish, *Scarus guacamaia*			
red hind, *Epinephelus guttatus*			
marbled grouper, *Dermatolepis inermis*			
goliath grouper, *Epinephelus itajara*	NOAA Fisheries, CFMC	DFW, FACs	
Nassau grouper, *Epinephelus striatus*	DFW, NOAA Fisheries, CFMC	FACs	
bigeye tuna, *Thunnus obesus*	NOAA Fisheries	DFW, FACs	NOAA Fisheries will continue assess the status of this species.

Table VII-2. Species of Greatest Concern Conservation Strategies, Primary Agency, Cooperating Agency, and Plans for Implementing Conservation Strategies (continued)			
Species of Concern	**Primary Agency**	**Cooperating Agencies**	**Implementing Strategies**
FISH SPECIES			
longsnout seahorse, *Hippocampus reidi* (and seahorses in general)	DFW, CFMC, NOAA Fisheries	FACs	Subject to the availability of funds and resources, DFW will implement the strategy stated in the previous chapter for these species. In addition, NOAA Fisheries will also assess the status of these species as requested to by the CFMC.
blacktip shark, *Carcharhinus limbatus*	DFW, NOAA Fisheries, CFMC	FACs	
tarpon, *Megalops atlanticus*	DEE	FACs, DFW	Management measures are already in place. Enforcement of the management measures is the responsibility of the primary agency.
bonefish, *Albula vulpes*			
foureyed, banded, longsnout butterflyfishes, *Chaetodon capistratus, C. striatus, C. aculeatus*	DEE, DFW, NOAA Fisheries	FACs, CFMC	Subject to the availability of funds and resources, DFW review and issue permits as appropriate. DEE and NOAA Fisheries will enforce ban on harvest in Federal waters.
billfish (various species)	DEE, NOAA Fisheries	DFW	NOAA Fisheries will continue to assess the status of this species. DFW will monitor fishing tournament catches.

Table VII-2. Species of Greatest Concern Conservation Strategies, Primary Agency, Cooperating Agency, and Plans for Implementing Conservation Strategies (continued)

Species of Concern	Primary Agency	Cooperating Agencies	Implementing Strategies
FISH SPECIES			
marine aquarium fish (various species)	DEE, DFW, NOAA Fisheries	FACs, CFMC	Subject to the availability of funds and resources, DFW review and issue permits as appropriate. DEE and NOAA Fisheries will enforce harvest regulations.
reef fish (various species)	DFW, NOAA Fisheries, CFMC	FACs	Subject to the availability of funds and resources, DFW will implement the detailed strategy stated in the previous chapter for these species. In addition, NOAA Fisheries will also assess the status of these species as requested by the CFMC.
tuna (various species)	DEE, NOAA Fisheries		NOAA Fisheries will continue to assess the status of these species. DEE and NOAA Fisheries will continue to enforce existing regulations.
whale shark, *Rhincodon typus* (and various other species of sharks)	NOAA Fisheries, CFMC, DFW	FACs	Subject to the availability of funds and resources, DFW will implement the strategy stated in the previous chapter for these species. In addition, NOAA Fisheries will assess the status of these species as requested to by the CFMC.

Table VII-2. Species of Greatest Concern Conservation Strategies, Primary Agency, Cooperating Agency, and Plans for Implementing Conservation Strategies (continued)

<table>
<tr><th>Species of Concern</th><th>Primary Agency</th><th>Cooperating Agencies</th><th>Implementing Strategies</th></tr>
<tr><td colspan="4">INVERTEBRATE SPECIES</td></tr>
<tr><td>elkhorn coral, Acropora palmata</td><td rowspan="3">DEE, DFW, NOAA Fisheries, CFMC</td><td rowspan="3">FACs</td><td rowspan="5">Subject to the availability of funds and resources, DFW will continue to assess stocks (see habitat priority issue strategy above). In addition, NOAA Fisheries will also assess the status of these species as requested to by the CFMC. DEE and NOAA Fisheries will enforce existing management regulations.</td></tr>
<tr><td>staghorn coral, Acropora cervicornis</td></tr>
<tr><td>fused-staghorn coral, Acropora prolifera</td></tr>
<tr><td>black coral (Order Antipatharia)</td><td>DEE, NOAA Fisheries, CFMC</td><td>DFW, FACs</td></tr>
<tr><td>queen conch, Strombus gigas</td><td>DEE, NOAA Fisheries, CFMC, DFW</td><td>FACs</td></tr>
<tr><td>whelk, Cittarium pica</td><td>DEE, DFW</td><td>FACs</td><td>Subject to the availability of funds and resources, DFW will continue to assess stocks. DEE will enforce existing management regulations.</td></tr>
</table>

Table VII-2. Species of Greatest Concern Conservation Strategies, Primary Agency, Cooperating Agency, and Plans for Implementing Conservation Strategies (continued)

Species of Concern	Primary Agency	Cooperating Agencies	Implementing Strategies
INVERTEBRATE SPECIES			
spiny lobster, *Panulirus argus*	DEE, NOAA Fisheries, CFMC, DFW	FACs	Subject to the availability of funds and resources, DFW will continue to assess stocks. In addition, NOAA Fisheries will also monitor the status of these species as requested to by the CFMC. DEE and NOAA Fisheries will enforce existing management regulations.
pink shrimp (*Penaeus duorarum*)	DEE	DFW, FACs	Subject to the availability of funds and resources, DFW will assess these stocks. DEE will enforce existing management regulations.
TURTLE SPECIES			
Leatherback,*Dermochelys coriacea*	NOAA Fisheries, DEE	DFW, NPS, Sandy Point Refuge	Subject to the availability of funds and resources, DFW will continue to collected data on these species. NOAA Fisheries and DEE will continue to enforce existing management regulations.
Hawksbill, *Eretmochelys imbricata*			
Green, *Chelonia mydas*			
MARINE MAMMAL SPECIES			
humpback whale, *Megaptera noveangliae*	NOAA Fisheries, DEE	DFW	Subject to the availability of funds and resources, DFW will continue to collected data on these species. NOAA Fisheries and DEE will continue to enforce existing management regulations.
fin whale, *Balaenoptera physalus*			
sei whale, *Balaenoptera borealis*			
sperm whale, *Physeter macrocephalus*			
West Indian manatee, *Trichechus manatus*			

CHAPTER VIII

PLANS TO MONITOR IMPLEMENTATION OF CONSERVATION STRATEGIES

1. PLANS TO MONITOR PRIORITY ISSUES STRATEGIES

Plans for monitoring implementation strategies are provided in Table VIII-1 below. It should be noted that for many of the conservation strategies for each priority issue, DFW is not the primary or lead agency. It is inappropriate for DFW to dictate to other agencies what their job is, what to do, or how to do it. Therefore, the plan for monitoring of implementation of strategies is left to the primary agency. The primary agency is identified in the table below. In cases where DFW is the primary agency, more detailed plans for monitoring of implementation of strategies is provided.

It should also be noted that these monitoring activities, especially those in which DFW is the primary agency, are subject to the availability of funds and resources. As funding opportunities for stated strategies come up, DFW can write proposals and solicit funding to support implementation and monitoring of implementation of these strategies.

2. PLANS TO MONITOR SPECIES OF CONCERN STRATEGIES

Plans for monitoring implementation strategies for species of concern are provided in Table VIII-2 below. It should be noted that for many of the conservation strategies for each species of concern, DFW is not the primary or lead agency. It is inappropriate for DFW to dictate to other agencies what their job is, what to do, or how to do it. Therefore, the plan for monitoring of implementation of strategies is left to the primary agency. The primary agency is identified in the Table VIII-2 below. In cases where DFW is the primary agency, more detailed plans for monitoring of implementation of strategies for species of concern is provided.

As with plans to monitor priority issues, these monitoring activities, especially those in which DFW is the primary agency, are subject to the availability of funds and resources. As funding opportunities for stated strategies come up, DFW write proposals and solicit funding to support implementation and monitoring of implementation of these strategies.

Table VIII-1. Priority Issue Conservation Strategies, Primary Agency, and Plans for Monitoring the Implementation of Conservation Strategies

Priority Issue Conservation Strategy	Primary Agency	Monitoring the Implementation of Conservation Strategies
Pollution Priority Conservation Strategies		
1. Oil pollution and dispersants a) Major Oil Spill Response and Preparedness b) Minor Oil Spill Response and Preparedness c) Boater Education	DEP DEP DEE	Monitoring implementation is the responsibility of the primary agency. Subject to the availability of funds and resources, the primary agency will also monitor progress to achieve stated strategies.
2. Siltation, groundwater contamination, and surface runoff a) Control Siltation b) Identify Sources of Groundwater Contamination c) Control Surface Runoff	DEP DEP DEP	Monitoring implementation is the responsibility of the primary agency. Subject to the availability of funds and resources, the primary agency will also monitor progress to achieve stated strategies.
3. Land use practices a) Environmentally Friendly Use of Chemicals b) Stop Excess Use of Chemicals c) Stop Runoff of Chemicals to the Sea	Dept of Agriculture Dept of Agriculture DEP	Monitoring implementation is the responsibility of the primary agency. Subject to the availability of funds and resources, the primary agency will also monitor progress to achieve stated strategies.

Table VIII-1. Priority Issue Conservation Strategies, Primary Agency, and Plans for Monitoring the Implementation of Conservation Strategies (continued)

Priority Issue Conservation Strategy	Primary Agency	Monitoring the Implementation of Conservation Strategies
Pollution Priority Conservation Strategies		
4. Wastewater discharge		
a) Monitor Sewage Plants	DEP	Monitoring implementation is the responsibility of the primary agency. Subject to the availability of funds and resources, the primary agency will also monitor progress to achieve stated strategies.
b) Backup Storage Tanks	DEP	
c) Backup Sewage Processing	DEP	
d) Stop Direct Discharge	DEP	
e) Boater Education	DEE	
5. Dredging		
a) Use Siltation Curtains	DEP	Monitoring implementation is the responsibility of the primary agency. Subject to the availability of funds and resources, the primary agency will also monitor progress to achieve stated strategies.
b) Use Siltation Curtains Properly	DEP	
c) Inspect Siltation Curtains Regularly	DEP	
6. Toxic and thermal pollution		
a) Identify Sources of Industrial Waste	DEP	Monitoring implementation is the responsibility of the primary agency. Subject to the availability of funds and resources, the primary agency will also monitor progress to achieve stated strategies.
b) Stop Discharge of Industrial Waste to the Sea	DEP	

Table VIII-1. Priority Issue Conservation Strategies, Primary Agency, and Plans for Monitoring the Implementation of Conservation Strategies (continued)

Priority Issue Conservation Strategy	Primary Agency	Monitoring the Implementation of Conservation Strategies
Pollution Priority Conservation Strategies		
7. Recreational activities a) Local and Visitor Education b) Boater Education	 DCZM, DEE DEE	Monitoring implementation is the responsibility of the primary agency. Subject to the availability of funds and resources, the primary agency will also monitor progress to achieve stated strategies.
8. Ship grounding-propeller scour a) Fine Boaters for Damage to the Seabed b) Continue Assessments of Seabed Damage c) Public and Boater Education	 DEE DFW DEE	Monitoring implementation is the responsibility of the primary agency. Subject to the availability of funds and resources, the primary agency will also monitor progress to achieve stated strategies.
Lack of Enforcement Priority Conservation Strategies		
1. Increase Territorial Enforcement	DEE	Monitoring implementation is the responsibility of the primary agency. Subject to the availability of funds and resources, the primary agency will also monitor progress to achieve stated strategies.
2. Increase Federal Enforcement	NOAA Fisheries	Monitoring implementation is the responsibility of the primary agency. Subject to the availability of funds and resources, the primary agency will also monitor progress to achieve stated strategies.

Table VIII-1. Priority Issue Conservation Strategies, Primary Agency, and Plans for Monitoring the Implementation of Conservation Strategies (continued)

Priority Issue Conservation Strategy	Primary Agency	Monitoring the Implementation of Conservation Strategies
Gillnet Priority Conservation Strategies		
1. Follow-up on Proposed Ban	DFW	Subject to the availability of funds and resources, DFW will advise the Commissioner of DPNR and monitor the status of finalization of the new proposed ban on trammel nets and regulations on gillnets.
2. Enforce Final Ban	DEE	Monitoring implementation is the responsibility of the primary agency. Subject to the availability of funds and resources, the primary agency will also monitor progress to achieve stated strategies.
Overfishing Priority Conservation Strategies		
1. Deployment of additional fish aggregation devices (FADs)[1]	DFW	Subject to the availability of funds and resources, DFW will monitor implementation of this strategy and document results in an annual report.
2. Development of additional artificial reef sites[1]	DFW	Subject to the availability of funds and resources, DFW will monitor implementation of this strategy and document results in an annual report.

[1] These strategies were suggested by public input through user group opinion surveys (Chapter 6). It should be stated that some issues concerning these strategies need to be addressed, such as whether they actually increase fish stocks or just attract existing stocks, in which case we may just be increasing the rate of depletion (Chapter 6, section 6).

Table VIII-1. Priority Issue Conservation Strategies, Primary Agency, and Plans for Monitoring the Implementation of Conservation Strategies (continued)

Priority Issue Conservation Strategy	**Primary Agency**	**Monitoring the Implementation of Conservation Strategies**
Overfishing Priority Conservation Strategies		
3. Moratorium on the issuance of new commercial fishing licenses	DPNR	The FACs will continue to monitor the impacts of the moratorium, periodically assess whether the moratorium should be continued, and advise the Commissioner of DPNR.
4. 30 percent reduction of fishing mortality in the Exclusive Economic Zone	CFMC	DFW will continue to closely monitor and assess CFMC's efforts to impose regulations that will reduce fishing mortality by 30%.
5. Fisheries Dependent Commercial Catch Reports	DFW	Subject to the availability of funds and resources, DFW will continue to monitor the implementation of this strategy and document results and progress in annual reports.
6. Fisheries Dependent Bio-statistical Catch Surveys	DFW	Subject to the availability of funds and resources, DFW will continue to monitor the implementation of this strategy and document results and progress in annual reports.

Table VIII-1. Priority Issue Conservation Strategies, Primary Agency, and Plans for Monitoring the Implementation of Conservation Strategies (continued)

Priority Issue Conservation Strategy	Primary Agency	Monitoring the Implementation of Conservation Strategies
Overfishing Priority Conservation Strategies		
7. Fisheries Independent SEAMAP-C surveys	DFW	Subject to the availability of funds and resources, DFW will continue to monitor the implementation of this strategy and document results and progress in annual reports.
8. Recreational Fisheries Data	DFW	Subject to the availability of funds and resources, DFW will continue to monitor the implementation of this strategy and document results and progress in annual reports.
9. Stock Assessment and Data Analyses	DFW	Subject to the availability of funds and resources, DFW will continue to monitor the implementation of this strategy and document results and progress in annual reports.
10. Research to Address Emerging Fisheries Issues	DFW	DFW will continue to monitor newly emerging issues and will continue to assess them to determine what action is necessary to address them.

Table VIII-1. Priority Issue Conservation Strategies, Primary Agency, and Plans for Monitoring the Implementation of Conservation Strategies (continued)

Priority Issue Conservation Strategy	Primary Agency	Monitoring the Implementation of Conservation Strategies
Trap Priority Conservation Strategies		
Regulating the number of traps	DPNR	Subject to the availability of funds and resources, DFW will monitor FAC and CFMC discussions and recommendations on implementation of this strategy, and advise the Commissioner of DPNR.
Additional trap regulations	DPNR	Subject to the availability of funds and resources, DFW will monitor FAC and CFMC discussions and recommendations on implementation of this strategy, and advise the Commissioner of DPNR.
Longline Fishing Priority Conservation Strategies		
1. Hold bilateral and multilateral discussions	U.S. Dept. of State	Subject to the availability of funds and resources, DFW will continue to monitor activities on this issue and provide up-dates to the local FACs and the Commissioner of Planning and Natural Resources.
Habitat Degradation Priority Conservation Strategies		
1. Benthic Image Collection	DFW	Subject to the availability of funds and resources, DFW will continue to monitor the progress of benthic image collection of the USVI shelf area by various agencies.

Table VIII-1. Priority Issue Conservation Strategies, Primary Agency, and Plans for Monitoring the Implementation of Conservation Strategies (continued)

Priority Issue Conservation Strategy	Primary Agency	Monitoring the Implementation of Conservation Strategies
Habitat Degradation Priority Conservation Strategies		
2. Ground Truthing	DFW	Subject to the availability of funds and resources, DFW will continue to monitor the progress of ground truthing of the USVI shelf area by various agencies.
3. Benthic Maps	DFW	Subject to the availability of funds and resources, DFW will continue to monitor the progress of producing benthic maps of the USVI shelf area by various agencies.
Coral Reef Habitat Conservation Strategy		
1. Control sedimentation runoff due to construction/development	DEP	Monitoring implementation is the responsibility of the primary agency. Subject to the availability of funds and resources, the primary agency will also monitor progress to achieve stated strategies.
2. Control nutrient runoff due to storm-water/sewage	DEP	Monitoring implementation is the responsibility of the primary agency. Subject to the availability of funds and resources, the primary agency will also monitor progress to achieve stated strategies.

Table VIII-1. Priority Issue Conservation Strategies, Primary Agency, and Plans for Monitoring the Implementation of Conservation Strategies (continued)

Priority Issue Conservation Strategy	Primary Agency	Monitoring the Implementation of Conservation Strategies
Coral Reef Habitat Conservation Strategy		
3. Control nutrient/sediment runoff to coral reef and mangrove habitats which are linked to the health of seagrass beds	DEP	Monitoring implementation is the responsibility of the primary agency. Subject to the availability of funds and resources, the primary agency will also monitor progress to achieve stated strategies.
4. Improve fisheries management to maintain ecologically balanced herbivorous fish populations	DPNR, CFMC	Subject to the availability of funds and resources, DFW will monitor efforts by the FACs and CFMC to promulgate management measures to maintain the ecological balance in the marine environment, and advise the Commissioner of DPNR.
Mangrove Habitat Conservation Strategy		
1. Conserve remaining mangroves	DPNR, DEE, DCZM, DFW	Subject to the availability of funds and resources, DFW will monitor activities that may damage or kill mangroves.
2. Accelerate re-colonization of restored or degraded habitats		
a) removal of all garbage from wetland areas;	DPW	Subject to the availability of funds and resources, DFW will monitor efforts to implement this strategy.
b) prohibition of future dumping, with sign postings and legal enforcement;	DEE, VIPD	Subject to the availability of funds and resources, DFW will monitor efforts to implement this strategy.

Table VIII-1. Priority Issue Conservation Strategies, Primary Agency, and Plans for Monitoring the Implementation of Conservation Strategies (continued)

Priority Issue Conservation Strategy	Primary Agency	Monitoring the Implementation of Conservation Strategies
Mangrove Habitat Conservation Strategy		
c) establishment of a greater network of channels, using construction equipment, to restore water flow to areas filled in by human-induced sedimentation; and	DCZM	Subject to the availability of funds and resources, DFW will monitor progress on implementing this strategy.
d) active planting activities of mangrove propagules, to accelerate re-colonization of restored and degraded habitats.	NGOs, DFW, UVI	Subject to the availability of funds and resources, DFW will monitor progress on implementing this strategy.
3. Increase or restore tidal flow where needed	DPNR	Subject to the availability of funds and resources, DFW will monitor progress on implementing this strategy.
4. Create buffer zones between mangroves and developments	DCZM	Subject to the availability of funds and resources, DFW will monitor progress on implementing this strategy.
5. Reduce storm-water and sewage runoff	DEP	Monitoring implementation is the responsibility of the primary agency. Subject to the availability of funds and resources, the primary agency will also monitor progress to achieve stated strategies.

Table VIII-1. Priority Issue Conservation Strategies, Primary Agency, and Plans for Monitoring the Implementation of Conservation Strategies (continued)

Priority Issue Conservation Strategy	Primary Agency	Monitoring the Implementation of Conservation Strategies
Salt Pond Habitat Conservation Strategy		
1. Conserve remaining salt ponds	DFW	Subject to the availability of funds and resources, DFW will monitor progress in implementing this strategy.
2. Accelerate re-colonization of restored or degraded habitats	DFW	Subject to the availability of funds and resources, DFW will monitor the effectiveness of projects and efforts to restore degraded habitats.
3. Increase or restore tidal flow where needed	DPNR	Subject to the availability of funds and resources, DFW will monitor progress in implementing this strategy.
4. Create buffer zones between salt ponds and developments	DCZM	Subject to the availability of funds and resources, DFW will monitor progress in implementing this strategy.
5. Reduce storm-water and sewage runoff.	DEP	Monitoring implementation is the responsibility of the primary agency. Subject to the availability of funds and resources, the primary agency will also monitor progress to achieve stated strategies.

Table VIII-1. Priority Issue Conservation Strategies, Primary Agency, and Plans for Monitoring the Implementation of Conservation Strategies (continued)

Priority Issue Conservation Strategy	Primary Agency	Monitoring the Implementation of Conservation Strategies
Lack of Mooring Priority Conservation Strategies		
1. Identify sites that require day-use mooring buoys.	REF, ICE	Subject to availability of funds, DFW monitor and documented these activities in annual reports
2. Obtain appropriate permits for day-use mooring buoys.	REF, ICE	Subject to availability of funds, DFW monitor and documented these activities in annual reports
3. Install day-use mooring buoys.	REF, ICE	Subject to availability of funds, DFW monitor and documented these activities in annual reports
4. Maintain day-use mooring buoys.	REF, ICE	Subject to availability of funds, DFW monitor and documented these activities in annual reports

Table VIII-2. Species of Greatest Concern, Primary Agency, and Plans for Monitoring the Implementation of Conservation Strategies

Species of Concern	Primary Agency	Monitoring the Implementation of Conservation Strategies
FISH SPECIES		
queen triggerfish, *Balistes vetula*	DEE, DFW, NOAA Fisheries, CFMC	Subject to the availability of funds and resources, DFW will monitor progress in implementing the strategy stated in the previous chapter for these species. In addition, NOAA Fisheries will also monitor the status of these species as requested to by the CFMC.
hogfish, *Lachnolaimus maximus*		
cubera snapper, *Lutjanus cyanopterus*		
mutton snapper, *Lutjanus analis*		
yellowtail snapper, *Ocyurus chrysurus*		
rainbow parrotfish, *Scarus guacamaia*		
red hind, *Epinephelus guttatus*		
marbled grouper, *Dermatolepis inermis*		
goliath grouper, *Epinephelus itajara*	NOAA Fisheries, CFMC, DEE	
Nassau grouper, *Epinephelus striatus*	DFW, DEE, NOAA Fisheries, CFMC	
bigeye tuna, *Thunnus obesus*	DEE, NOAA Fisheries	NOAA Fisheries will continue monitoring the status of this species.

<table>
<tr><th colspan="3">Table VIII-2. Species of Greatest Concern, Primary Agency, and Plans for Monitoring the Implementation of Conservation Strategies (continued)</th></tr>
<tr><th>Species of Concern</th><th>Primary Agency</th><th>Monitoring the Implementation of Conservation Strategies</th></tr>
<tr><td>FISH SPECIES</td><td></td><td></td></tr>
<tr><td>longsnout seahorse, Hippocampus reidi (and seahorses in general)</td><td>DEE, CFMC, NOAA Fisheries</td><td rowspan="2">Subject to the availability of funds and resources, DFW will monitor progress in implementing the strategy stated in the previous chapter for these species. In addition, NOAA Fisheries will also monitor the status of these species as requested to by the CFMC.</td></tr>
<tr><td>blacktip shark, Carcharhinus limbatus</td><td>DFW, NOAA Fisheries, CFMC</td></tr>
<tr><td>tarpon, Megalops atlanticus</td><td rowspan="2">DEE</td><td rowspan="2">Subject to the availability of funds and resources, DEE will monitor compliance with existing regulations.</td></tr>
<tr><td>bonefish, Albula vulpes</td></tr>
<tr><td>foureyed, banded, longsnout butterflyfishes, Chaetodon capistratus, C. striatus, C. aculeatus</td><td>DFW, NOAA Fisheries, CFMC</td><td>Subject to the availability of funds and resources, DFW will monitor compliance of existing regulations and monitor issuance of collection permits within territorial waters.</td></tr>
<tr><td>billfish (various species)</td><td>DEE, NOAA Fisheries</td><td>NOAA Fisheries will continue monitoring the status of this species.</td></tr>
</table>

Table VIII-2. Species of Greatest Concern, Primary Agency, and Plans for Monitoring the Implementation of Conservation Strategies (continued)

Species of Concern	Primary Agency	Monitoring the Implementation of Conservation Strategies
FISH SPECIES		
marine aquarium fish (various species)	DFW, NOAA Fisheries	Subject to the availability of funds and resources, DFW will monitor compliance of existing regulations and monitor issuance of collection permits within territorial waters.
reef fish (various species)	DFW, NOAA Fisheries, CFMC	Subject to the availability of funds and resources, DFW will monitor progress in implementing the strategy stated in the previous chapter for these species. In addition, NOAA Fisheries will also monitor the status of these species as requested to by the CFMC.
tuna (various species)	DEE, NOAA Fisheries	NOAA Fisheries will continue monitoring the status of these species.
whale shark, *Rhincodon typus* (and various other species of sharks)	DFW, NOAA Fisheries, CFMC	Subject to the availability of funds and resources, DFW will monitor progress in implementing the strategy stated in the previous chapter for these species. In addition, NOAA Fisheries will the status of these species as requested to by the CFMC.

Table VIII-2. Species of Greatest Concern, Primary Agency, and Plans for Monitoring the Implementation of Conservation Strategies (continued)

Species of Concern	Primary Agency	Monitoring the Implementation of Conservation Strategies
INVERTEBRATE SPECIES		
elkhorn coral, *Acropora palmata*	DFW, NOAA Fisheries, CFMC	Subject to the availability of funds and resources, DFW will monitor progress in assessing the status of these species (see habitat priority issue strategy) and monitor compliance with existing management regulations. In addition, NOAA Fisheries will also monitor the status of these species as requested to by the CFMC.
staghorn coral, *Acropora cervicornis*	DFW, NOAA Fisheries, CFMC	Subject to the availability of funds and resources, DFW will monitor progress in assessing the status of these species (see habitat priority issue strategy) and monitor compliance with existing management regulations. In addition, NOAA Fisheries will also monitor the status of these species as requested to by the CFMC.
fused-staghorn coral, *Acropora prolifera*	DFW, NOAA Fisheries, CFMC	Subject to the availability of funds and resources, DFW will monitor progress in assessing the status of these species (see habitat priority issue strategy) and monitor compliance with existing management regulations. In addition, NOAA Fisheries will also monitor the status of these species as requested to by the CFMC.
black coral (Order Antipatharia)	DEE, NOAA Fisheries, CFMC	Subject to the availability of funds and resources, DFW will monitor progress in assessing the status of these species (see habitat priority issue strategy) and monitor compliance with existing management regulations. In addition, NOAA Fisheries will also monitor the status of these species as requested to by the CFMC.
queen conch, *Strombus gigas*	DEE, NOAA Fisheries, CFMC	Subject to the availability of funds and resources, DFW will monitor progress in assessing the status of these species (see habitat priority issue strategy) and monitor compliance with existing management regulations. In addition, NOAA Fisheries will also monitor the status of these species as requested to by the CFMC.
whelk, *Cittarium pica*	DEE, DFW	Subject to the availability of funds and resources, DFW will monitor progress in assessment of stocks and of compliance with existing management regulations.
spiny lobster, *Panulirus argus*	DEE, NOAA Fisheries, CFMC	Subject to the availability of funds and resources, DFW will monitor progress in implementing the strategy stated in the previous chapter for these species. In addition, NOAA Fisheries will also monitor the status of these species as requested to by the CFMC.

Table VIII-2. Species of Greatest Concern, Primary Agency, and Plans for Monitoring the Implementation of Conservation Strategies (continued)

Species of Concern	Primary Agency	Monitoring the Implementation of Conservation Strategies
INVERTEBRATE SPECIES		
pink shrimp (*Penaeus duorarum*)	DEE	Subject to the availability of funds and resources, DFW will monitor progress in implementing the strategy stated in the previous chapter for these species and will also monitor compliance with existing regulations.
TURTLE SPECIES		
Leatherback,*Dermochelys coriacea*	NOAA Fisheries, DEE, NPS, Sandy Point Refuge	Subject to the availability of funds and resources, DFW will continue to monitor data collection on these species and to monitor compliance with existing regulations. NOAA Fisheries also monitors the protection of these species.
Hawksbill, *Eretmochelys imbricata*		
Green, *Chelonia mydas*		
MARINE MAMMAL SPECIES		
humpback whale, *Megaptera noveangliae*	NOAA Fisheries, DEE, DFW	Subject to the availability of funds and resources, DFW will continue to monitor data collection on these species and to monitor compliance with existing regulations. NOAA Fisheries also monitors the protection of these species.
fin whale, *Balaenoptera physalus*		
sei whale, *Balaenoptera borealis*		
sperm whale, *Physeter macrocephalus*		
West Indian manatee, *Trichechus manatus*		

3. ADJUSTING AND ADAPTING CONSERVATION STRATEGIES BASED ON FEEDBACK FROM MONITORING

Available information and local conditions continually change. New or previously unknown information can become available to decision makers and planners. In addition, local conditions can change. A natural disaster such as a hurricane can hit and devastate large inshore areas, gravely impacting near-shore critical marine habitats. Additional rules and regulations can be made at the political level, without regard to technical or scientific information. There are numerous conditions that can and do change over time.

Change can be detected through monitoring. However, once change is detected, what happens to that information? A feed back loop is required so that information collected is available for management consideration. Based on this information, there may be a need to adjust or modify a stated objective or implementation plan. This can be considered adaptive management, adapting a strategy and its implementation based on information obtained from monitoring the implementation.

Adaptive management has been defined in a variety of ways, some of which are outlined below.

- Johnson (1999) indicated that the adaptive management approach … "bringing together interested parties … to discuss the management problem and available data, and then to develop computer models that express participant's collective understanding of how the system operates. … As monitoring proceeds, new data are analyzed and management plans are revised as we improve our understanding of how the system works."

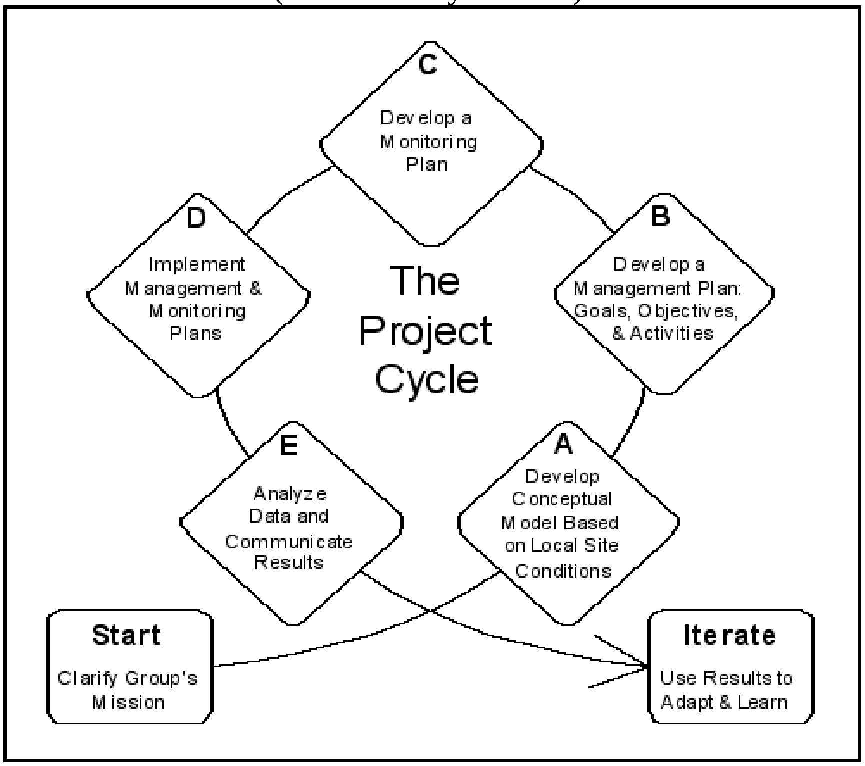
- Forest Ecosystem Management Assessment Team (1993) defined it as "the process of implementing policy decisions as scientifically driven management experiments that test predictions and assumptions in management plans and using the resulting information to improve the plans."

- Walters (1997) defined adaptive management as "a structured process of learning by doing." It "should begin with a concerted effort to integrate existing interdisciplinary experience and scientific information into dynamic models that attempt to make predictions about the impacts of alternative policies."

- Salafsky (undated) defined adaptive management as follows: "Adaptive management incorporates research into conservation action. Specifically, it is the integration of design, management, and monitoring to systematically test assumptions in order to adapt and learn." This is illustrated in Figure VIII-1 below.

- Lee (1999) defined adaptive management as formulating "management policies as experiments that probe the responses of ecosystems as people's behavior in them changes."

Figure VIII-1. Conceptual Diagram of Adaptive Management (from Salafsky undated).



In general, adaptive management includes inputs and information from a variety of sources (including biological, social, economic, political) to identify management objectives and develop strategies for addressing those objectives. As management strategies are applied, they are monitored. Based on monitoring, changes or new insights can be detected or observed. These results then provide the basis for adjusting or refining the management approach so that the objective can be better achieved.

The strategies identified in Chapter VI and their implementation plans specified in Chapter VII will be monitored according to the monitoring plan proposed in Tables VIII-1 and VIII-2. However, because the bio-geo-political environment is dynamic and available information constantly changes, changes can and will occur that necessitate the need to adjust or alter the conservation strategies and their implementation plans. By monitoring the implementation of conservation strategies (following Tables VIII-1 and VIII-2), we should be able to detect these changes.

Since DFW does not have a primary role in strategy implementation for many actions (see Tables VII-1 and VII-2), it may also not have the primary role in monitoring strategy implementation (see Tables VIII-1 and VIII-2). This is especially true for the conservation strategies for pollution and lack of enforcement (priority issues in Table VII-1), and for conservation strategies for marine species under Federal control (primarily highly migratory pelagic species in Table VII-2). For these conservation strategies, DFW can monitor and provide advice and guidance to the primary agency (specified in Tables VII-1 and VII-2). DFW's role would have to be limited to monitoring and providing information (feedback) to the primary agency (as part of the feedback loop). It would be the responsibility of the primary agencies to act or adjust the conservation strategy based on information gathered during monitoring.

Adaptive management is especially relevant to the implementation and monitoring of strategies that target critical marine habitats (see Tables VII-1 and VIII-1) and species of concerns (see Tables VII-2 and VIII-2). Some of the critical marine habitat conservation strategies and most of the species of concern conservation strategies are within the primary responsibility of DFW (see Tables VII-1 and VII-2). As such, DFW has the mandate to monitor and manage them. For these conservation strategies, information collected from monitoring (see Tables VIII-1 and VIII-2 above), will be reviewed and assessed against current conservation strategies (Table VII-1 and VII-2). If adjustments or modifications are needed in the existing conservation strategy, they can be made. For example, if a hurricane restricts or closes a natural channel to a mangrove area and this is detected through monitoring (mangrove habitat conservation strategy #3 in Table VII-1), actions can then be taken to open the channel (of course, after appropriate permits are obtained).

For many of the species of concern (most fish species on Table VII-2 for which DFW is the primary agency), a standard scientific approach will be applied (outlined on page 218). As this approach is applied to each species, new information or issues may come to light. These should be revealed during monitoring of the implementation of this conservation strategy (see Table VIII-2). As new information and insights become available, DFW will review them (feedback loop) and make appropriate adjustments to relevant conservation strategies, or formulate new conservation strategies to address issues raised by the new information (adapt management strategies based on feedback information).

It should be noted that several of the conservation strategies outlined (see Table VII-1) are basically data collection efforts (see overfishing priority conservation strategies such as #7 commercial catch reports, #8 bio-statistical catch surveys, #9 SEAMAP-C surveys, etc. in Table VII-1). These long term data collection efforts need to continue as they provide the baseline for detecting changes in the fishery. As critical fisheries issues surface based on analysis of these long term datasets, existing conservation strategies can be adjusted or appropriate new conservation strategies can be formulated. However, detailed monitoring of the implementation of these data collection conservation strategies will be limited to ensuring that appropriate data, collected accurately, and in a timely manner, are available in electronic format for analysis. Much of the analysis using these data will be done at the species level (see most fish species of concern Table VII-2 for which DFW is the primary agency, and the protocol outlined on page 218).

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CHAPTER IX
DECADAL REVIEW AND UPDATE OF THIS PLAN

1. REVIEW PERIOD

There are many possibilities for the time between updating this plan. Since it took the better part of three years to complete this first plan, a one to five year period between reviews may be too short. The plan would have to be reviewed and updated almost as soon as it is completed and implemented. As such, it is proposed that the review period be 10 years, dependent on the availability of funding.

Since this plan will be completed in 2005, the next review and update of this plan should be in 2015.

2. DECADAL REVIEW PROCEDURES

Procedures for the decadal review of this plan are basically the same as for formulating this plan (see Chapter II). This chapter has detailed protocol on how this plan was researched and developed. It also specifies and details public inputs, suggestions, and review to the development of this plan. Protocol is basically as follows:

1) Solicit public and user group input to identify major fisheries and marine resource issues.

2) Contact local governmental and private sector agencies within the USVI and solicit relevant scientific and technical reports and documents relating to USVI marine resources and fisheries. Update the DFW library with copies of all relevant USVI marine resources and fisheries reports. Update the DFW searchable database for these reports. This should be done annually.

3) Review USVI marine resources and fisheries related reports and incorporate information into relevant sections of the decadal review of this plan.

4) Identify priorities and major problems 10 years after the original plan was produced.

5) Propose solutions or specific actions to address priorities and resolve major problems that are present in 10 years.

6) Propose programs to monitor resolution of priorities and major problems that are suggested in the decadal review of this plan.

7) Review of the decadal review of this plan.

It is highly recommended that the various opinion surveys of different user groups (public input) that were completed for this plan be repeated before updating this plan. Results from these surveys were highly valuable when identifying priority issues in USVI marine resources and fisheries. Results from these surveys also provided insights into, and suggestions for, possible solutions of priority issues.

In addition, a similar approach (as outlined in Chapter II) should be taken to up-date literature and reports on U.S. Virgin Islands marine resources and fisheries. Having reports readily available when this plan was written was extremely valuable. Now that most reports (to date) have been collected, it would not be as momentous of a job to update this collection in ten years.

3. REVIEW THE SUCCESS IN IMPLEMENTATION OF THIS PLAN

A mid-term review should also be conducted in 5 years to evaluate the progress or effectiveness of the conservation strategies identified here in this plan, if implemented, with revision of the plan at 10 years. As was stated earlier, DFW is 100 percent dependent on Federal grants. Grants typically are focused on priority issues of the grantor, not the grantee. Therefore, available Federal funding priorities may not be the same as USVI priority issues as indicated here.

4. RESOURCES FOR CONDUCTING THE REVIEW

It normally takes between 1 to 2 years to hire new staff at DFW. In 10 years, if DFW staffing is limited, then consideration should be given to contracting out this work. In the research and writing of this plan, it took about 2 years to hire the principal investigator. This greatly delayed and limited significant progress on the development of this plan. This situation should be avoided when this plan is updated in 10 years.

In addition, as noted above and in several places in this plan, any work mandated by USFWS, will require substantial support. Review and update of this plan in 10 years is contingent on the availability of funds and resources.

APPENDIX 1
MARINE SPECIES OVERVIEW (Source: CFMC 2004)

The following is from CFMC (2004), Chapter 5. The full reference for CFMC (2004) is as follows:

Caribbean Fishery Management Council. 2004. DRAFT 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 Draft Supplemental Environmental Impact Statement, Regulatory Impact Review, and Regulatory Flexibility Act Analysis. 14 July 2004. CFMC, San Juan, Puerto Rico, NOAA Fisheries, Southeast Regional Office, St. Petersburg, Florida.

A. HARVESTABLE REEF FISH SPECIES

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).

Herbivorous Fish

The two most important herbivorous fish families on Caribbean reefs in terms of density, biomass, and impact on the macrophyte (large aquatic plant) community are the family Scaridae (parrot fish) and the family Acanthuridae (surgeon fish) (TNC 2002). Parrot fish will be discussed here as a target species for conservation because of the important role they play in the ecological community, and because they are under strong fishing pressure in the USVI, as well as the rest of the Caribbean (TNC 2000). Although Acanthurids experience similar intense fishing pressures, and have been suggested to play an equally important role in structuring reef communities, the focus here will be on parrot fish as the representative herbivore and conservation target because the diversity in this group is an order of magnitude greater than Acanthurids (TNC 2002). However, all conservation strategies proposed for the preservation of parrot fish will equally protect surgeon fish, as the strategies are designed to protect habitat, and not to limit the take of specific species. Since Acanthurids are sympatric (overlap geographically) with parrot fish, we will assume that efforts taken to protect parrot fish will also protect Acanthurids in a similar manner (TNC 2002).

Parrot fish are ecologically and economically important for a variety of reasons (TNC 2002). First, they are a primary fish sought by local fishermen for sale at local markets. Second, encounters with the often colorful parrot fish are the focus of many ecotourism dives/snorkels; most sponsored by large hotels, resorts, and local merchants, which bring much needed money into the local economy. Third, parrot fish play an integral, though often overlooked, role in maintaining the structure of important, shallow-water communities (TNC 2002). For example, it has been suggested by many studies that by suppressing the abundance of fast-growing algae, herbivorous fish indirectly facilitate the persistence of coral reefs (TNC 2002). Conservation of these fish will thus benefit the local economy in a variety of ways, and likely facilitate the persistence of important, shallow-water reef communities (TNC 2002). However, like any effective conservation plan, the management design for the long-term preservation of these fishes must be based on an accurate understanding of the animal's life history.

The parrot fish species, which inhabit the shallow waters of the USVI, range in size from the four-foot rainbow to the six-inch green blotch, and can be found primarily in three habitats: coral reefs, seagrasses, and mangroves (TNC 2002). The dominant and most common parrot fish in coral reef communities include: stoplight (*Sparisoma viride*), queen (*Scarus vetula*), midnight blue (*Scarus coelestinus*), red-band (*Sparisoma aurofrenatum*), princess (*Scarus taeniopterus*), and, at times, blue (*Scarus coeruleus*) and rainbow (*Scarus guacamaia*) parrot fish (TNC 2002). However, it should be noted that due to various trends in fishing and environmental disturbances, these fish are not present in great abundance, at least in waters surrounding St. Croix (TNC 2002). Many of these same species can be found during the day, foraging on algae and turtle grass in nearby flats. These species return to the reef at night however, for protection from predators. Again, although this is their habitat, certain species of parrot fish may presently be difficult to locate in St. Croix waters due to reductions in the population (TNC 2002). Those species that live almost exclusively in seagrass habitat include: bucktooth (*Sparisoma radians*), striped (*Scarus croicensis*), green blotch (*Sparisoma atomarium*), redtail (*Sparisoma chrysopterum*), redfin (*Sparisoma rubripinne*), and the blue lip (*Cryptotomus roseus*) (TNC 2002). However, studies conducted by the V.I. Division of Fish and Wildlife have only identified bucktooth parrot fish in significant numbers (TNC 2002). Mangrove communities, although not primary habitats for adult parrot fish, are important nursery grounds for many parrot fish including rainbows, blues, queens, and striped (TNC 2002). Successful conservation of parrot fish must then incorporate preservation of not only coral reef and seagrass habitats for adult fish, but also mangrove communities, which act as critical nursery areas for vulnerable juvenile stages (TNC 2002). In essence, conservation efforts must take on a landscape level approach.

Parrot fish are unique among all reef fishes in their ability to consume fleshy as well as heavily calcified algae (TNC 2002). In addition, a variety of parrot fish (e.g., red-band, stoplight, redfinned queen, striped, and especially the bucktooth) will consume seagrasses which are both epiphitized (serve as habitat for smaller animals or algae) and unepiphitized (TNC 2002). Parrot fish as a group display considerable plasticity in their diet of macrophytes, and are usually large in population size and, at times, in individual biomass (TNC 2002). For these reasons, it is not surprising that a variety of scientific studies have pointed to their keystone role as important top-down agents, affecting the distribution and abundance of seagrass and macroalgae across flats and coral reef communities (TNC 2002; Rogers et al. 1997). For more information on parrotfish biology, fishery, and status in the Caribbean and U.S. Virgin Islands, refer to the following papers: Lobel and Ogden (1981) and DFW (1992, 1993, 1994, 1995).

Three key factors which can be controlled by effective human management are critical to the long-term preservation of parrot fish in the Virgin Islands (TNC 2002):

First: Permanent no-take zones which incorporate large tracts (km x km) of barrier reef, patch reef, and fore reef must be established. For future planning, it is critical that the deep fore reef area also be included, as this contains most of the large fish that contribute a disproportionate amount of gametes to spawning aggregations. These no-take zones must also incorporate seagrass habitats used by various species of parrot fish as foraging and resident areas. Too many no-take zones have failed by just protecting the reef. Intermingled in these areas should be take zones, which allow for commercial and recreational fishing.

Second: There needs to be a strong effort to conserve the critical nursery habitats described above (seagrass and mangrove habitats). Without such efforts, the juvenile life stage of these fish will soon become a bottleneck in their population numbers.

Third: Educational outreach to local fishermen, discussing the benefits of no-take areas to the long-term preservation of their historic fisheries and coral reef communities, must be a constant and never-ending goal. Without their support, little in regards to conservation can be accomplished. The importance of the co-dependency of species in these nearshore habitats must be emphasized. The potential for declines at one trophic level to cascade up, down, and sideways in the food web, i.e., the propagation of negative effects throughout this community, is high in this intensely interconnected system. Coral reefs buffer the island from the intense wave action of storms and hurricanes, facilitate seagrass and mangrove communities, increase fish production, and increase tourism, thus increasing the influx of money into the local economy, but they cannot persist without preserving herbivorous fish populations. Conserving fish species, such as parrot fish, is critical in conserving the entire nearshore marine system.

Aggregating Fish Predators

In this context, the phrase "aggregating fish predators" does not refer to fish that feed in groups; rather the term refers to large piscivorous fish which are solitary hunters, but must gather in large aggregations to effectively reproduce (TNC 2002). Aggregating fish predators refer primarily to two families of reef fish, the snappers—Lutjanidae, and the groupers or sea basses—Serranidae. Some examples of large sea basses that historically inhabited the USVI include the Nassau grouper (*Epinephelus striatus*), coneys (*Epinephelus fulvus*), red hinds (*Epinephelus guttatus*), rock hinds (*Epinephelus adscensionis*), tiger groupers (*Mycteroperca tigris*), and graysbys (*Epinephelus cruentatus*). Unfortunately, the likelihood of encountering mature adults of any of these species has decreased due to a variety of stresses, both current and historical (TNC 2002). Both the Nassau and tiger grouper fisheries are locally extinct (TNC 2002). Examples of abundant and large snappers include mutton snapper (*Lutjanus analis*), schoolmasters (*Lutjanus apodus*), mangrove or gray snappers (*Lutjanus griseus*), lane snappers (*Lutjanus synagris*), cubera (*Lutjanus cyanopterus*) and yellow-tail snappers (*Ocyurus chrysurus*).

Snappers and groupers are ecologically and economically important for a variety of reasons. First, they are the primary fish sought by local fishermen for sale at both local and regional scales. Groupers and snappers, unlike many others fished locally (e.g., parrot fish, squirrel fish, and surgeon fish), are in high demand in off-island markets (e.g., continental U.S.), bring a higher price per pound, and thus suffer from increased fishing pressure. However, due to reduced stocks, neither grouper nor snapper have been exported from the Virgin Islands in over 20 years (TNC 2002). Second, snappers and groupers are prized game fish for many tourists. Third, encounters with these impressive fish are often the focus of eco-tourism dives, sponsored by large hotels, resorts, and local merchants, which bring much needed money into the local economy. Fourth, snappers and groupers play an integral role in maintaining the structure of important, shallow-water communities. For example, it has been suggested by correlation and lab studies that predators, by suppressing the densities of plant-eating fish, indirectly facilitate the persistence of important macrophyte habitats (e.g., seagrasses and patches of calcium-rich macroalgae) (Hay 1981, 1984, 1985). Conservation of these fish will thus benefit the local economy in a variety of ways and likely facilitate the persistence of important, shallow-water plant communities. However, like any effective conservation plan, the management design for the long-term preservation of these fishes must be based on an accurate understanding of the animal's life history (TNC 2002).

During the day, adult groupers and snappers are typically found associated with complex biogenic structure on the barrier reef or on nearby patch reefs. The depth range of groupers is routinely greater than snappers, as they are distributed from the shallow parts of the back reef (10-30 m) to the deeper reaches (100-300 m) of the fore reef. Adult snappers typically inhabit shallow areas of the barrier and patch reefs but, unlike groupers, are also found in abundance in mangrove creeks and in shallow waters near biogenic (rocks, caves, and blue holes), or artificial (piers, marinas, docks) structures (TNC 2002). This differentiation in habitat use may in part be due to the ability of many species of snappers to endure a much greater variation in salinity (Ray et al. 2000). At night, both groupers and snappers leave the structural refuge of the reef and other habitats (e.g., mangrove roots, docks, and rocky shores) and fan out over adjacent seagrass beds and sand flats to feed on smaller fish and invertebrates (TNC 2002).

Relatively little is known about the life histories of juvenile snappers and groupers. Importantly, what is definitive is that these fish do not use the barrier or patch reefs as nursery habitats. Instead, mangroves (e.g., grey, schoolmaster, and cubera snappers), shallow-water sand flats, rocky shores (many groupers), seagrasses and algal beds (e.g., juvenile Nassau groupers are thought to home to red algal *Laurencia* beds), have been shown routinely to be the nursery grounds of aggregating fish predators (Layman et al. 2001). Transplant and tethering experiments of juvenile fish onto the reef complex demonstrate that predation rates are far too high and intense for these areas to act as nurseries. Successful conservation of these large aggregating predators must then incorporate preservation of not only barrier and patch reef habitats for adult fish, but also seagrass, mangrove, and other communities which act as critical nursery areas for vulnerable juvenile stages (TNC 2002). In essence, conservation efforts must take on a landscape level approach.

Besides a spatial, habitat-based conservation strategy, a successful management plan for these fish must also include temporal protection of fish populations during aggregated spawning events. These events often take place in the fore reef area where gametes can be dispersed into fast-moving currents and, historically, were thought to attract up to 10,000 fish (Ray et al. 2000). Today's estimates suggest that those numbers have dwindled by an order of magnitude for most aggregations, to around 1,000 fish (Ray et al. 2000). In most cases, known aggregation sites have gone extinct due to overfishing. For example, the aggregation of Nassau groupers off the East End of St. Croix, once thought to number in the thousands, is now ecologically extinct (TNC 2002). Similar documented accounts and stories abound in Florida and the Bahamas (Ray et al. 2000). These aggregations represent key bottlenecks in the life histories of these fish. Essentially, they provide the seed for future generations and must be thought of as the "suppliers" which sustain nearshore fisheries. During these aggregations, the usually coy and solitary snappers and groupers are particularly social and undeterred or frightened by typically threatening activities, which usually result in evasive escape behavior (TNC 2002). The critical point here is that making known fish aggregation sites off limits to fishing during aggregation times (typically 2-3 days every month for three months a year; but this varies from species to species) preserves the supply of fish to the region for generations to come (TNC 2002). This is particularly applicable to the management of USVI marine fisheries, as recent studies using the chemistry of fish otoliths (i.e., ear bones) to trace the origin of juvenile fish, suggest that up to 50% of bluehead wrasse, *Thalassoma bifasciatum*, recruits on St. Croix are self-recruiting; that is, they originate from spawning events on St. Croix (Swearer et al. 1999).

The area of fish conservation has long been chided by community and ecosystem ecologists for its attempts to conserve species solely by regulating yearly catch and size limits (TNC 2002). This method alone has proven time and time again to be painfully ineffective at conserving or revitalizing depleted fish populations (TNC 2002). What has been recommended instead is an integrated natural history and community level ecology approach combined with active management of fish extraction for commercial sale (TNC 2002). This approach results in: 1) decreased fishing pressure on stressed fish populations and 2) conservation of critical habitat and life history events, which often represent extremely vulnerable stages in the ontogeny of these ecologically and economically important fish.

For more information on grouper/snapper biology, fishery, and status in the Caribbean and U.S. Virgin Islands, refer to the following papers: AFS (2004), Beets and Hixon (1994), Sadovy and Eklund (1999), Sadovy (1993a, 1993b), Sadovy et al. (1989, 1992), Sadovy and Figuerola (1992), Bohnsack (1989), Olsen and LaPlace (1978), Sylvester (1976), Bolden (1994), Nelson et al. (1984), Clavijo et al. (1986), Beets and Friedlander (1997), and Shapiro et al. (1993). For more information on spawning aggregations in the U.S. Caribbean, refer to Colin (1996), Nemeth (2005), and Nemeth et al. (2004, in press), and on conservation strategies for spawning aggregations, refer to Luckhurst (2003).

Four key factors which can be controlled by effective human management are critical to the long-term preservation of snapper and grouper populations in the Virgin Islands (TNC 2002):

First: Permanent no-take zones must be established that provide refuge over a large enough spatial scale to theoretically incorporate, using modeling and fish counts in the literature, at least 1,000 adult fish of the targeted species. Because this goal is often too difficult to accomplish, no-take zones which incorporate large tracts (km x km) of barrier reef, patch reef, and fore reef must be established. For future planning, it is critical that this deep fore reef area be included in the no-take zones as this contains most of the large fish, which contribute a disproportionate amount of gametes to spawning aggregations. These no-take zones must also incorporate seagrass, sand flat, and mangrove habitats, which are used by adult snappers and groupers as foraging areas at night. Too many no-take zones have failed by just protecting the reef. Intermingled in these areas should be take zones, which allow for commercial and recreational fishing.

Second: There needs to be a strong effort to conserve the critical nursery habitats described above. Without such efforts, the juvenile life stage of these fish will soon become a bottleneck in their population numbers.

Third: Spawning aggregations must be located and designated as no-take areas with proper enforcement. Again, enforcement here is critical. One slip in the large, no-take zone means a few fish are lost in the day; one slip at this bottleneck, aggregating period could completely wipe eliminate the effective reproduction population of the fish.

Fourth: Educational outreach to local fishermen discussing the benefits of no-take areas and protection of breeding aggregations to the long-term preservation of their historic fisheries must be a constant and never-ending goal. Without their support, little in regards to conservation can be accomplished.

Species Descriptions[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.

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).

Biology:
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).

[1] Species descriptions were taken from a draft CFMC document (CFMC 2004).

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).

<u>Status:</u>
The status of the ocean surgeonfish has not been assessed relative to the pre-SFA definitions of overfished and overfishing. Under these definitions, the stock would be overfished if 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). This species is managed together with the doctorfish and the blue tang in the Surgeonfish Complex. The SFA Working Group classified the status of the Surgeonfish Complex as “unknown.”

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).

<u>Biology:</u>
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).

<u>Status:</u>
The status of the doctorfish 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). This species is managed together with the ocean surgeonfish and the blue tang in the Surgeonfish Complex. The SFA Working Group classified the status of the Surgeonfish Complex as “unknown”.

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).

<u>Biology:</u>
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).

<u>Status:</u>
The status of the blue tang 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). This species is managed together with the ocean surgeonfish and the doctorfish in the Surgeonfish Complex. The SFA Working Group classified the status of the Surgeonfish Complex as “unknown.”

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).

Biology:
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).

Status:
The status of the frogfishes has not been assessed relative to the pre-SFA definitions of overfished and overfishing. Under these definitions, this stock is 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). The frogfishes are identified as aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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).

Flamefish, ***Apogon maculates***

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).

Biology:
The flamefish is found to 128 m depth, commonly along sea walls and pilings, in harbors, and 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).

Status:
The status of the flamefish 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). This species is identified as an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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).

Biology:
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).

Status:
The status of the conchfish 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). This species is identified as an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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.

Trumpetfish, ***Aulostomus maculates***

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).

Biology:
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).

Status:
The status of the trumpetfish 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). This species is identified as an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown.”

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.

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.

Biology:
The queen triggerfish is generally found over rocky or coral areas, from depths of 2-275 m. Italso 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).

Status:

The 1996 IUCN (World Conservation Union) Red List of Threatened Species lists the queen triggerfish as “vulnerable,” indicating that it 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 ten years or three generations, whichever is the longer, based on (and specifying) actual or potential levels of exploitation (IUCN 2002). The status of the queen triggerfish in the U.S. Caribbean 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). This species is managed together with the black durgon, the ocean and sargassum triggerfish, and the scrawled and whitespotted filefish, in the Triggerfish and Filefish Complex. That complex has been classified as "at risk" by the SFA Working Group.

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).

Biology:

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).

Status:
The status of the ocean triggerfish 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). This species is managed together with the black durgon, the queen and sargassum triggerfish, and the scrawled and whitespotted filefish, in the Triggerfish and Filefish Complex. That complex was classified as“at risk” by the SFA Working Group.

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).

Biology:
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).

Status:
The status of the black durgon 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). This species is managed together with the queen, ocean, and sargassum triggerfish, and the scrawled and whitespotted filefish, in the Triggerfish and Filefish Complex. That complex was classified as "at risk" by the SFA Working Group.

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).

Biology:
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).

Status:
The status of the sargassum triggerfish 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). This species is managed together with the black durgon, the queen and ocean triggerfish, and the scrawled and whitespotted filefish, in the Triggerfish and Filefish Complex. The SFA Working Group classified the status of that complex as "at risk".

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*.

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.

Biology:
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).

Status:
The status of the scrawled filefish 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). This species is managed together with the black durgon, the queen, ocean, and sargassum triggerfish, and the whitespotted filefish, in the Triggerfish and Filefish Complex. The SFA Working Group classified the status of that complex as “at risk”.

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.

Biology:
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).

Status:
The status of the whitespotted filefish 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). This species is managed together with the black durgon, the queen, ocean, and sargassum triggerfish, and the scrawled filefish, in the Triggerfish and Filefish Complex. The SFA Working Group classified the status of that complex as "at risk".

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).

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).

Biology:
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).

Status:
The status of the redlip blenny 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). This fish is identified as an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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).

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).

<u>Biology:</u>
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).

<u>Status:</u>
The status of the peacock flounder 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). This species is identified as an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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*.

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.

Biology:
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).

Status:
The status of the yellow jack 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). This species is managed together with the blue runner, the greater amberjack, and the horse-eye, black, almaco, and bar jacks in the Jack complex. The SFA Working Group classified the status of that complex as “unknown”.

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.

Biology:
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).

Status:
The status of the blue runner 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). This species is managed together with the greater amberjack, and horse-eye, black, almaco, bar, and yellow jacks in the Jack complex. The SFA Working Group classified the status of that complex as "unknown".

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).

Biology:
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).

Status:
The status of the horse-eye jack 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). This species is managed together with the blue runner, the greater amberjack, and the black, almaco, bar, and yellow jacks in the Jack complex. The SFA Working Group classified the status of that complex as "unknown".

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.

Biology:
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).

Status:
The status of the black jack 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). This species is managed together with the blue runner, the greater amberjack, and the horse-eye, almaco, bar, and yellow jacks in the Jack complex. The SFA Working Group classified the status of that complex as "unknown."

Bar jack, *Caranx rubber*

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).

Biology:
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).

Status:
The status of the bar jack 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). This species is managed together with the blue runner, the greater amberjack, and the horse-eye, black, almaco, and yellow jacks in the Jack complex. The SFA Working Group classified the status of that complex as “unknown”.

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).

Biology:
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).

Status:
The status of the greater amberjack 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). This species is managed together with the blue runner, and the horse-eye, black, almaco, bar, and yellow jacks in the Jack complex. The SFA Working Group classified the status of that complex as "unknown".

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).

Biology:
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).

Status:
The status of the almaco jack 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). This species is managed together with the blue runner, the greater amberjack, and the horse-eye, black, bar, and yellow jacks in the Jack complex. The SFA Working Group classified the status of that complex as "unknown".

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).

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).

<u>Biology:</u>
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).

Status:
The status of the longsnout butterflyfish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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.

Biology:
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 from 2-20 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).

Status:
The status of the foureye butterflyfish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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).

<u>Biology:</u>
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).

<u>Status:</u>
The status of the spotfin butterflyfish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

Biology:
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 occur singly or in pairs. But adults may form planktonfeeding 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).

Status:
The status of the banded butterflyfish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown.”

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.

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).

Biology:

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).

Status:

The status of the redspotted hawkfish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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.

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.

Biology:

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).

Status:

The status of the flying gurnard 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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.

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.

<u>Biology:</u>
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).

<u>Status:</u>
The status of the Atlantic spadefish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

Gobies, Gobiidae

The largest family of marine fishes, the Gobiidae family contains at least 1,800 species in 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.

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).

Biology:
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 ectoparasites from other fishes (Robins and Ray 1986 in Froese and Pauly 2002).

Status:
The status of the neon goby 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

Biology:
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).

Status:
The status of the rusty goby 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). This fish is an aquarium trade

species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

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).

Biology:
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).

Status:
The status of the royal gramma 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

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).

<u>Biology:</u>
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).

<u>Status:</u>
The status of the porkfish 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). This fish is managed together with the margate, the tomtate, and the white, bluestriped and French grunts in the Grunt complex. The SFA Working Group classified the status of the Grunt complex as “unknown”.

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).

Biology:
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).

Status:
The status of the margate 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). This species is managed together with the porkfish, the tomtate, and the white, bluestriped and French grunts in the Grunt complex. The SFA Working Group classified the status of the Grunt complex as “unknown”.

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).

Biology:
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).

Status:
The status of the tomtate 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). This fish is managed together with the margate, the porkfish, and the white, bluestriped and French grunts in the Grunt complex. The SFA Working Group classified the status of the Grunt complex as "unknown".

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).

Biology:
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).

Status:
The status of the French grunt 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). This species is managed together with the margate, the porkfish, the tomtate, and the white and bluestriped grunts in the Grunt complex. The SFA Working Group classified the status of the Grunt complex as "unknown".

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).

Biology:
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).

Status:
The status of the white grunt 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). This species is managed together with the margate, the porkfish, the tomtate, and the bluestriped and French grunts in the Grunt complex. The SFA Working Group classified the status of the Grunt complex as "unknown".

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).

Biology:
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).

Status:
The status of the bluestriped grunt 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). This species is managed together with the margate, the porkfish, the tomtate, and the white and French grunts in the Grunt complex. The SFA Working Group classified the status of the Grunt complex as “unknown”.

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*.

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.

Biology:

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).

Status:

The status of the squirrelfish 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). This species is managed together with the bigeye, the blackbar soldierfish, and the longspine squirrelfish in the Squirrelfish complex. The SFA Working Group classified the status of the Squirrelfish complex as “unknown”.

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.

Biology:

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).

Status:
The status of the longspine squirrelfish 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). This fish is managed together with the bigeye, the blackbar soldierfish, and the squirrelfish in the Squirrelfish complex. The SFA Working Group classified the status of the Squirrelfish complex as “unknown”.

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).

Biology:
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).

Status:
The status of the blackbar soldierfish 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). This species is managed together with the bigeye, the squirrelfish, and the longspine squirrelfish in the Squirrelfish complex. The SFA Working Group classified the status of the Squirrelfish complex as “unknown”.

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).

Biology:
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).

Status:
The status of the Cardinal soldierfish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown.”

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.

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.

Biology:
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).

Status:
The status of the Spanish hogfish 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). This species is managed together with the puddingwife and the hogfish in the Wrasse Complex. The SFA Working Group classified the status of the Wrasse Complex as “unknown”.

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).

Biology:
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).

Status:
The status of the creole wrasse 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

Biology:
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).

Status:
The status of the yellowcheek wrasse 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

Biology:
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).

Status:
The status of the yellowhead wrasse 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

Biology:
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).

Status:
The status of the clown wrasse 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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.

Biology:
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).

Status:
The status of the puddingwife 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). This species is managed together with the hogfish and Spanish hogfish in the Wrasse Complex. The SFA Working Group classified the status of the Wrasse Complex as “unknown”.

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).

Biology:
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).

Status:
The status of the pearly razorfish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

Biology:
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).

Status:
The status of the green razorfish 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). This fish is an aquarium trade

species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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).

Biology:
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).

Status:
The hogfish is listed as "vulnerable" on the 1996 IUCN Red List of Threatened Species, indicating it 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 ten years or three generations, whichever is the longer, based on (and specifying) actual or potential levels of exploitation (IUCN 2002). The status of this species in the U.S. Caribbean 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). This fish is managed together with the puddingwife and the Spanish hogfish in the Wrasse Complex. The SFA Working Group classified the status of the Wrasse Complex as "unknown".

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).

Biology:
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).

Status:
The status of the bluehead wrasse 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

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 et al. (1970), in Froese and Pauly (2002), report that it can be ciguatoxic.

Biology:
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).

Status:
The status of the black snapper 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). This species is managed together with the silk, vermilion, and blackfin snappers in Snapper Unit 1. The SFA Working Group classified the status of Snapper Unit 1 as “at risk”.

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).

Biology:
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.* 1988). 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).

Status:
The status of the queen snapper 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). This species is managed together with the wenchman in Snapper Unit 2. The SFA Working Group classified the status of Snapper Unit 2 as “unknown (at risk)”.

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.

Biology:

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). The approximate location of an aggregation area off the western coast of Puerto Rico described by Figuerola and Torres (2001) is indicated in Figure 13. 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).

Status:

The mutton snapper is listed as “vulnerable” on the 1996 IUCN Red List of Threatened Species, indicating it faces “a high risk of extinction in the wild in the medium-term future.” This determination is based on 1) a population reduction of at least 20%, projected or suspected to be met within the next ten years or three generations, whichever is the longer, based on (and specifying) actual or potential levels of exploitation; and on 2) an extent of occurrence or area of occupancy that is estimated to be less than 20,000 km^2 or 2000 km^2, respectively, estimates indicating severely fragmented or known to exist at no more than ten locations, and continuing decline, inferred, observed or projected, in number of mature individuals (IUCN 2002). The status of the mutton snapper in the U.S. Caribbean 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). This species is managed together with the gray, lane, dog, schoolmaster, and mahogany snappers in Snapper Unit 3. The SFA Working Group classified the status of Snapper Unit 3 as "unknown".

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 (1960), in Froese and Pauly (2002), report that it can be ciguatoxic.

Biology:
The schoolmaster snapper is found in shallow, clear, warm, coastal waters over coral reefs, from 2-63 m depth. Adults often seek 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).

Status:
The status of the schoolmaster snapper 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). This species is managed together with the gray, lane, dog, mutton, and mahogany snappers in Snapper Unit 3. The SFA Working Group classified the status of Snapper Unit 3 as "unknown".

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).

Biology:
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).

Status:
The status of the blackfin snapper 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). This species is managed together with the silk, vermilion, and black snappers in Snapper Unit 1. The SFA Working Group classified the status of Snapper Unit 1 as "at risk".

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.

Biology:

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).

Status:

The status of the gray snapper 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). This species is managed together with the mutton, lane, dog, schoolmaster, and mahogany snappers in Snapper Unit 3. The SFA Working Group classified the status of Snapper Unit 3 as “unknown”.

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).

Biology:

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).

Status:
The status of the dog snapper 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). This species is managed together with the gray, lane, mutton, schoolmaster, and mahogany snappers in Snapper Unit 3. The SFA Working Group classified the status of Snapper Unit 3 as “unknown”.

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.

Biology:
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).

Status:
The status of the mahogany snapper 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). This species is managed together with the gray, lane, dog, schoolmaster, and mutton snappers in Snapper Unit 3. The SFA Working Group classified the status of Snapper Unit 3 as “unknown”.

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.

Biology:
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).

Status:
The status of the lane snapper 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). This species is managed together with the gray, mutton, dog, schoolmaster, and mahogany snappers in Snapper Unit 3. The SFA Working Group classified the status of Snapper Unit 3 as “unknown”.

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).

Biology:
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).

<u>Status:</u>
The status of the silk snapper 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). This species is managed together with the black, vermilion, and blackfin snappers in Snapper Unit 1. The SFA Working Group classified the status of Snapper Unit 1 as "at risk".

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.

Biology:
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).

Status:
The status of the yellowtail snapper 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). The SFA Working Group classified the status of the yellowtail snapper as “at risk”.

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).

Biology:
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).

Status:
The status of the wenchman 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). This species is managed together with the queen snapper in Snapper Unit 2. The SFA Working Group classified the status of Snapper Unit 2 as “unknown (at risk)”.

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).

Biology:
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).

Status:
The status of the vermilion snapper 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). This species is managed together with the silk, black, and blackfin snappers in Snapper Unit 1. The SFA Working Group classified the status of Snapper Unit 1 as “at risk”.

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).

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).

Biology:
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).

Status:
The status of the blackline tilefish 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). This species is managed together with the goldface and sand tilefish in the Tilefish complex. The SFA Working Group classified the status of the Tilefish complex as “unknown”.

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).

Biology:
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).

Status:
The status of the sand tilefish 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). This species is managed together with the goldface and blackline tilefish in the Tilefish complex. The SFA Working Group classified the status of the Tilefish complex as “unknown”.

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).

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.

Biology:
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).

Status:
The status of the yellow goatfish 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). This species is managed together with the spotted goatfish in the Goatfish complex. The SFA Working Group classified the status of the Goatfish complex as “unknown”.

Spotted goatfish, ***Pseudupeneus maculates***

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.

Biology:
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).

Status:
The status of the spotted goatfish 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). This species is managed together with the yellow goatfish in the Goatfish complex. The SFA Working Group classified the status of the Goatfish complex as “unknown”.

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 utilized primarily in the aquarium trade.

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).

Biology:
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).

Status:
The status of the chain moray 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

Biology:
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).

Status:
The status of the green moray 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

Biology:
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).

Status:
The status of the goldentail moray 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

Batfishes, Ogcocephalidae

The Ogcocephalidae family contains 62 species in 9 genera, distributed in all tropical and manysubtropical 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”.

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.

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).

<u>Biology:</u>
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).

<u>Status:</u>
The status of the goldspotted eel 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). This fish is an aquarium trade

species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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*.

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).

<u>Biology:</u>
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).

<u>Status:</u>
The status of the yellowhead jawfish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

<u>Biology:</u>
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).

<u>Status:</u>
The status of the dusky jawfish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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*.

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.

<u>Biology:</u>
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).

<u>Status:</u>
The status of the spotted trunkfish 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). This species is managed together with the scrawled and honeycomb cowfishes, and the trunkfish and smooth trunkfish, in the Boxfish Complex. The SFA Working Group classified the status of the Boxfish Complex as “at risk”.

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.

Biology:
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).

Status:
The status of the honeycomb cowfish 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). This species is managed together with the scrawled cowfish, and the trunkfish and spotted and smooth trunkfishes, in the Boxfish Complex. The SFA Working Group classified the status of the Boxfish Complex as “at risk”.

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.

Biology:
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).

Status:

The status of the scrawled cowfish 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). This species is managed together with the honeycomb cowfish, and the trunkfish and spotted and smooth trunkfishes, in the Boxfish Complex. The SFA Working Group classified the status of the Boxfish Complex as "at risk".

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.

Biology:
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).

Status:
The status of the trunkfish 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). This species is managed together with the scrawled and honeycomb cowfishes, and the spotted and smooth trunkfishes, in the Boxfish Complex. The SFA Working Group classified the status of the Boxfish Complex as "at risk".

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.

Biology:
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).

Status:
The status of the smooth trunkfish 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). This species is managed together with the scrawled and honeycomb cowfishes, and the trunkfish and spotted trunkfish, in the Boxfish Complex. The SFA Working Group classified the status of the Boxfish Complex as "at risk."

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*.

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).

Biology:
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).

Status:
The status of the cherubfish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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).

Biology:
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).

Status:
The status of the queen angelfish 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). This species is managed together with the gray and French angelfishes, in the Angelfish Complex. The SFA Working Group classified the status of the Angelfish Complex as “unknown”.

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).

Biology:
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).

Status:
The status of the rock beauty 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

<u>Biology:</u>
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).

<u>Status:</u>
The status of the gray angelfish 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). This species is managed together with the queen and French angelfishes, in the Angelfish Complex. The SFA Working Group classified the status of the Angelfish Complex as “unknown”.

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 t he Gulf of Me xico and C aribbean 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).

<u>Biology:</u>
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).

Status:
The status of the French angelfish 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). This species is managed together with the gray and queen angelfishes, in the Angelfish Complex. The SFA Working Group classified the status of the Angelfish Complex as "unknown".

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*.

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).

Biology:
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).

Status:
The status of the sergeant major 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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).

Biology:
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).

Status:
The status of the blue chromis 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

Biology:
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).

Status:
The status of the sunshinefish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

<u>Biology:</u>
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).

<u>Status:</u>
The status of the yellowtail damselfish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

<u>Biology:</u>
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).

Status:
The status of the dusky damselfish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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.

Biology:
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 mat urity is 7 cm T L; natu ral mo rtali ty rate, 2.12 (Froese and P auly 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).

Status:
The status of the beaugregory 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

Biology:
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 (Allen 1991 in Froese and Pauly 2002).

Status:
The status of the bicolor damselfish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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).

Biology:
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).

Status:
The status of the threespot damselfish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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*.

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).

<u>Biology:</u>
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).

<u>Status:</u>
The status of the bigeye 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). This species is managed together with the squirrelfish, the longspine squirrelfish, and the blackbar soldierfish in the Squirrelfish complex. The SFA Working Group classified the status of the Squirrelfish complex as "unknown".

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.

<u>Biology:</u>
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).

Status:
The status of the glasseye snapper 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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.

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).

Biology:
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).

Status:
The status of the midnight parrotfish 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). This species is managed together with the blue, princess, queen, rainbow, redfin, redtail, stoplight, redband, and striped parrotfishes in the Parrotfish Complex. The SFA Working Group classified the status of the Parrotfish Complex as "at risk".

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).

Biology:
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).

Status:
The status of the blue parrotfish 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). This species is managed together with the midnight, princess, queen, rainbow, redfin, redtail, stoplight, redband, and striped parrotfishes in the Parrotfish Complex. The SFA Working Group classified the status of

the Parrotfish Complex as “at risk”.

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).

Biology:
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).

Status:
The status of the striped parrotfish 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). This species is managed together with the midnight, princess, queen, rainbow, redfin, redtail, stoplight, redband, and blue parrotfishes in the Parrotfish Complex. The SFA Working Group classified the status of the Parrotfish Complex as “at risk”.

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).

Biology:
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).

Status:
The rainbow parrotfish is listed as "vulnerable" on the 1996 IUCN Red List of Threatened Species, indicating that it faces "a high risk of extinction in the wild in the medium-term future." This determination is based on an observed, estimated, inferred or suspected reduction of at least 20% over the last 10 years or three generations, whichever is the longer, based on (and specifying) actual or potential levels of exploitation, and a reduction of at least 20%, projected or suspected to be met within the next ten years or three generations, whichever is the longer, based on (and specifying) actual or potential levels of exploitation (IUCN 2002).

The status of the rainbow parrotfish in the U.S. Caribbean 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). This species is managed together with the midnight, princess, queen, blue, redfin, redtail, stoplight, redband, and striped parrotfishes in the Parrotfish Complex. The SFA Working Group classified the status of the Parrotfish Complex as "at risk".

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).

Biology:
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).

Status:
The status of the princess parrotfish 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). This species is managed together with the midnight, blue, queen, rainbow, redfin, redtail, stoplight, redband, and striped parrotfishes in the Parrotfish Complex. The SFA Working Group classified the status of the Parrotfish Complex as "at risk".

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).

Biology:
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).

Status:
The status of the queen parrotfish 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). This species is managed together with the midnight, princess, blue, rainbow, redfin, redtail, stoplight, redband, and striped parrotfishes in the Parrotfish Complex. The SFA Working Group classified the status of the Parrotfish Complex as “at risk”.

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).

Biology:
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).

Status:
The status of the redband parrotfish 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). This species is managed together with the midnight, princess, queen, rainbow, redfin, redtail, stoplight, blue, and striped parrotfishes in the Parrotfish Complex. The SFA Working Group classified the status of the Parrotfish Complex as "at risk".

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).

Biology:
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).

Status:
The status of the redtail parrotfish 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). This species is managed together with the midnight, princess, queen, rainbow, redfin, blue, stoplight, redband, and striped parrotfishes in the Parrotfish Complex. The SFA Working Group classified the status of the Parrotfish Complex as "at risk".

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).

Biology:
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).

Status:
The status of the redfin parrotfish 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). This species is managed together with the midnight, princess, queen, rainbow, blue, redtail, stoplight, redband, and striped parrotfishes in the Parrotfish Complex. The SFA Working Group classified the status of the Parrotfish Complex as “at risk”.

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).

Biology:
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).

Status:
The status of the stoplight parrotfish 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). This species is managed together with the midnight, princess, queen, rainbow, redfin, redtail, blue, redband, and striped parrotfishes in the Parrotfish Complex. The SFA Working Group classified the status of the Parrotfish Complex as "at risk".

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.

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).

Biology:
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).

Status:
The status of the high-hat 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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.

Biology:
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).

Status:
The status of the jacknife-fish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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.

Biology:
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).

Status:
The status of the spotted drum 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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.

Biology:
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).

Status:
The status of the scorpionfishes 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”.

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).

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.

Biology:
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).

Status:
The status of the rock hind 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). This species is managed together with the coney, red hind, graysby, and creole-fish in Grouper Unit 3. The SFA Working Group classified the status of Grouper Unit 3 as “unknown”.

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.

Biology:
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).

Status:
The status of the graysby 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). This species is managed together with the coney, rock hind, red hind, and creole-fish in Grouper Unit 3. The SFA Working Group classified the status of Grouper Unit 3 as “unknown”.

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).

Biology:
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).

Status:
The status of the yellowedge grouper 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). This species is managed together with the red, black, misty, tiger, and yellowfin groupers in Grouper Unit 4. The SFA Working Group classified the status of Grouper Unit 4 as “at risk”.

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.

Biology:
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).

Status:
The status of the coney 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). This species is managed together with the red hind, rock hind, graysby, and creole-fish in Grouper Unit 3. The SFA Working Group classified the status of Grouper Unit 3 as “unknown”.

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.

Biology:
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).

Status:
The status of the red hind 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). This species is managed together with the coney, rock hind, graysby, and creole-fish in Grouper Unit 3. The SFA Working Group classified the status of Grouper Unit 3 as “unknown”.

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.

Biology:
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 2.5 m 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 8-21 m TL; females, from 3-22 m. Estimated size at maturity and age at first maturity are .98 m TL and 4.3 years, respectively (Froese and Pauly 2002). 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.

<u>Status:</u>
The lack of occurrence in sampling and catches prior to the prohibition on catch in Federal waters implemented in 1990 indicated that the Goliath grouper was severely overfished at that time (NMFS 2002). And there is no evidence of recovery in this fishery despite the long-standing moratorium. Those stocks in the region of North Carolina southward to the Gulf of Mexico were considered a candidate for listing under the ESA since 1991, but more recently were identified as a Species of Concern under the ESA (NMFS 2001a). This fish also is listed as “critically endangered” on the 1996 IUCN Red List of Threatened Species, indicating that it faces “an extremely high risk of extinction in the wild in the immediate future.” This determination is based on an observed, estimated, inferred or suspected population reduction of at least 80% over the last 10 years or three generations, whichever is the longer, based on actual or potential levels of exploitation, and a reduction of at least 80%, 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 2002).

In its 2001 report to Congress on the status of U.S. fish stocks, NOAA Fisheries reports that the U.S. Caribbean stock is overfished, but is not experiencing overfishing. These determinations are based on definitions of overfished and overfishing that were approved under pre-SFA guidelines. 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).

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).

Biology:
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).

Status:
The status of the red grouper 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). This species is managed together with the yellowedge, black, misty, tiger, and yellowfin groupers in Grouper Unit 4. The SFA Working Group classified the status of Grouper Unit 4 as “at risk”.

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).

Biology:
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).

Status:
The status of the misty grouper 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). This species is managed together with the red, black, tiger, yellowedge, and yellowfin groupers in Grouper Unit 4. The SFA Working Group classified the status of Grouper Unit 4 as "at risk".

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).

Biology:
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).

<u>Status:</u>
The lack of occurrence in sampling and catches prior to the prohibition on catch in Federal waters implemented in 1990 indicated that Nassau grouper was severely overfished at that time (NMFS 2002). There is no evidence of recovery in this fishery despite the long-standing moratorium. This species was considered a candidate for listing under the ESA since 1991, but more recently identified as a Species of Concern under the ESA (NMFS 2001b).
The Nassau grouper also is listed as "endangered" on the 1996 IUCN Red List of Threatened Species, indicating that it faces "a very high risk of extinction in the wild in the near future." This determination is based on an observed, estimated, inferred or suspected reduction of at least 50% over the last 10 years or three generations, whichever is the longer, based on (and specifying) actual or potential levels of exploitation, and a reduction of at least 50%, 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 2002).

In its 2001 report to Congress on the status of U.S. fish stocks, NOAA Fisheries reports that the Nassau grouper is overfished, but is not experiencing overfishing. These determinations are based on definitions of overfished and overfishing that were approved under pre-SFA guidelines. 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).

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).

<u>Biology:</u>
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).

Status:

The status of the butter hamlet 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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).

Biology:

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).

Status:

The status of the swissguard basslet 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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).

Biology:

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).

Status:
The status of the yellowfin grouper 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). This species is managed together with the red, black, misty, yellowedge, and tiger groupers in Grouper Unit 4. The SFA Working Group classified the status of Grouper Unit 4 as “at risk”.

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.

Biology:
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 gro ups (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).

<u>Status:</u>
The status of the tiger grouper 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). This species is managed together with the red, black, misty, yellowedge, and yellowfin groupers in Grouper Unit 4. The SFA Working Group classified the status of Grouper Unit 4 as “at risk”.

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).

<u>Biology:</u>
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).

Status:
The status of the creole-fish 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). This species is managed together with the coney, rock hind, graysby, and red hind in Grouper Unit 3. The SFA Working Group classified the status of Grouper Unit as "unknown".

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).

Biology:
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).

Status:
The status of the greater soapfish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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).

Biology:
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).

Status:
The status of the orangeback bass 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

Biology:
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).

Status:
The status of the lantern bass 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

Biology:
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).

Status:
The status of the tobaccofish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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).

Biology:
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).

Status:
The status of the harlequin bass 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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).

Biology:
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).

Status:
The status of the chalk bass 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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.

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).

Biology:
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).

Status:
The status of the Caribbean tonguefish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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*.

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).

Biology:
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 2022 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).

Status:
The status of the sea bream 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). This species is managed together with the jolthead, sheepshead and pluma porgies in the Porgy complex. The SFA Working Group classified the status of the Porgy Complex as “unknown”.

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.

Biology:
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).

Status:
The status of the jolthead porgy 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). This species is managed together with the sea bream, and the sheepshead and pluma porgies in the Porgy complex. The SFA Working Group classified the status of the Porgy Complex as “unknown”.

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.

Biology:
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).

Status:
The status of the sheepshead porgy 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). This species is managed together with the sea bream, and the jolthead and pluma porgies in the Porgy complex. The SFA Working Group classified the status of the Porgy Complex as “unknown”.

Pluma, ***Calamus pennatula***

The pluma porgy 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.

Biology:
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).

Status:
The status of the pluma porgy 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). This species is managed together with the sea bream, and the sheepshead and jolthead porgies in the Porgy complex. The SFA Working Group classified the status of the Porgy Complex as “unknown”.

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.

Biology:
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).

Status:
The status of the seahorses and pipefishes 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”.

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.

Sand diver, ***Synodus intermedius***

The sand diver occurs in the Western Atlantic, ranging from Bermuda and North Carolina (USA) to Guyana, 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).

Biology:
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).

Status:
The status of the sand diver 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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.

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).

Biology:
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).

Status:
The status of the sharpnose puffer 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

Biology:
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).

Status:
The status of the porcupinefish 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). This fish is an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

APPENDIX 1
MARINE SPECIES OVERVIEW (Source: CFMC 2004)

The following is from CFMC (2004), Chapter 5. The full reference for CFMC (2004) is as follows:

Caribbean Fishery Management Council. 2004. DRAFT 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 Draft Supplemental Environmental Impact Statement, Regulatory Impact Review, and Regulatory Flexibility Act Analysis. 14 July 2004. CFMC, San Juan, Puerto Rico, NOAA Fisheries, Southeast Regional Office, St. Petersburg, Florida.

B. HARVESTABLE INVERTEBRATE SPECIES

This section summarizes the available information on the biology, life history, and status of Caribbean Council-managed species. NOAA Fisheries' 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.* (1996), "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).

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.

Biology:

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 (1974a) 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 eburneus*) settle on the carapace of large specimens and could serve as indicators of habitat and of the intermolt period (Munro 1974a).

Status:
The United Nations Food and Agriculture Organization (FAO) (1997) reports that the spiny lobster is considered to be overexploited throughout much of its range. Fisheries throughout the Western Central Atlantic have experienced a substantial decrease in catch per unit effort over the

years, suggesting that this species has declined in abundance throughout at least a portion of its range (Bowen 1980; Marx and Herrnkind 1986; Quinn and Kojis 1997). NMFS (1999a) has expressed a need to identify the actual sources of all stocks (both U.S. and foreign) and to establish an international management regime to prevent overfishing.

The U.S. Caribbean stock was last assessed in 1990. The findings of that assessment, reported by Bohnsack *et al.* (1991), indicated that total landings in Puerto Rico had declined over 70% between 1979 and 1989, and that a large number of undersized lobsters were landed in Puerto Rico. The authors noted that growth overfishing appeared to be a significant problem in Puerto Rico, but that recruitment overfishing did not appear to be a problem at the level of fishing effort exerted at that time, based on calculated levels of spawning potential. The assessment team concluded that improving compliance with the minimum size limit in Puerto Rico was the most obvious management action to increase the productivity of the spiny lobster fishery. Matos-Caraballo (1995) reported that about 43% of the spiny lobster taken in Puerto Rico waters from 1992 to 1994 were below the minimum size - 36% of the males; 48% of the females. The report concluded that the spiny lobster fishery in the USVI appeared healthy (Bohnsack *et al.* 1991). But an updated assessment of the St. Croix fishery suggests that the spiny lobster resource is overfished in those waters (Mateo and Tobias 2001). Noting that the results of that assessment may contain errors as a consequence of biases in the data and violations of assumptions during analysis, Mateo and Tobias (2001) suggest that fishing pressure be reduced considerably in waters around St. Croix. These findings are consistent with those of Quinn and Kojis (1997), who reported that fishermen in the USVI must exert more effort to catch the same quantity of lobsters, and that older fishermen in the USVI have noted a considerable decline in abundance, particularly in shallow coastal habitats.

In its 2001 report to Congress on the status of U.S. fish stocks, NOAA Fisheries reports that the Caribbean spiny lobster is neither overfished nor approaching an overfished condition, and that overfishing is not occurring on this species. Those determinations were based on definitions of overfished and overfishing that were approved under pre-SFA guidelines. Under these definitions, a spiny lobster stock or stock complex is overfished when it is below the level of 20% of the Spawning Potential Ratio (SPR). When a spiny lobster stock or stock complex is overfished, overfishing is defined as the harvesting rate that is not consistent with a program that has been established to rebuild the stock or stock complex to the 20% SPR. When a spiny lobster stock or stock complex is not overfished, overfishing is defined as a harvesting rate that, if continued, would lead to a state that would not allow harvest at optimum yield (OY) on a continuing basis (NMFS 2002). The SFA Working Group classified the status of the spiny lobster as "unknown".

For more information on spiny lobster biology, fishery, and status in the Caribbean and U.S. Virgin Islands, refer to the following papers: Acosta (1999), Beets (1996), Bohnsack et al. (1991), Bolden (2001), Boulon (1987), Brandon (1983), Clavijo (1986), Cooper et al. (1975), Davis and Dodrill (1979), DFW (1982), Gordon and Vasques (2004), Herrnkind et al. (1975), Keithly and Garcia-Moliner (1998), Kojis et al. (2003), Maidment (1997, 2001), Mateo and Tobias (2002), Olsen (undated), Olsen et al. (1975), Olsen and Koblic (1975), Quinn and Kojis (1995, 1997), Tobias (1990, 1994), and Villegas et al. (1982).

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.

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.

Biology:
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 atmaturation 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).

<u>Status:</u>
The queen conch resources of Puerto Rico and the USVI have been reported as overfished and in decline since the late 1970s (Valle-Esquivel 2002a). Most who have studied queen conch resources in the Caribbean believe overfishing has been a significant problem since the late 1960s. In many areas, fishermen themselves have acknowledged overfishing as a serious problem, and indicated that the resource is noticeably declining (CFMC 2002c).

Concern with the status of the stock encouraged the Caribbean Council and NOAA Fisheries to analyze the queen conch landings statistics and to review and implement fisheries-independent surveys to assess stock abundance, age, and size composition, and fishing effort (Valle-Esquivel

2002a). In addition, 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).

A more recent assessment conducted by Valle-Esquivel in 2002 used fishery-dependent catch and effort data from 1983-2001 to develop relative indices of abundance for queen conch in the U.S. Caribbean. That report concludes that the queen conch resource in the U.S. Caribbean is experiencing overfishing, but is only just approaching an overfished condition. But the author indicates this conclusion is very optimistic, noting that the time series used in the assessment was constrained by the available data and that "the first years of the assessment do not represent, by any means, the early part of the fishery, when indeed, population levels relative to the virgin biomass must have been high." She indicates that, had the assessment accurately reflected the status of the stock in 1983, it would likely have generated a finding of overfished (Valle-Esquivel 2002b). In addition, that assessment did not consider recreational landings, which were estimated to be about 50 percent of commercial catch (Valle-Esquivel pers. comm.).

In its 2001 report to Congress on the status of U.S. fish stocks, NOAA Fisheries reports that the queen conch is overfished and that overfishing is occurring on this species. These determinations are based on definitions of overfished and overfishing that were approved under pre-SFA guidelines. Under these definitions, a queen conch stock is overfished when it is below the level of 20% of the spawning stock biomass per recruit (SSBR) that would occur in the absence of fishing. When a queen conch stock is overfished, overfishing is defined as harvesting at a rate that is not consistent with a program that has been established to rebuild the stock to the 20% SSBR level. When a queen conch stock is not overfished, overfishing is 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 (NMFS 2002).

The queen conch was listed in Appendix II of CITES on November 6, 1992, which means this species is protected through regulation of international trade in live specimens, parts and derivatives. Appendix II lists species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled. Rhines (2000) reports that their numbers are declining now more than ever. In the Bahamas, for example, it is believed that deep water populations sustain the smaller shallow water populations.

For more information on queen conch biology, fishery, and status in the Caribbean and U.S. Virgin Islands, refer to the following papers: Appeldoorn (undated, 1987, 1992, 1994), Wood and Olsen (1982), Beets and Appeldoorn (1994), Tobias (1987), Friedlander and Caseau (1997), Garcia-Moliner (undated), Stoner (1997), Chakalall and Cochrane (undated), CITES (2003), Boulon (1987), Valle-Esquivel (2002a, 2002b), Friedlander (1997), Posada and Appeldoorn (1994), Randall (1964a), and Gordon (2002).

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 commercial fisheries conservation strategies section) is to move them to a monitoring-only category.

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).

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).

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).

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).

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).

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).

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).

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).

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).

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).

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).

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

Whelks (*Cittarium pica*), also called the West Indian Topshell, are large snails that occur in shallow rocky habitats throughout the USVI. Their large size (to ~ 4 inches wide) and tasty flesh make them a popular and traditional meal. In fact, whelks were an important part of the island diet since before Columbus—the Taino Indians ate whelk quite frequently judging by their shell middens. These days, whelks are still eaten regularly and a modest recreational and commercial fishery makes whelks the second most important marine snail, behind the queen conch (*Strombus gigas*), in the USVI (Toller, 2003b).

Whelk shells are hard and heavy—about ¾ of a whelk's weight is in its shell—making the shell quite durable. These sturdy shells resist destruction by waves and, as a result, are commonly found by beachcombers along our shorelines. In addition to delighting shell collectors, the attractive shell pattern with alternating white and black bands has inspired the use of whelk shells in Caribbean jewelry (Toller, 2003b).

Biology:
Although a whelk shell is easy to observe, the living animal found inside is harder to see, with most of it safely tucked deep inside the shell. Usually, only two parts are exposed. The first is a muscular foot, which allows the whelk to firmly grip onto rocks, resist crashing waves, and crawl around [when whelk are eaten, it is the foot that forms most of the meal]. The other exposed part is the head, which includes two stalked eyes and a snout (called a proboscis). At the end of the proboscis is a small, hard, tooth-like structure called a radula. A whelk uses its radula to scrape algae from rocks. When threatened, a whelk can withdraw completely into its shell, closing the opening with a trapdoor-like operculum (Toller, 2003b).

Whelks are found throughout the Caribbean, ranging from the Bahamas to the central coast of South America. Whelks live in rocky areas along the seashore in a habitat known as the intertidal zone. The intertidal zone is the shoreline that extends from highest high tide down to the lowest low-water line. Whelk habitat is like a narrow band running along the shoreline, and it does not extend very deep—most whelks are found immediately at the water's edge. Large adult whelks may occur slightly deeper, but generally not below about three feet deep. Whelks seem to prefer areas with some wave action. In such wave-washed rocky areas, whelks occupy a slightly greater depth range (Toller, 2003b).

Food preference is the main reason whelks are restricted to the intertidal zone. Whelks like to eat filamentous algae—thin strands of seaweed—that grow abundantly on intertidal rocks, especially where surf prevents fish from feeding on the shallow beds of algae (Toller, 2003b).

Whelks grow slowly. If there is plenty of good food, their shell width increases by about 1/16 of an inch (1.5 mm) per month. It may take a whelk five years to reach the large size of reproductive adults and scientists still don't know how long whelk can live (Toller, 2003b).

Whelks reproduce mostly in the late summer around the new moon. Females release small green eggs (~ 1/100 of an inch wide) that are fertilized by the sperm released simultaneously by males.

The fertilized eggs drift away in the ocean currents, developing rapidly into a larval stage called a veliger. Free-swimming veligers feed on microscopic algae called phytoplankton. After 3 to 5 days, ocean currents bring the larvae to suitable rocky shores where they settle and remain for the rest of their lives (Toller, 2003b).

Status:
After a cursory review of the literature, there appears to be extremely limited scientific information on whelk. As long ago as the late 1970s, it was reported that whelk numbers in the USVI "were a fraction of even recent historical abundance" (Mudre et al., 1981).
In 2001 the St. Thomas/St. John Fisheries Advisory Committee (FAC) noted that whelk stocks and landings were way down and that harvest of this species be stopped to allow stocks to recover. Based on preliminary commercial landings statistics at that time, whelk landings for the USVI appeared to be rather limited (about a ton annually). The price of whelk was very good ($8/pound in St. Thomas and $10/pound in St. Croix). A public meeting with St. Thomas/St. John commercial fishers was held in late-2001. During this meeting, it was apparent that whelk information was lacking. In addition, there had never been any assessment of whelk stocks in the USVI. Prior to considering extreme management measures such as closure of the whelk fishery, it is appropriate to assess local whelk stocks. In response to this need, the USVI Division of Fish and Wildlife undertook, and just completed, a study to assess local whelk stocks (Caribbean/NMFS Cooperative SEAMAP Whelk and Finfish Assessment Project), however, at this time, the data has yet to be analyzed and written up. The whelk stock assessment will provide the first baseline information on the size distribution and density of whelk stocks in the USVI. Information collected will be the foundation for any whelk management actions. Results of this survey will also provide the basis for future time series studies on the whelk stocks in the USVI.

Low densities of large snails in accessible areas near population centers have often been attributed to heavy fishing (Clench and Abbott, 1943; Mudre, 1979; Olsen, 1982).

Ecological Role:
Whelks are generally sedentary, meaning they don't go far in their lifetimes. The longest trip recorded for a whelk was about 160 yards over 6 months. Most of their movements occur at night, when whelks actively crawl about in search of something to eat. By day, they tend to remain in holes or crevices. This sedentary behavior, plus slow growth and a short larval stage, makes local populations of whelks vulnerable to overfishing (Toller, 2003b).

Without doubt, people are the number one predators on whelks, but whelks have many natural predators as well. Three shallow water snails prey upon whelk: the wide-mouthed rock shell (*Pupura patula*), the deltoid rock drill (*Thais deltoidea*), and the rustic rock drill (*Thais rustica*). Some fish also eat whelk. The porcupine fish (*Diodon hystrix*) eats whelks, as will larger Puddingwife wrasses (*Halichoeres radiatus*). Octopuses regularly prey upon whelks, and a bird called the oystercatcher (*Haematopomus palliates*) plucks whelks off of intertidal rocks (Toller, 2003b).

Some organisms depend upon whelks. Dwarf suck-on limpets (*Acmea luecopluera*) can be found living on the undersurface of the whelk shells. After a whelk's death, their empty shells provide homes for hermit crabs. In fact, following whelk extinctions in Bermuda, purple-clawed hermit crabs (*Coenobita clypeatus*) began to die off. Lack of whelk shells apparently created a housing shortage for these hermit crabs (Toller, 2003b).

For more information on whelk biology, fishery, and status in the Caribbean and U.S. Virgin Islands, refer to the following papers: Boulon (1987) and Randall (1964b).

APPENDIX 1
MARINE SPECIES OVERVIEW (Source: CFMC 2004)

The following is from CFMC (2004), Chapter 5. The full reference for CFMC (2004) is as follows:

Caribbean Fishery Management Council. 2004. DRAFT 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 Draft Supplemental Environmental Impact Statement, Regulatory Impact Review, and Regulatory Flexibility Act Analysis. 14 July 2004. CFMC, San Juan, Puerto Rico, NOAA Fisheries, Southeast Regional Office, St. Petersburg, Florida.

C. NON-HARVESTABLE SPECIES

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 the harvested species section), 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.

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*.

Biology:

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 for the clarity of the water above the reef (Sefton and Webster 1986).

Status:
The status of the sponges has not been assessed relative to the pre-SFA definition of overfishing. Under that definition, the stocks are experiencing overfishing when annual catch exceeds OY. No definition of overfished has been developed for these stocks (NMFS 2002). These invertebrates are aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as “unknown”.

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).

Hydrocorals, Class Hydrozoa

Biology:
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).

<u>Status:</u>
In its 2001 report to Congress on the status of U.S. fish stocks, NOAA Fisheries reports that the hydrocorals are not experiencing overfishing based on the definition of overfishing that was approved under pre-SFA guidelines. Under that definition, the 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 did not make a determination on the status of the hydrocorals in large part due to the fact that the take or possession of those species has been prohibited under the Caribbean Council's Coral FMP for numerous years (CFMC 1994).

Anthozoans, Class Anthozoa

The second class of Coelenterata in the management unit, anthozoans include black corals (Order Antipatharia), gorgonians, sea fans (Sub-class Octocoralia), sea anemones and other similar organisms (Orders Actinaria, Zoanthidea and Corallimorpha), as well as the true reef-building corals (Order Scleractinia) (CFMC 1994). Anthozoans has its life cycle restricted to the polyp phase exclusively, with no medusa stage occurring. They typically attach to a substrate and have the oral end expanded into a flattened oral disk. A calcareous skeleton may be constructed.

Further, a planula larvae may be produced, which is capable of being transported some distance by ocean currents.

Octocorals, Orders Alcyonacea and Gorgonacea

Due to the large numbers of species in these two orders, please refer to Table 4 for a list of all managed species. The following discussion on octocoral biology is offered to represent the order.

<u>Biology:</u>
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.

Status:
In its 2001 report to Congress on the status of U.S. fish stocks, NOAA Fisheries reports that the octocorals are not experiencing overfishing based on the definition of overfishing that was approved under pre-SFA guidelines. Under that definition, the 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 did not make a determination on the status of the octocorals. The take or possession of gorgonian species is prohibited under the Caribbean Council's Coral FMP, while species included in the order Alcyonacea are not currently prohibited from harvest (CFMC 1994).

Anemones, Orders Actiniaria and Zoanthidea

Biology:
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.

Status:
In its 2001 report to Congress on the status of U.S. fish stocks, NOAA Fisheries reports that the Actinarians and Zoanthids are not experiencing overfishing based on the definition of overfishing that was approved under pre-SFA guidelines. Under that definition, the stocks are experiencing overfishing when annual catch exceeds OY. Anemones are an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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.

Biology:

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 *Montastraea 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 is common throughout the Caribbean, but is rare below 20 m (Colin 1978).

Status:
This order contains the most endangered corals in Puerto Rico and the USVI (Goenaga and Boulon 1992). In its 2001 report to Congress on the status of U.S. fish stocks, NOAA Fisheries reports that the hard corals are not experiencing overfishing based on the definition of overfishing that was approved under pre-SFA guidelines. Under that definition, the 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 did not make a determination on the status of the hard corals. The take or possession of these species is prohibited under the Caribbean Council's Coral FMP (CFMC 1994).

On March 4, 2004, NOAA Fisheries received a petition from the Center for Biological Diversity requesting NOAA Fisheries to list three Caribbean acroporids (elkhorn coral, staghorn coral, and fused-staghorn coral) as endangered or threatened, and to designate critical habitat under the ESA. On June 23, 2004, NOAA Fisheries announced its finding that the petition presented substantial scientific and commercial information indicating listing of the three acroporids may be warranted (69 FR 34995). NOAA Fisheries is now initiating a status review per Section 4(b)(3)(A) of the ESA. These three species are now considered to be candidate species (69 FR 19976; April 15, 2004). Within one year of the receipt of the petition

(March 4, 2005), NMFS must make a finding as to whether listing the elkhorn coral, staghorn coral, or fused-staghorn coral as endangered or threatened under the ESA is warranted , as required by Section 4(b)(3)(B) of the ESA. If warranted, NMFS will publish a proposed rule and take public comment before developing and publishing a final rule.

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).

Biology:
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).

Status:
In its 2001 report to Congress on the status of U.S. fish stocks, NOAA Fisheries reports that the black corals are not experiencing overfishing based on the definition of overfishing that was approved under pre-SFA guidelines. Under that definition, the 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 did not make a determination on the status of the black corals. The take or possession of these species is prohibited under the Caribbean Council's Coral FMP (CFMC 1994).

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).

Biology:
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.

Status:
In its 2001 report to Congress on the status of U.S. fish stocks, NOAA Fisheries reports that the false corals are not experiencing overfishing based on the definition of overfishing that was approved under pre-SFA guidelines. Under that definition, the stocks are experiencing overfishing when annual catch exceeds OY. No definition of overfished has been developed for these stocks (NMFS 2002). The false corals are an aquarium trade species. The SFA Working Group classified the status of the Aquarium Trade Species Complex as "unknown".

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.

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. 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 following offers biological information on these remaining groups.

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.

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. 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*).

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. They 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 mantis 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.

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.

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 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 and most species are widespread in their distribution.

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).

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).

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.

<u>Biology:</u>
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).

<u>Status:</u>
In its 2001 report to Congress on the status of U.S. fish stocks, NOAA Fisheries reports that the seagrasses are not experiencing overfishing based on the definition of overfishing that was approved under pre-SFA guidelines. Under that definition, the stocks are experiencing overfishing when annual catch exceeds OY. No definition of overfished has been developed for seagrass (NMFS 2002).

Other affected species

Protected species

Protected species under the ESA, MMPA, and MBTA include various species of cetaceans, sea turtles, and other animals, such as the West Indian manatee. 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.

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, Mignucci-Giannoni et al 1999). 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 (Roden and Mullin 2000; Mignucci-Giannoni 1998; Mignucci-Giannoni *et al.*

1999).

Mignucci-Giannoni (1998) 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 1998. 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), 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 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 *et al.* (1999) and Schwarts *et al.* (2001). More general information on the biology and status of marine mammals may be found in Perry *et al.* (1999) and on NOAA Fisheries' website: http://www.nmfs.noaa.gov/prot_res/PR2/Stock_Assessment_Program/individual_sars.html.

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).

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; Stevick *et al.* 1998 in Waring *et al*. 2002). 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; Whitehead and Moore 1982; Mattila *et al.* 1989, 1994 in Waring *et al*. 2002). Humpback whales are also found at much lower densities throughout the remainder of the Antillean arc, from Puerto Rico to the coast of Venezuela (Winn *et al.* 1975; Levenson and Leapley 1978; Price 1985; Mattila and Clapham 1989 in Waring *et al*. 2002). 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 1991c).

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 *et al.* 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 in Waring *et al*. 2002). 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).

<u>Status:</u>
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 Year 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 19th century. Observed densities were one or two orders of magnitude lower than those recorded from the primary wintering areas in the eastern Greater Antilles.

Sperm Whale, ***Physeter macrocephalus***

Sperm whales are typically found throughout the world's oceans in deep waters between about 60^{o} N and 60^{o} S latitudes (Leatherwood and Reeves 1983; Rice 1989). 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.* (1993) 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).

Biology:

Sperm whales are the largest of the odontocetes (or toothed whales). Males reach a length of 18.3 m, with fem ales 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).

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 (IWC Committee for Whaling Statistics 1959-1983). 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.* 1997; Blaylock *et al.* 1995). 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).

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 in Geo-Marine, Inc. 2001). 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).

<u>Biology:</u>
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 approximately 1.47 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).

<u>Status:</u>
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, NOAA Fisheries 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.

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).

<u>Biology:</u>
The sei whales is the third largest baleen 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 (Rice 1977 and Lockyer and Martin 1983 in Perry *et al.* 1999).

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.* 1984c in Perry *et al.* 1999).

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 NOAA Fisheries 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).

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 (FWS 2003a).

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 (FWS 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 lifetime 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 (FWS 2003a).

<u>Status:</u>
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 2002).

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 (FWS 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 (FWS 2003a).

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 1998). 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. NOAA Fisheries 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.

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 Guyana), 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.

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), Eckert (1999) 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. 2001j), 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).

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 (2001), the nesting aggregation in French Guyana 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 Guyana coast (NMFS 2001). 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.

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. NOAA Fisheries 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.

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 1999). Females nest an average of 3-5 times per season (Meylan and Donnelly 1999; Richardson *et al.* 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; Mayor *et al.* 1998; Leon and Diez 2000).

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 1999). 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 1999; 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 1999).

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 NOAA Fisheries' 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 FWS 1991). 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). NOAA Fisheries 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.

<u>Biology:</u>
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 1991).

Age at sexual maturity is estimated to be between 20-50 years (Balazs 1982; Frazer and Ehrhart 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 1982). 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 FWS 1991a).

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, (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.* 1998).

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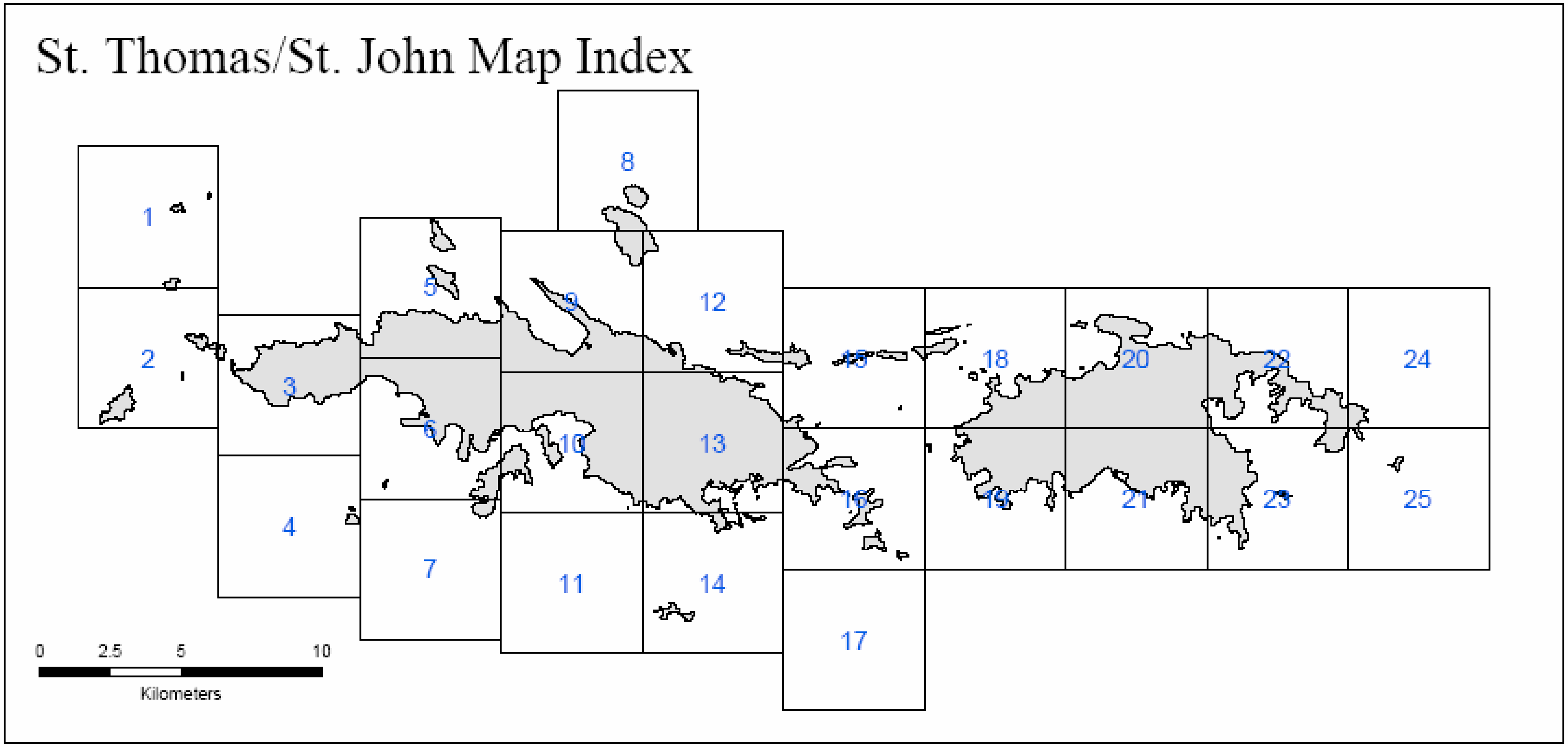

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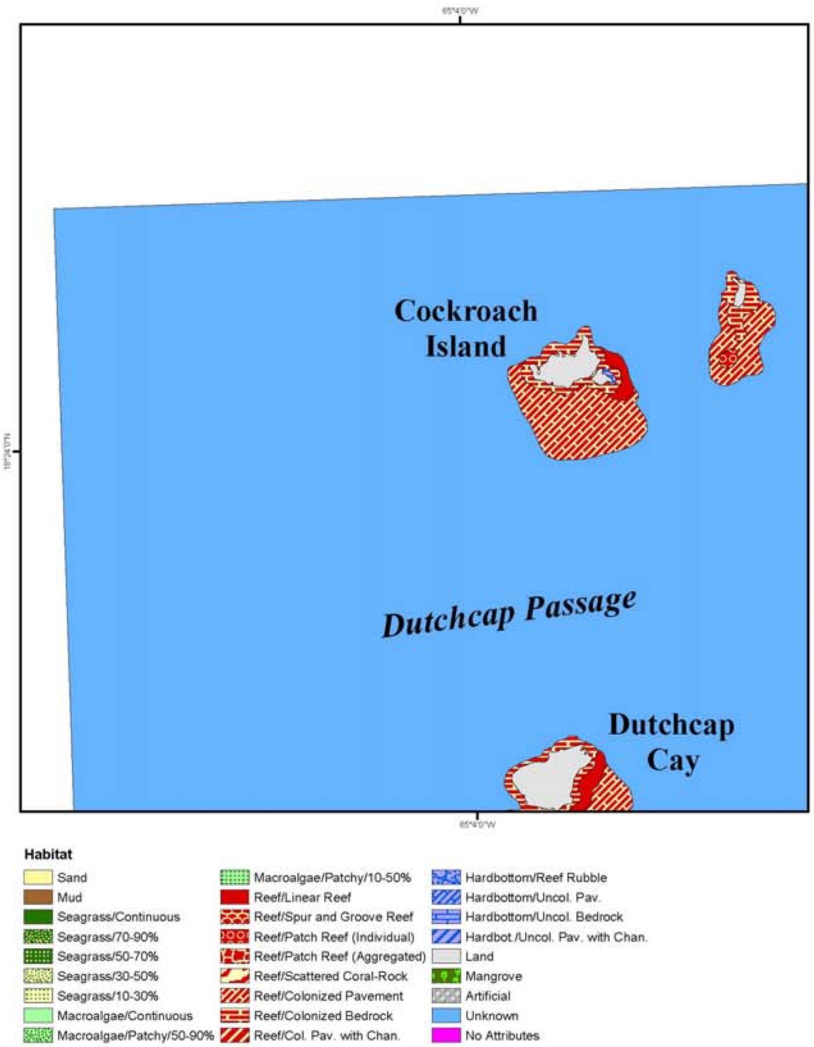

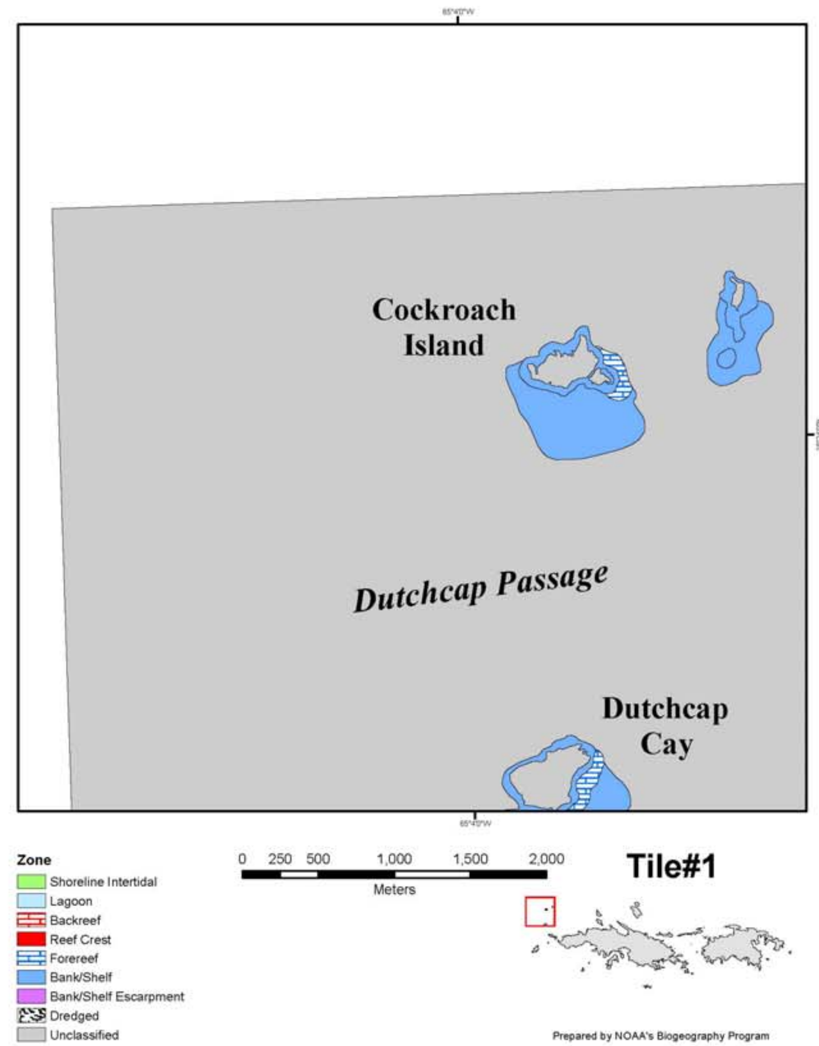

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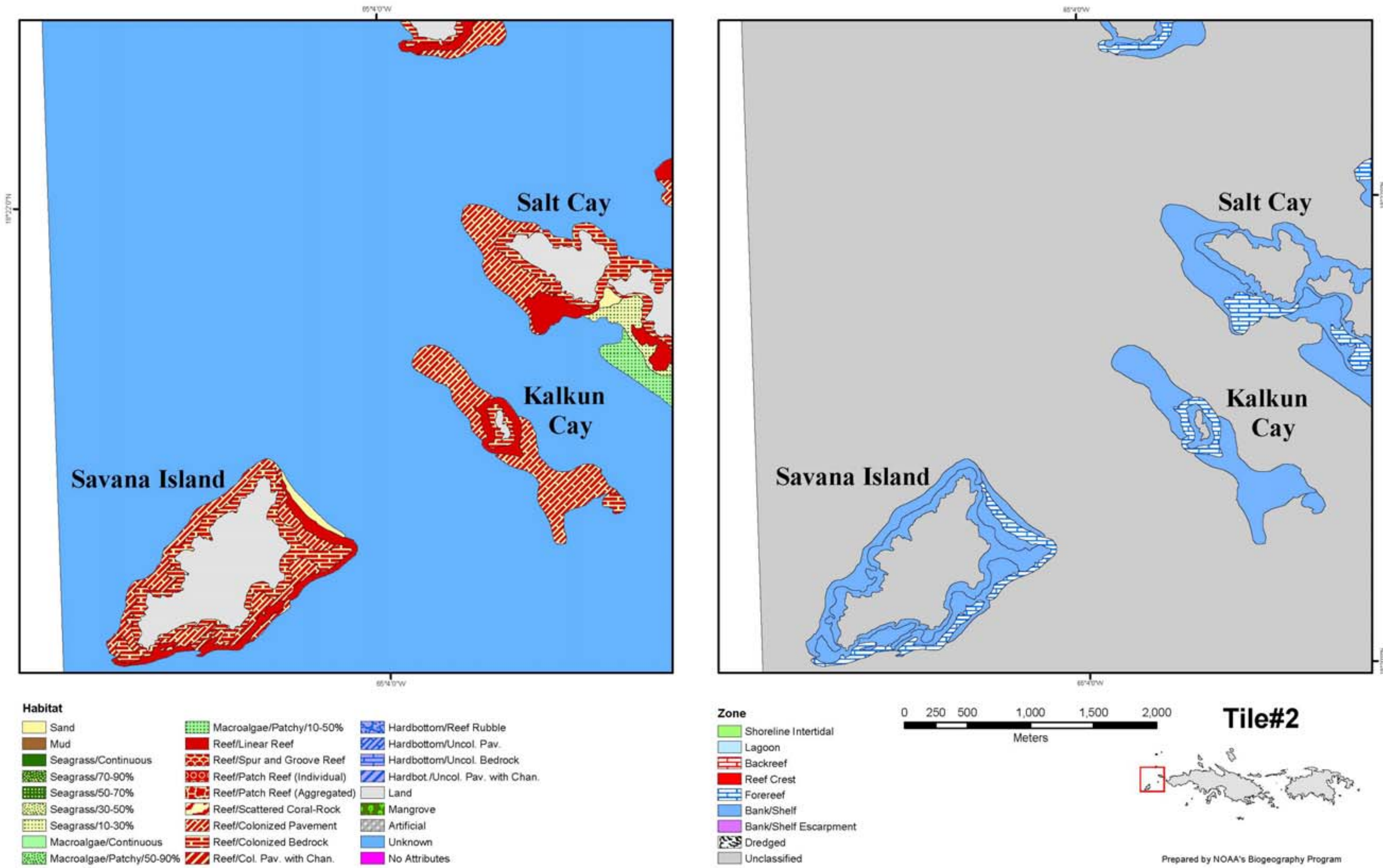

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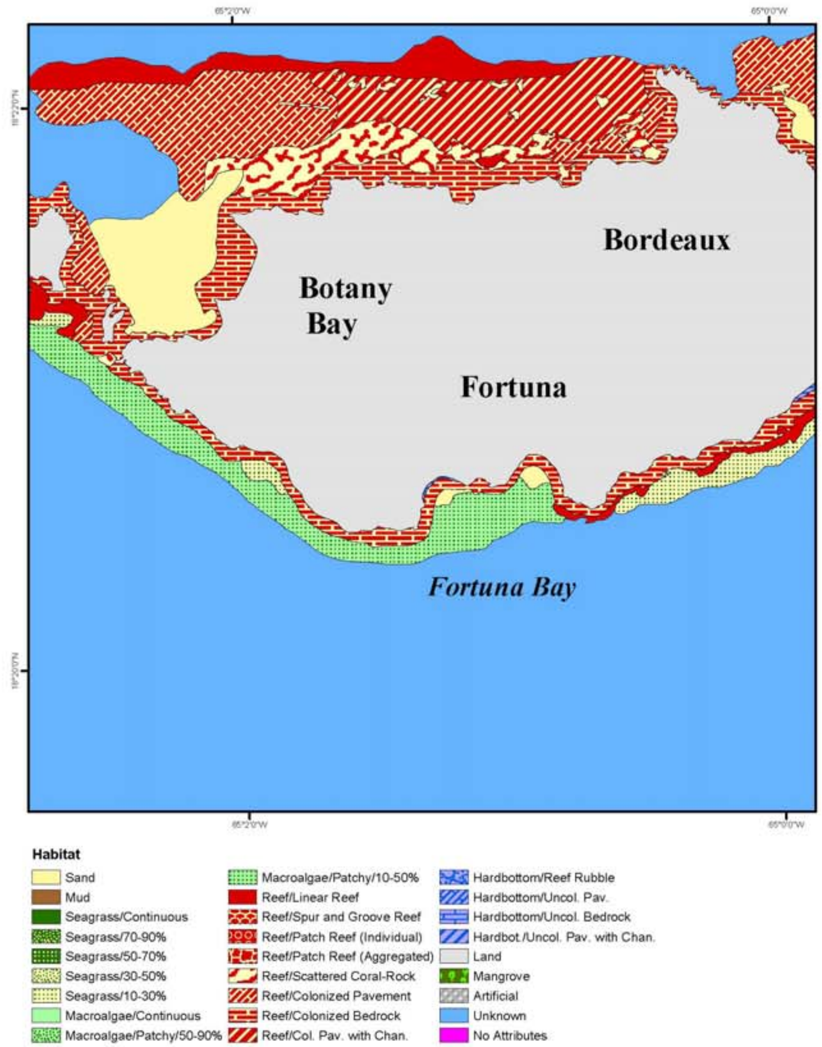

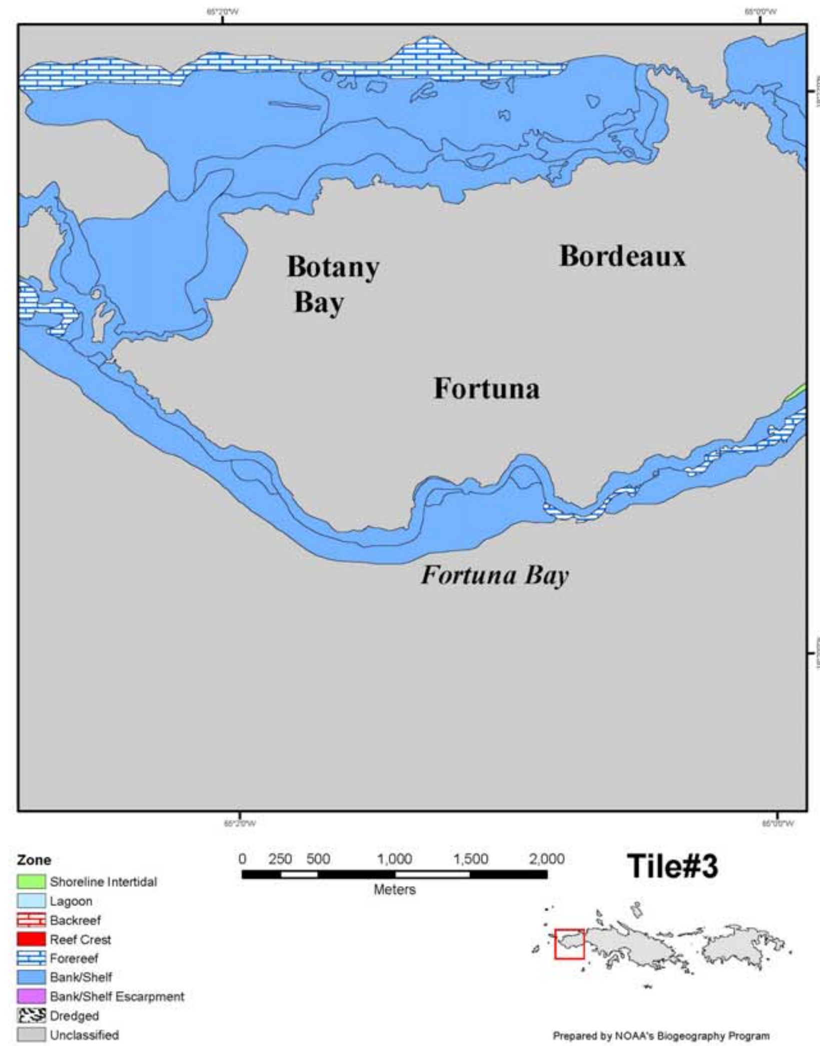

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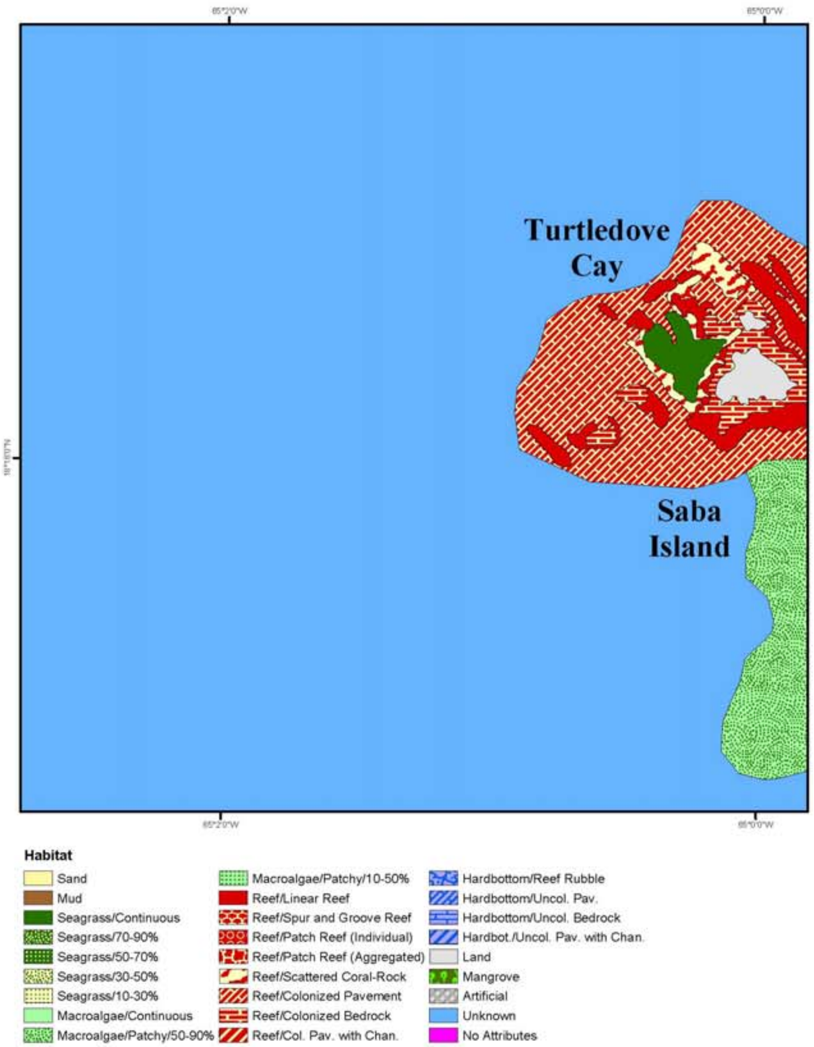

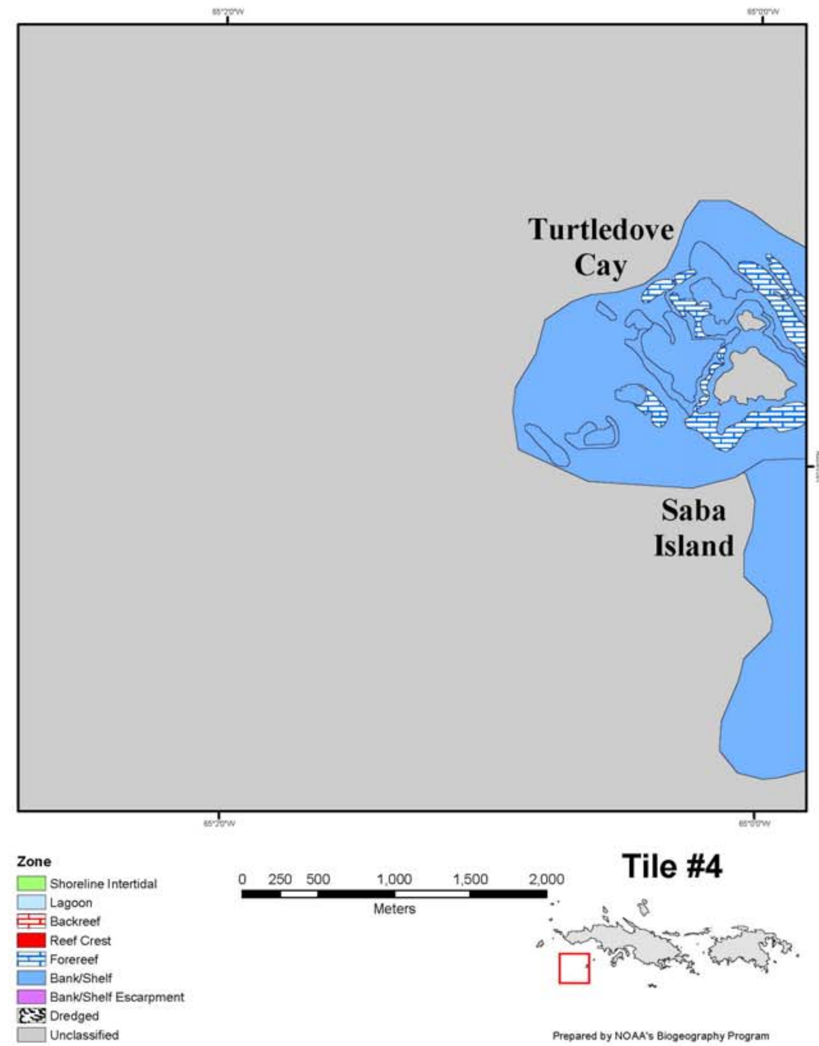

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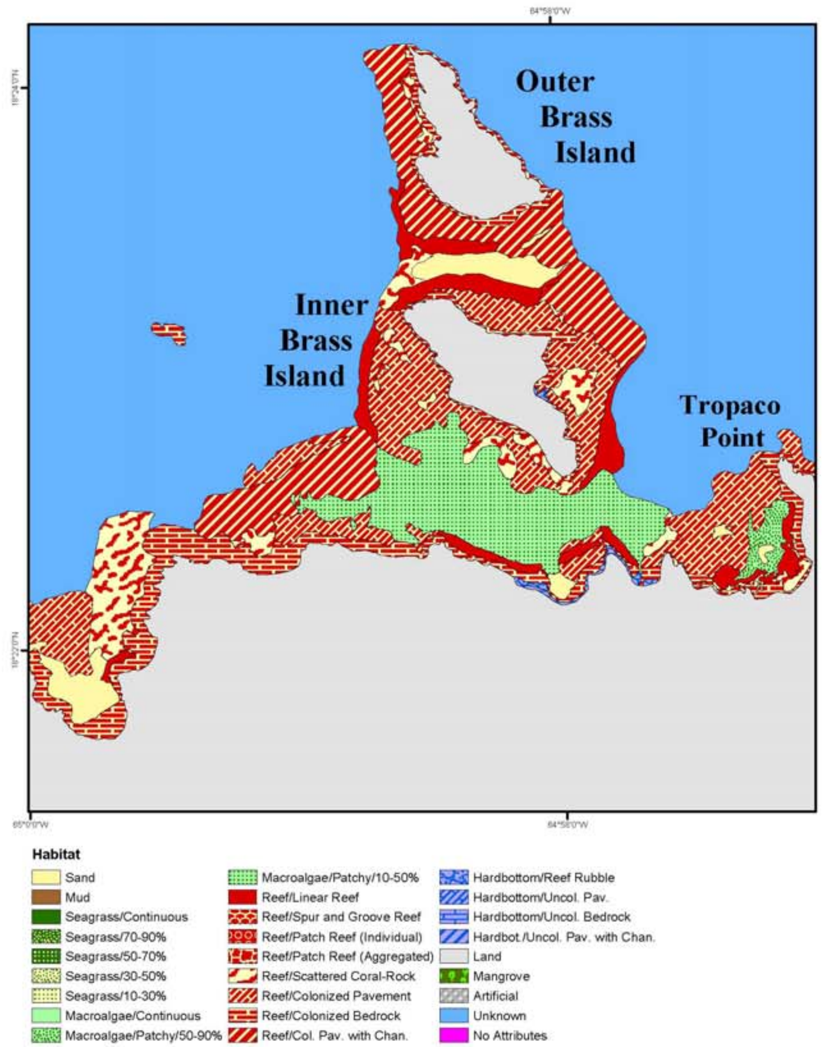

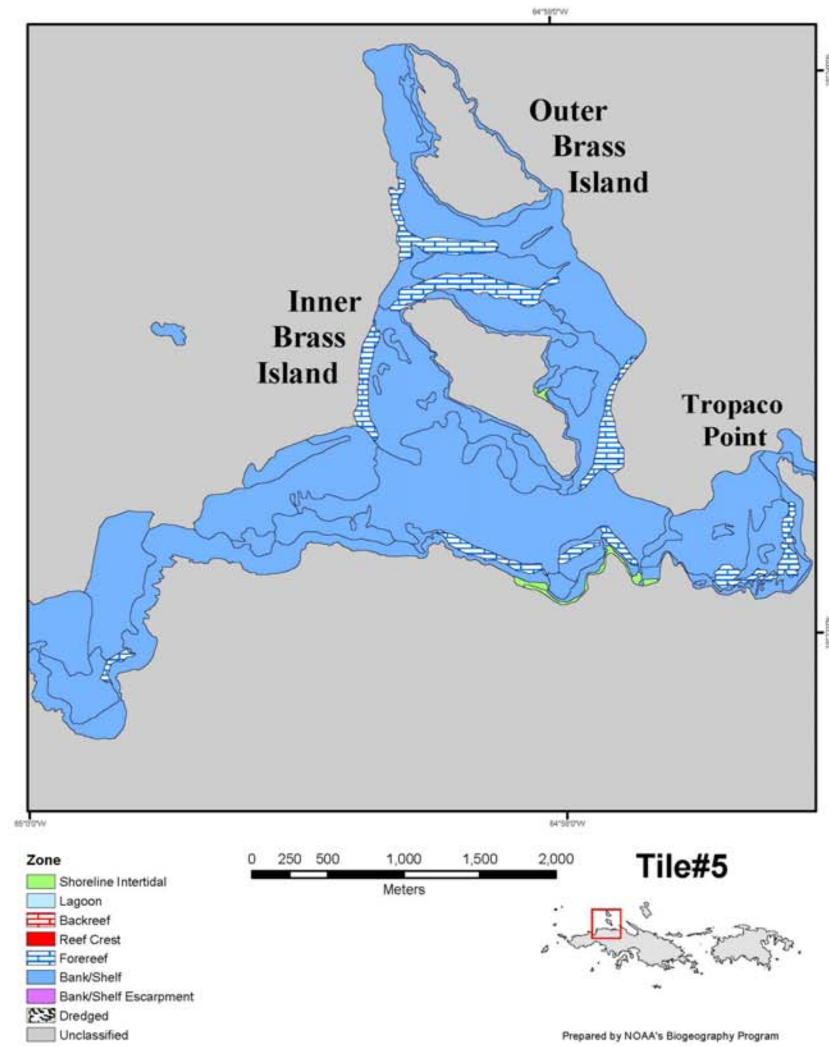

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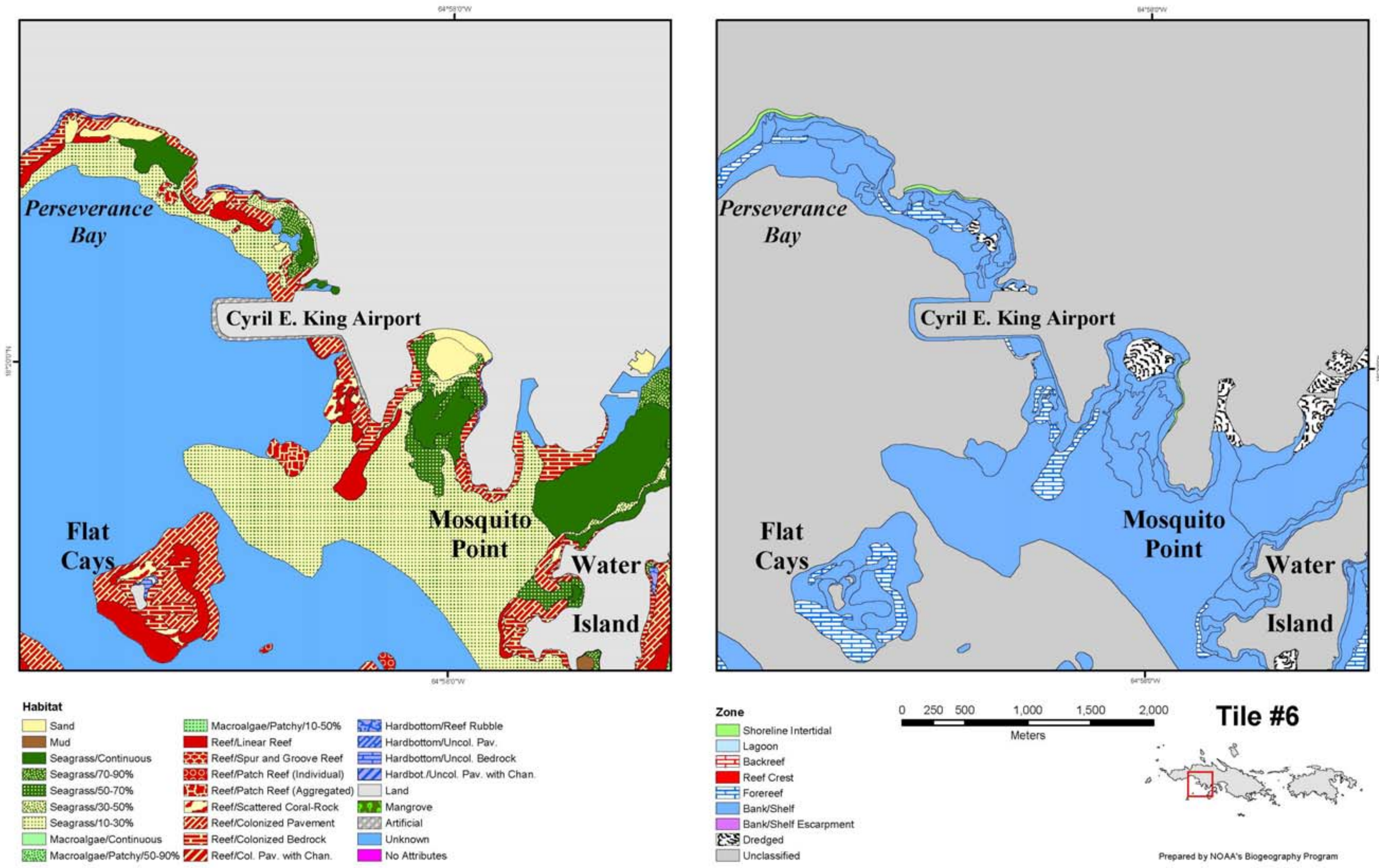

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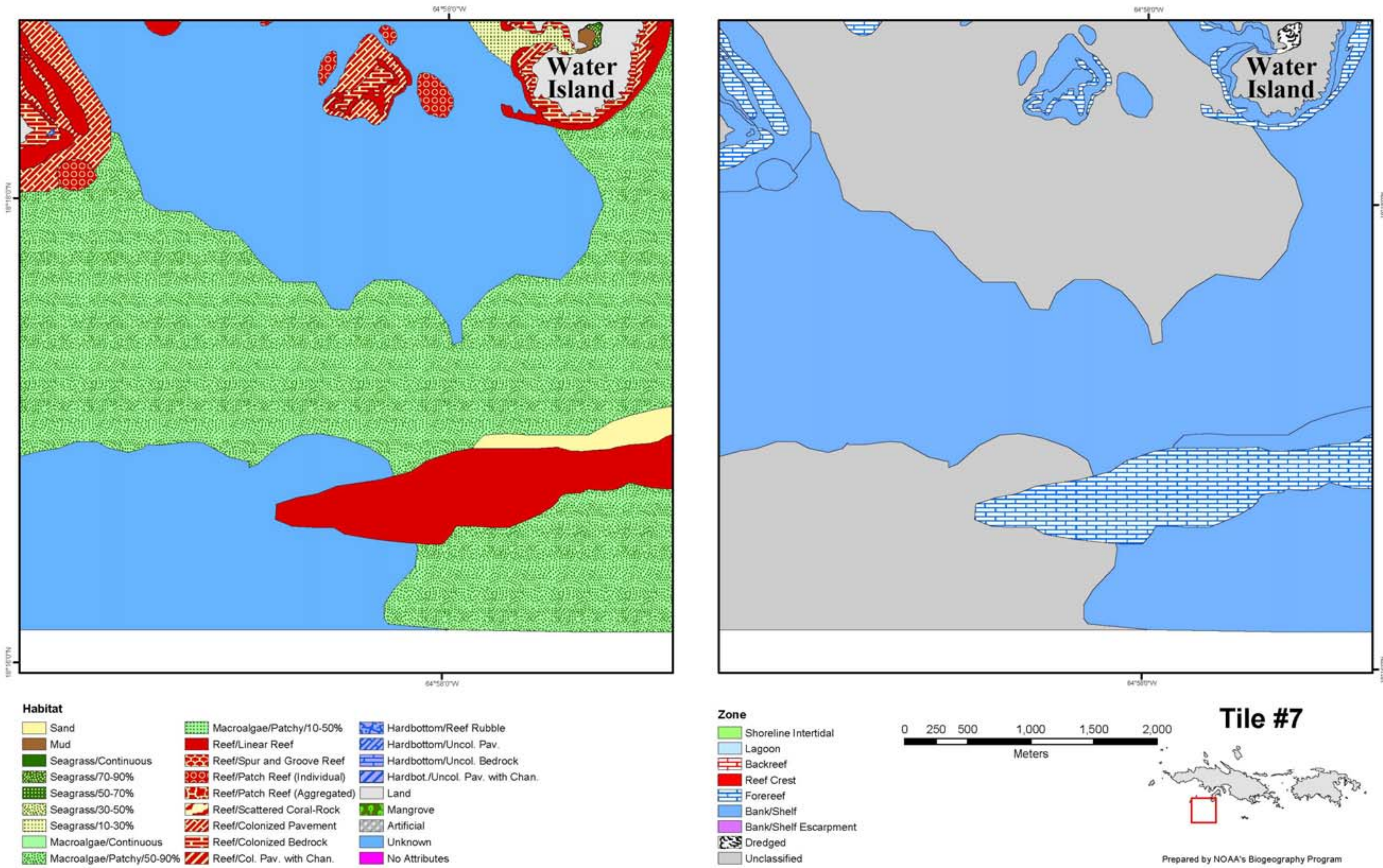

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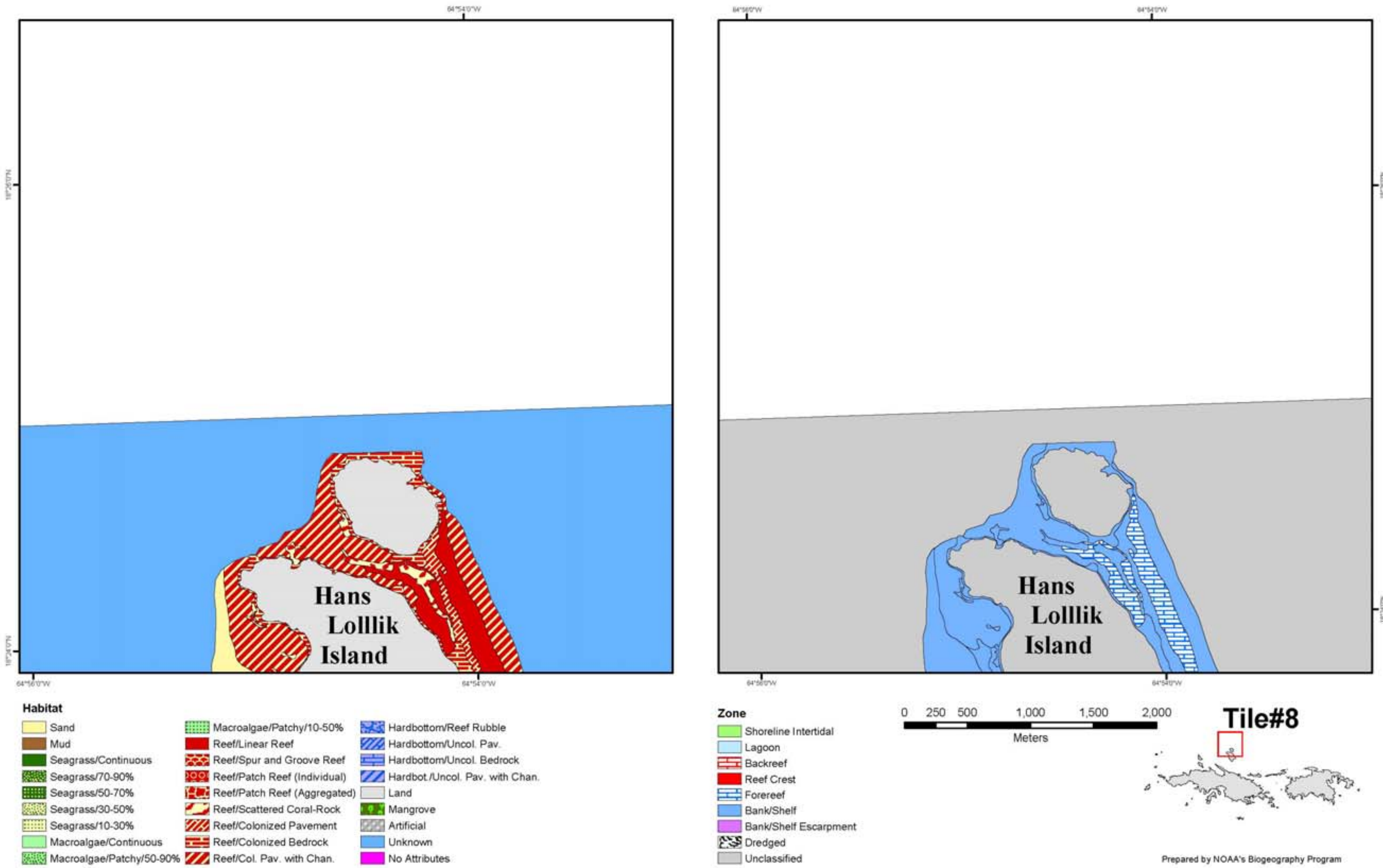

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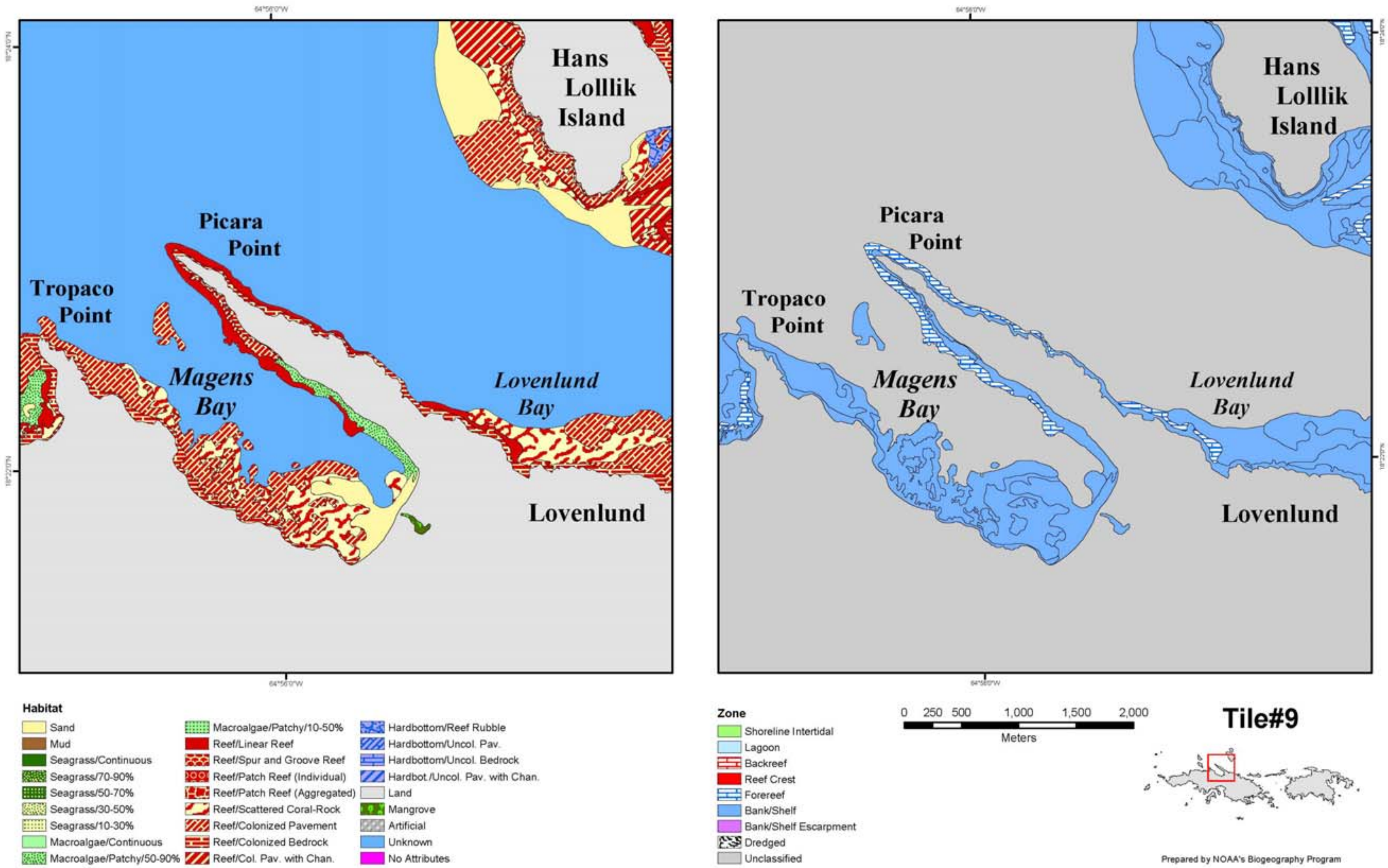

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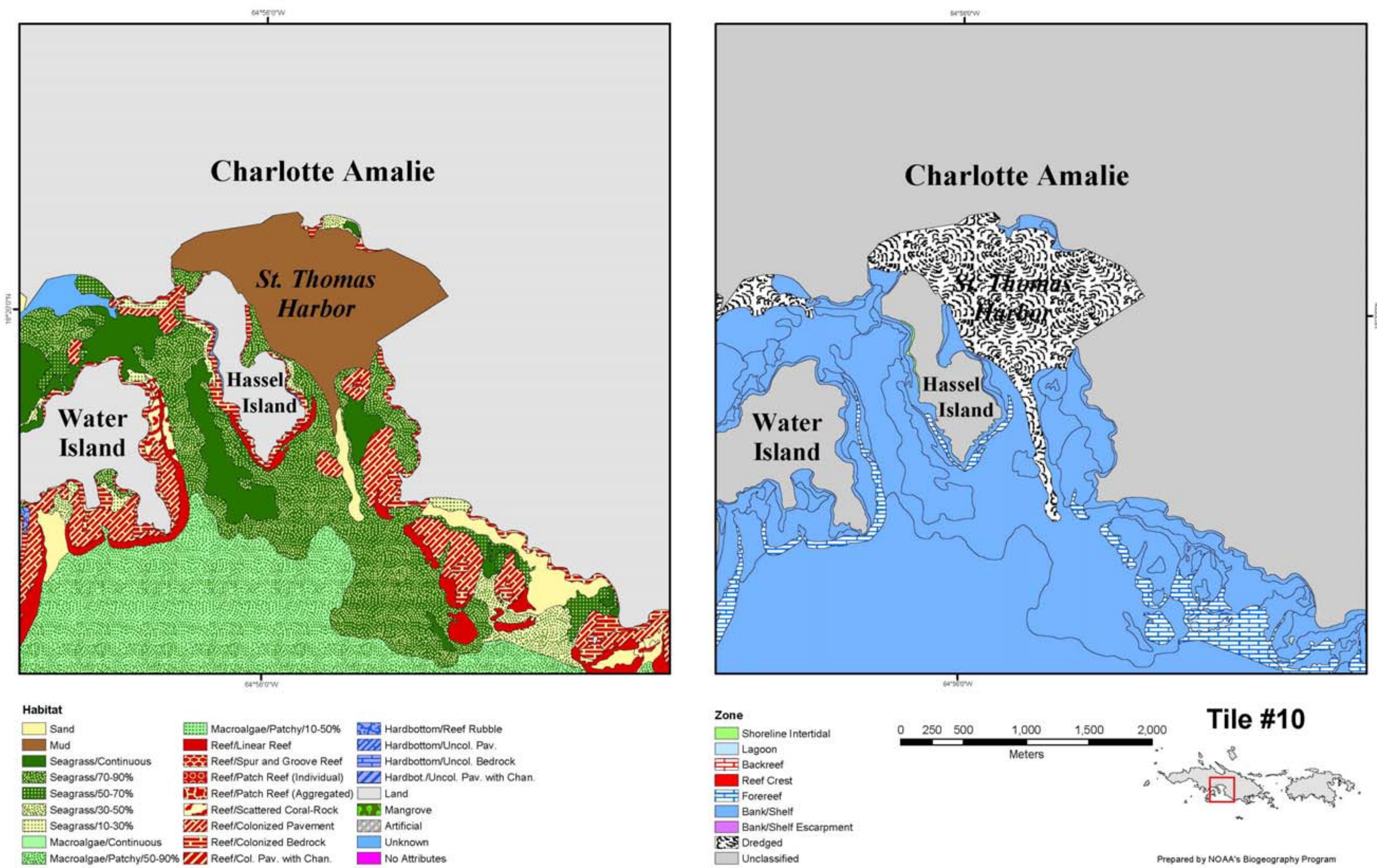

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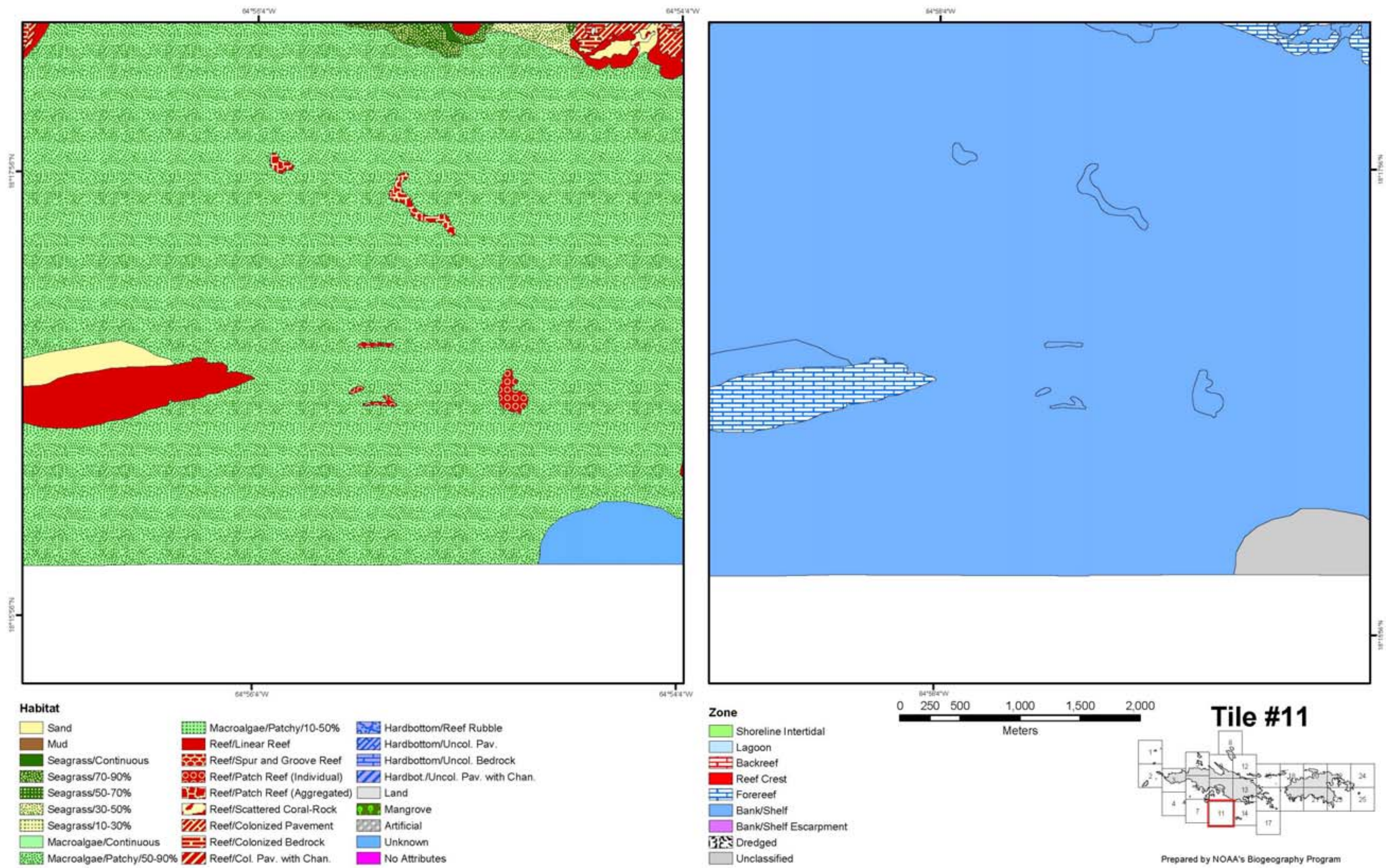

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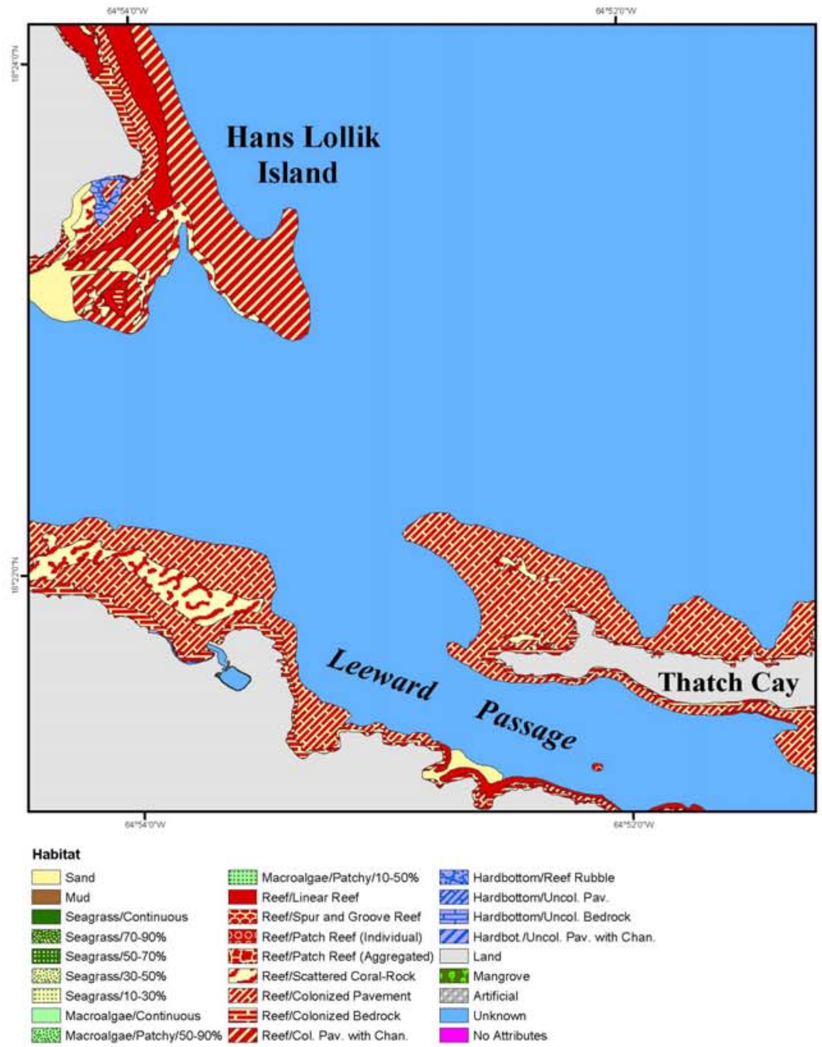

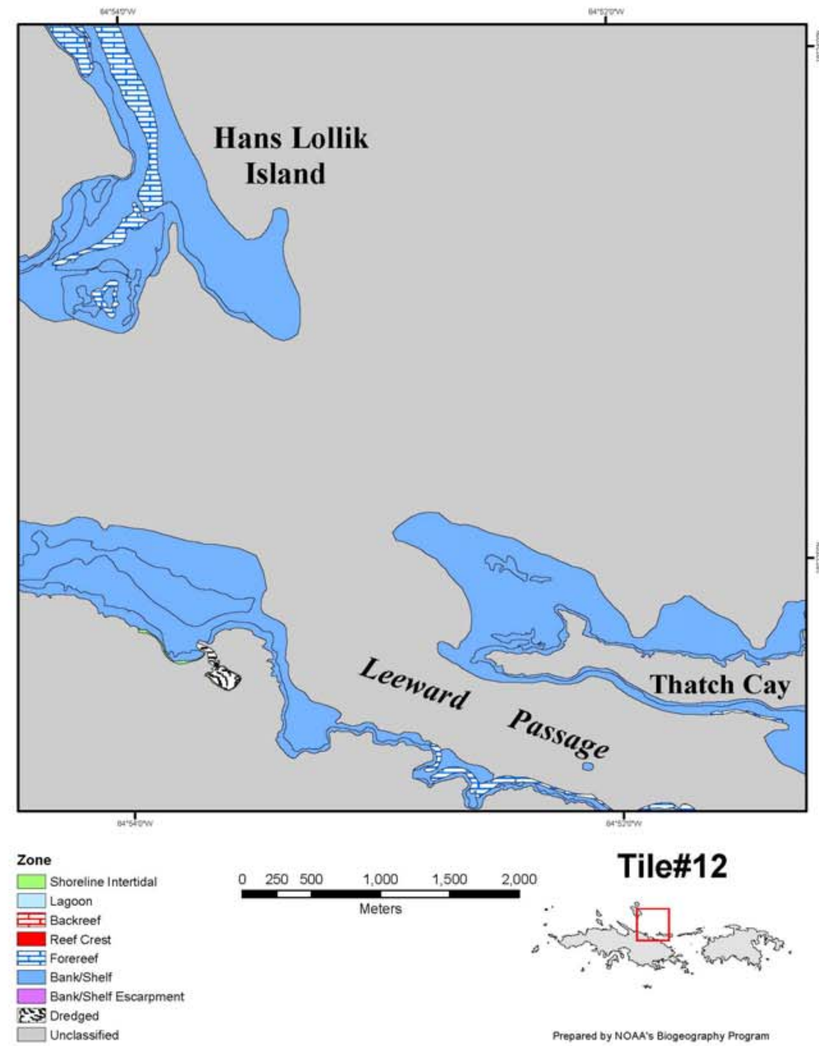

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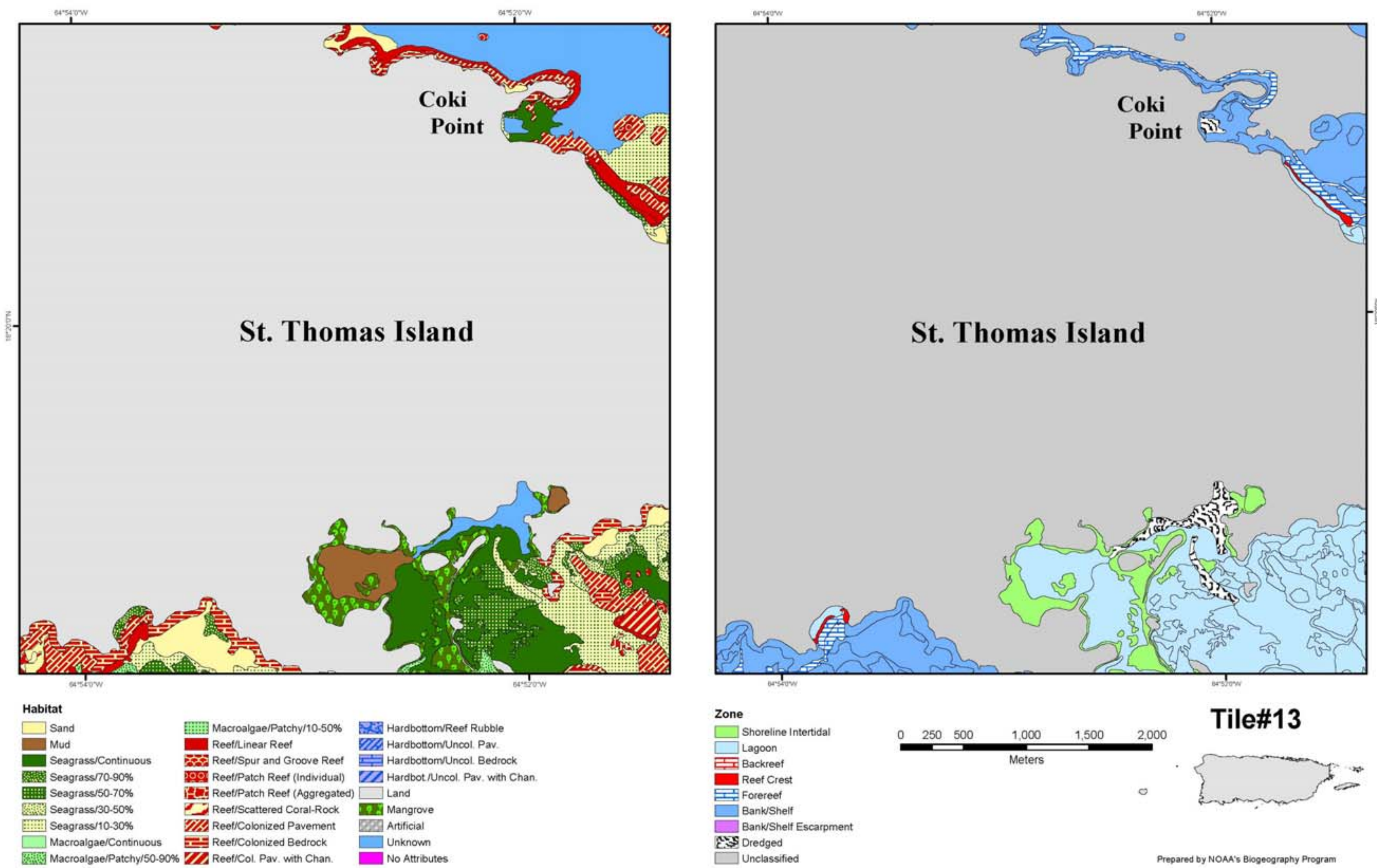

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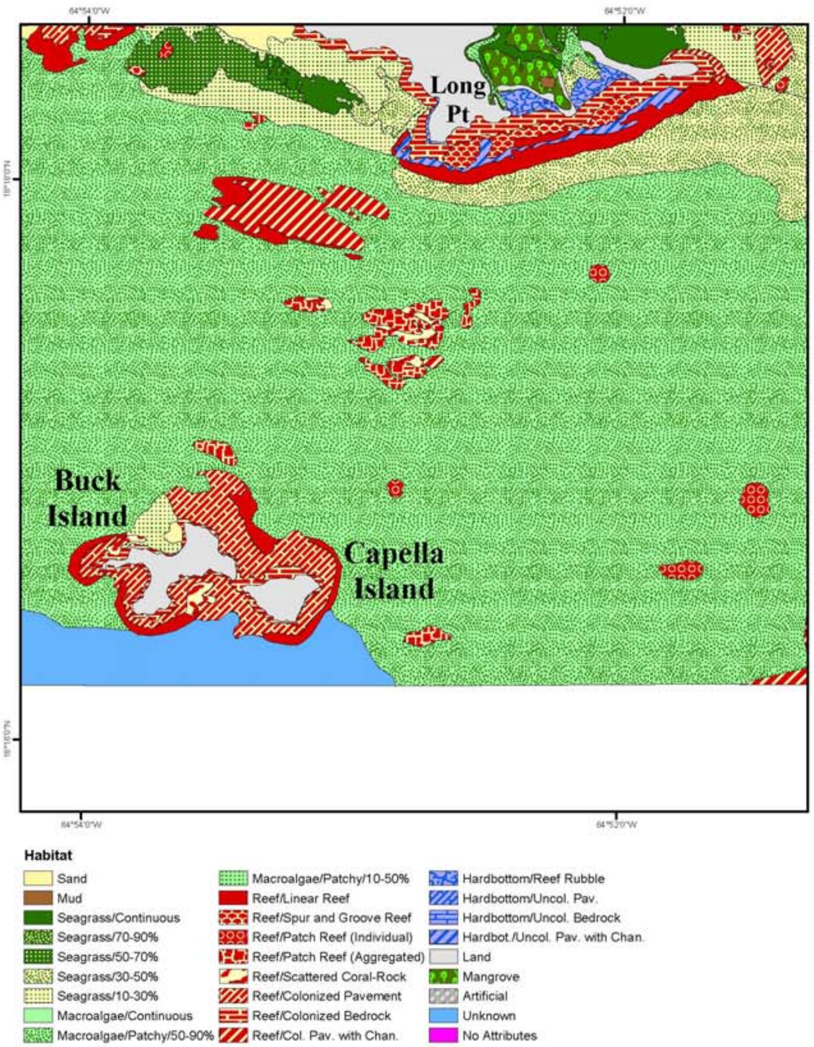

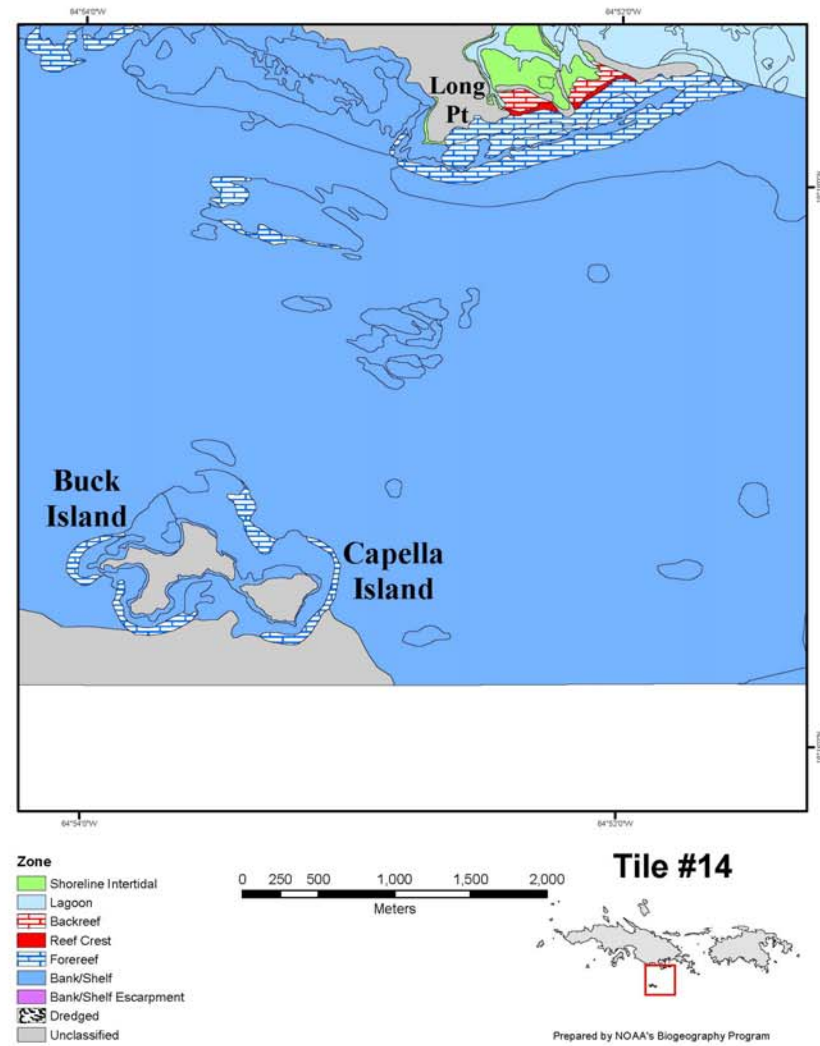

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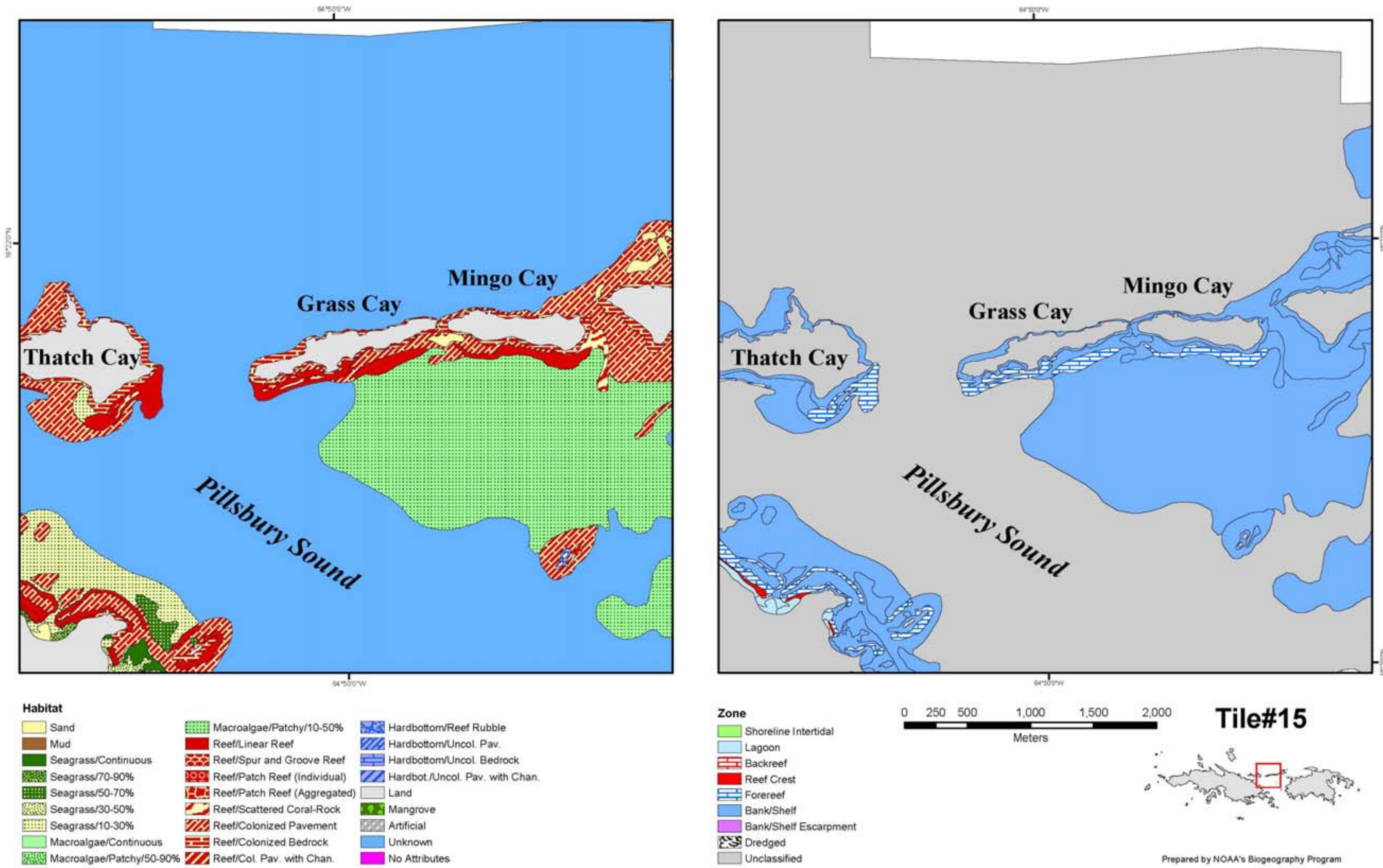

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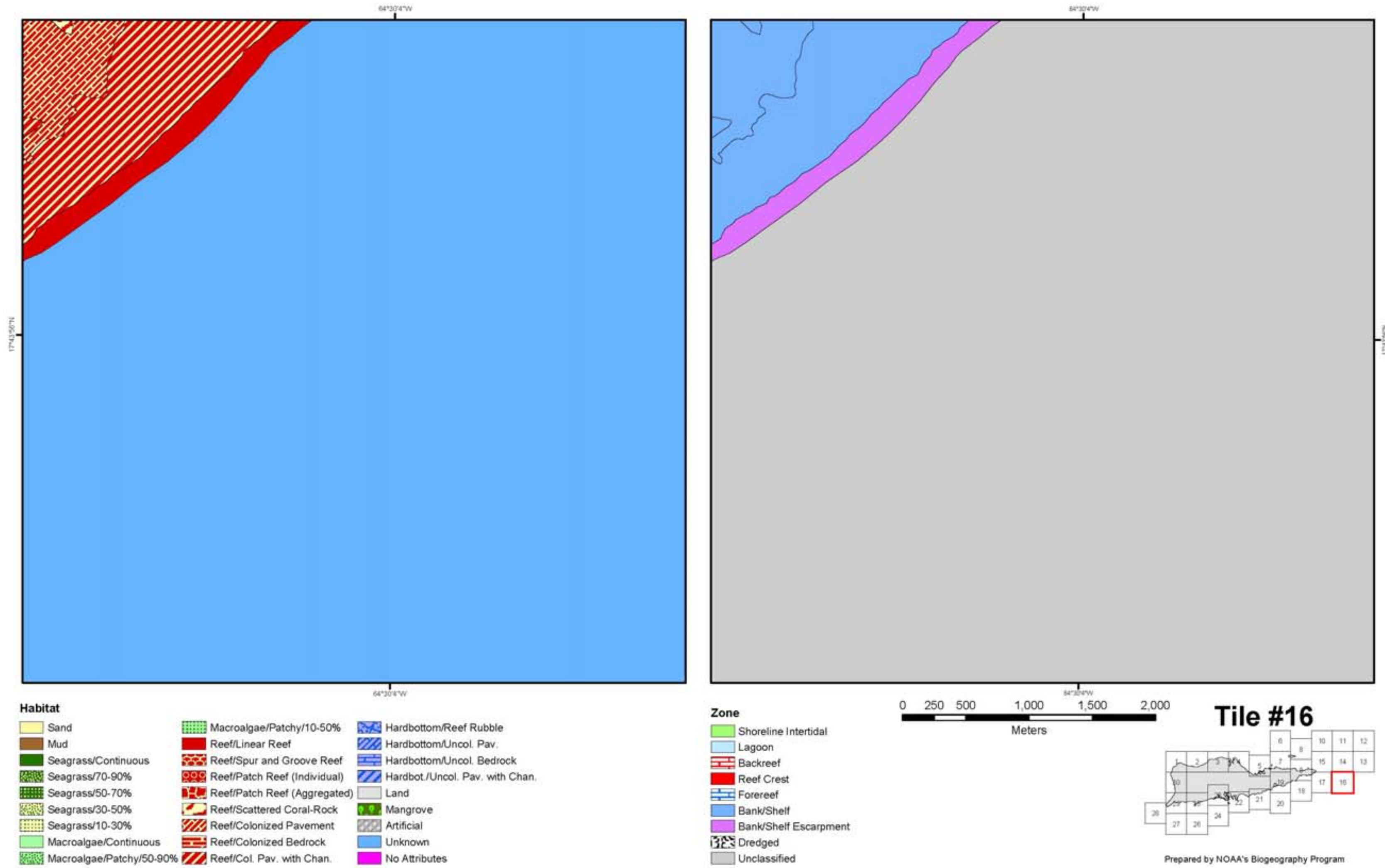

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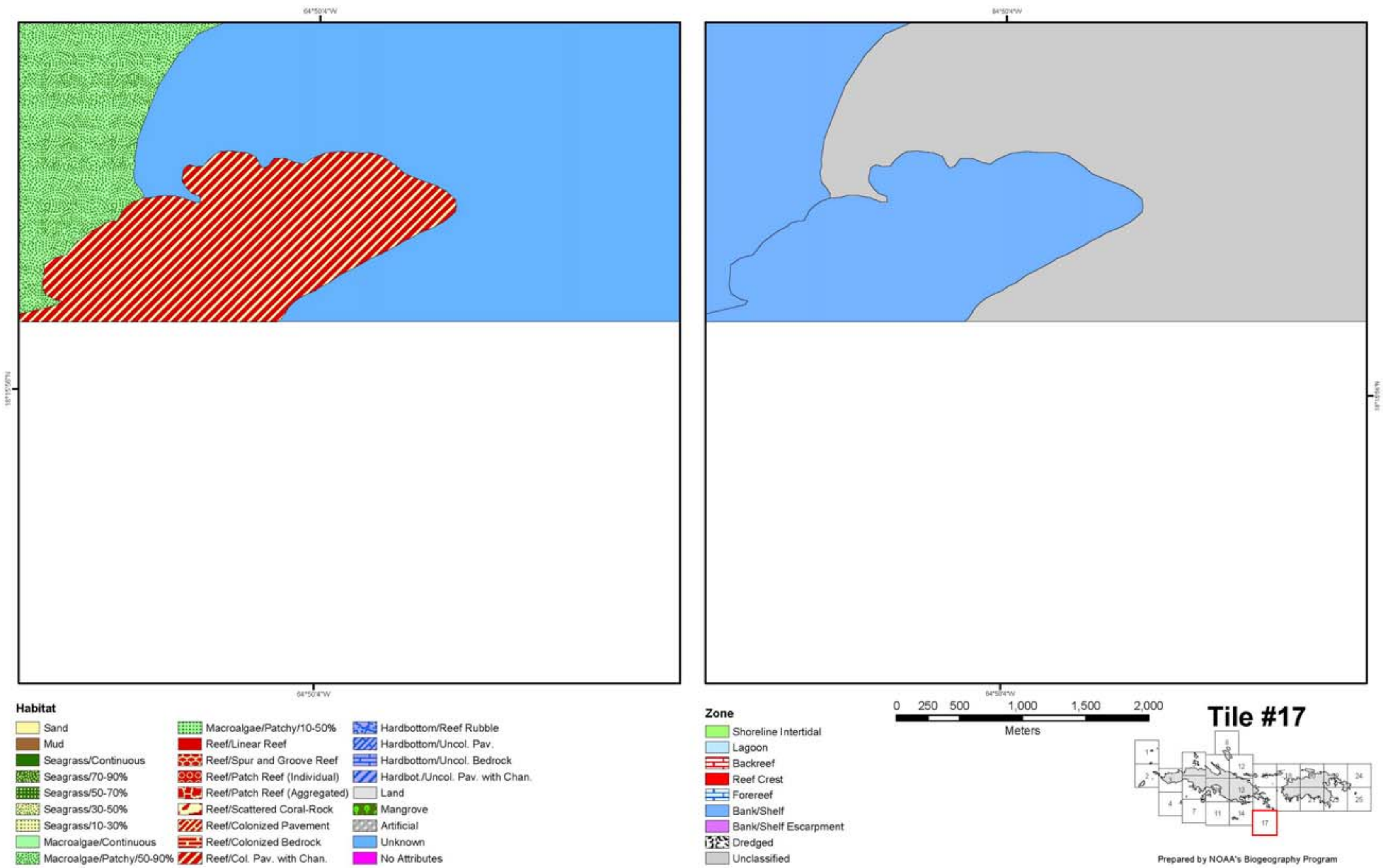

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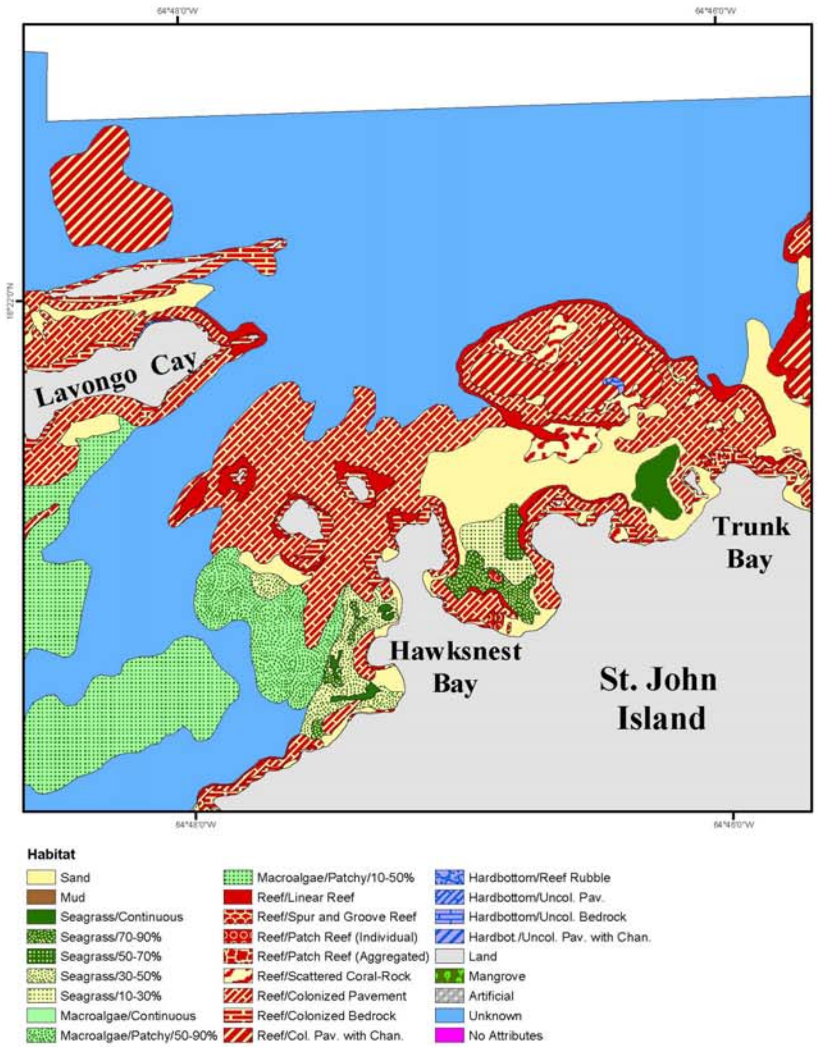

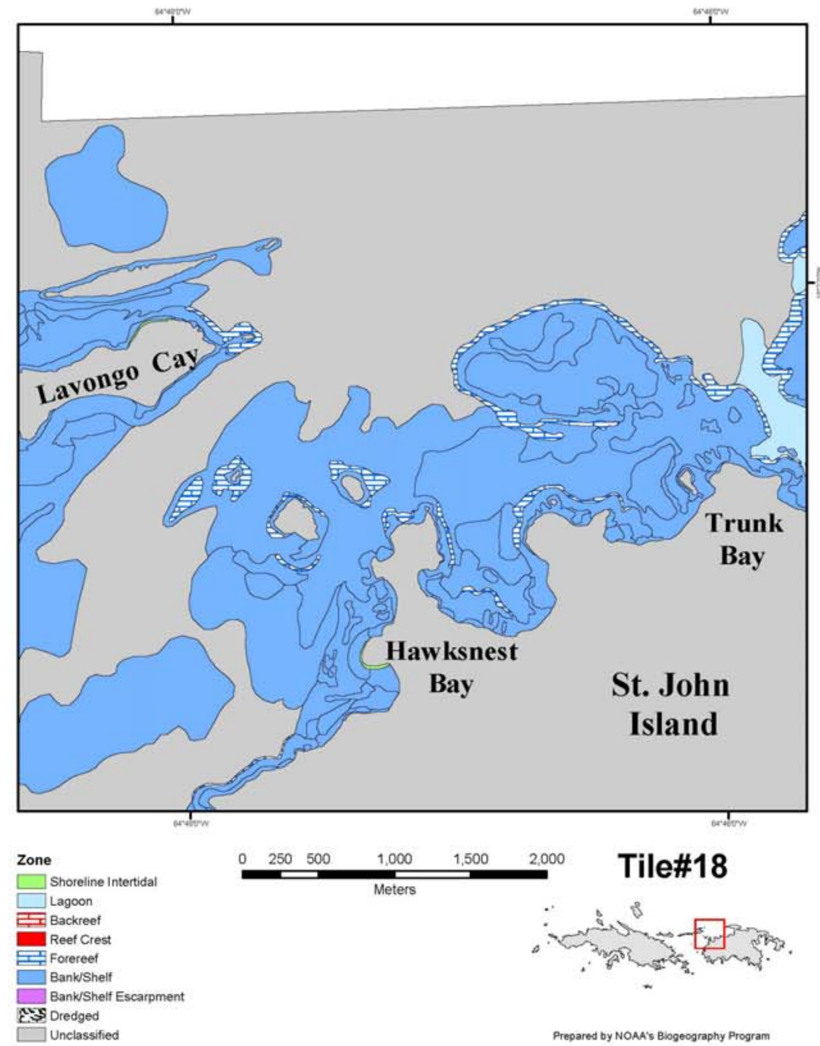

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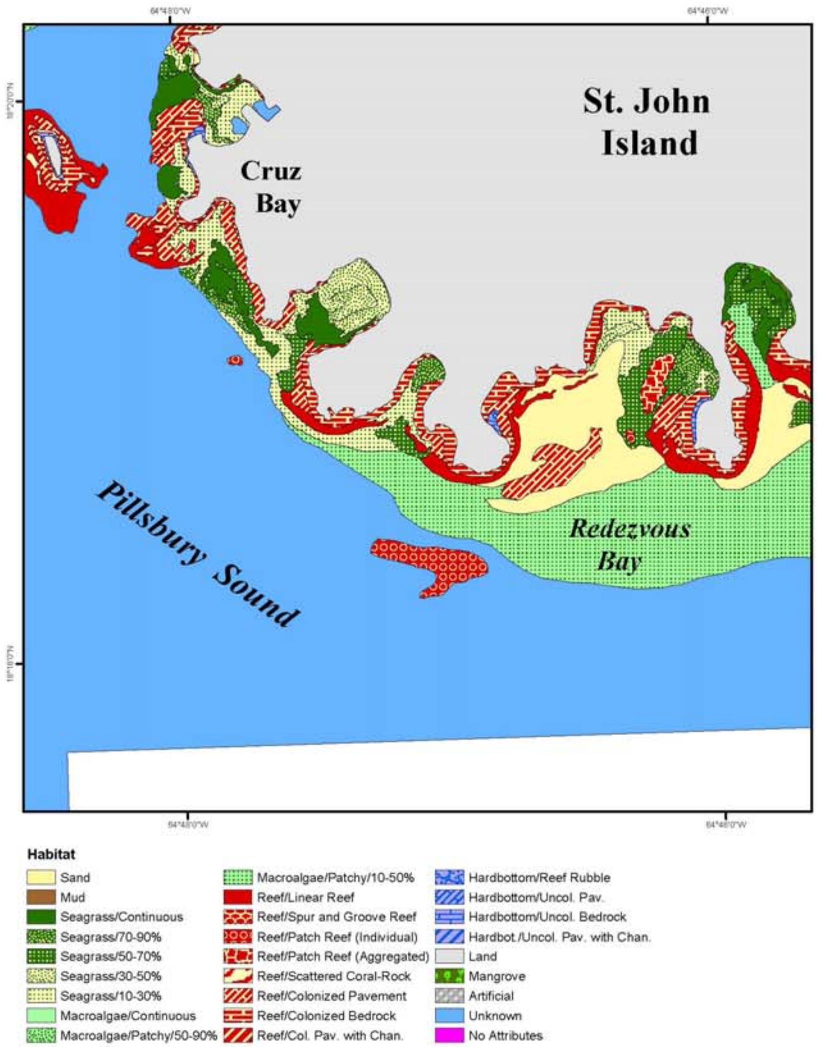

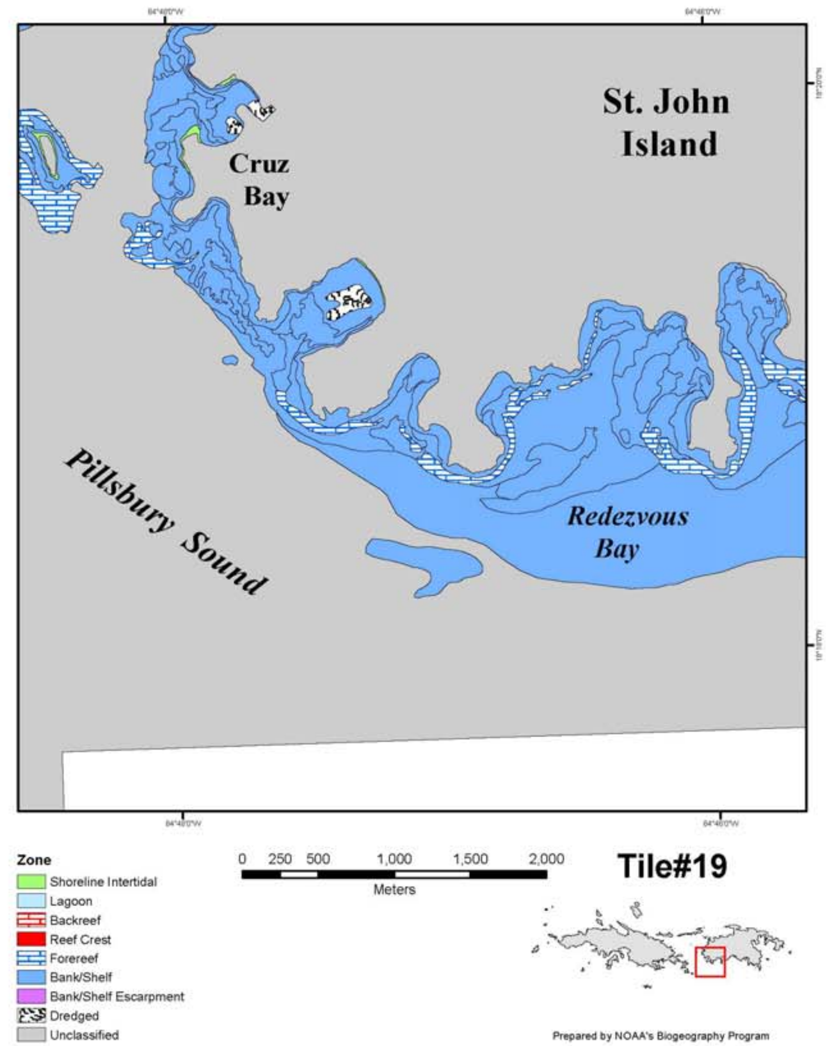

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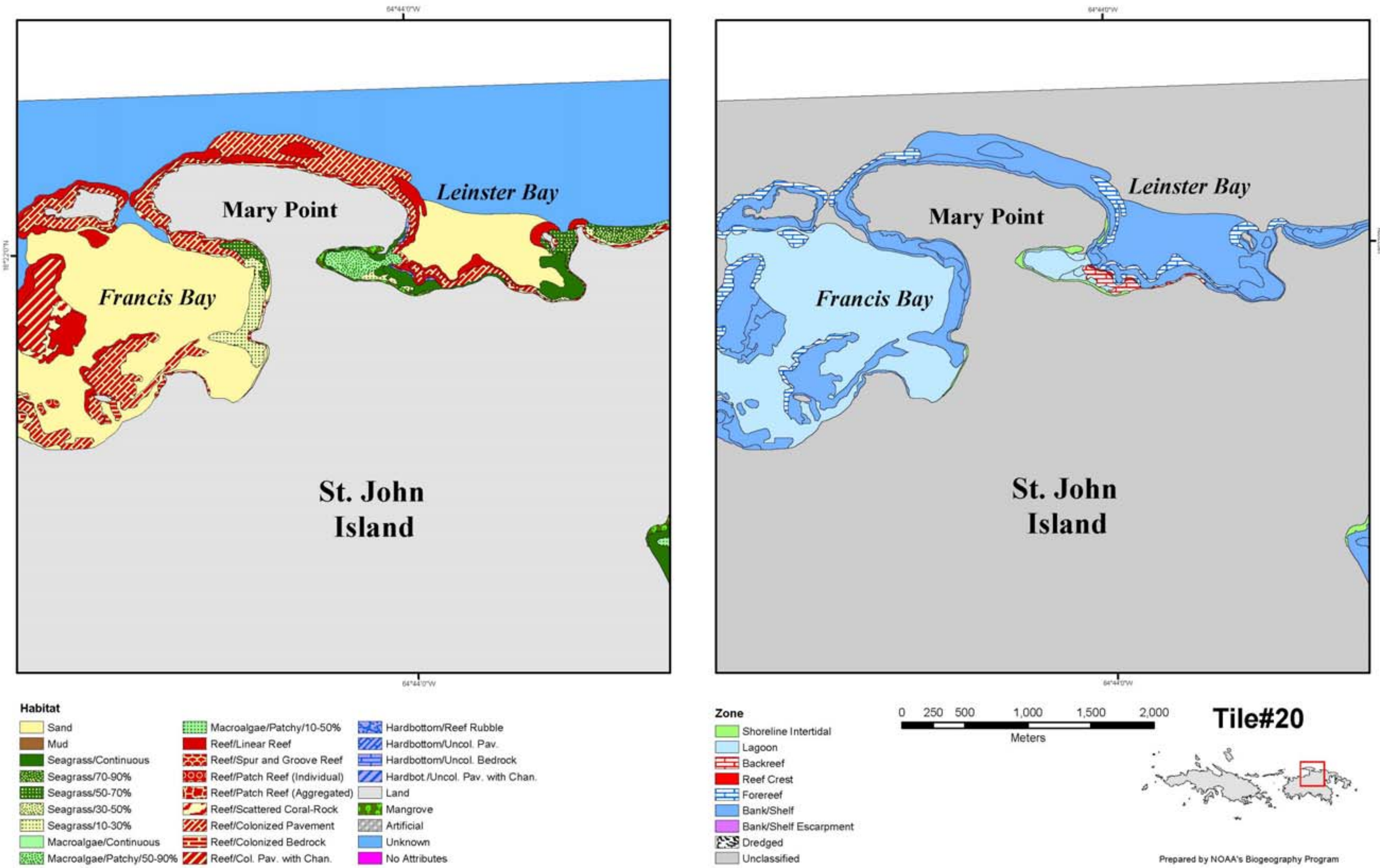

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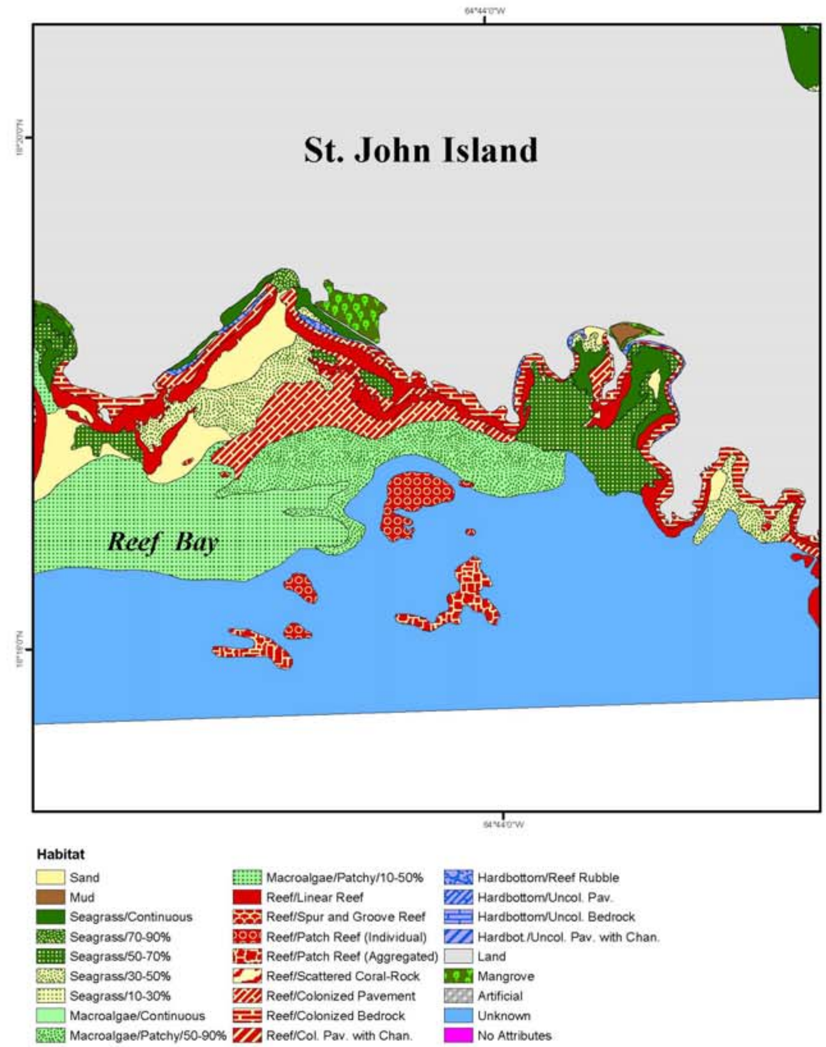

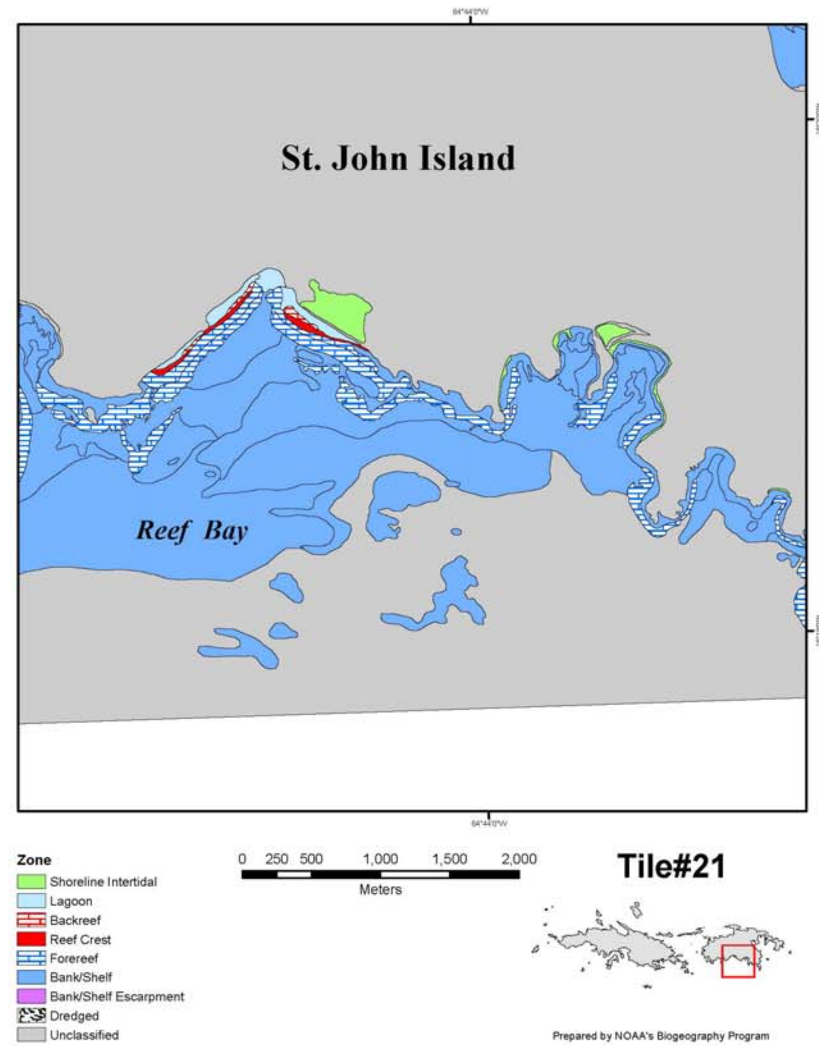

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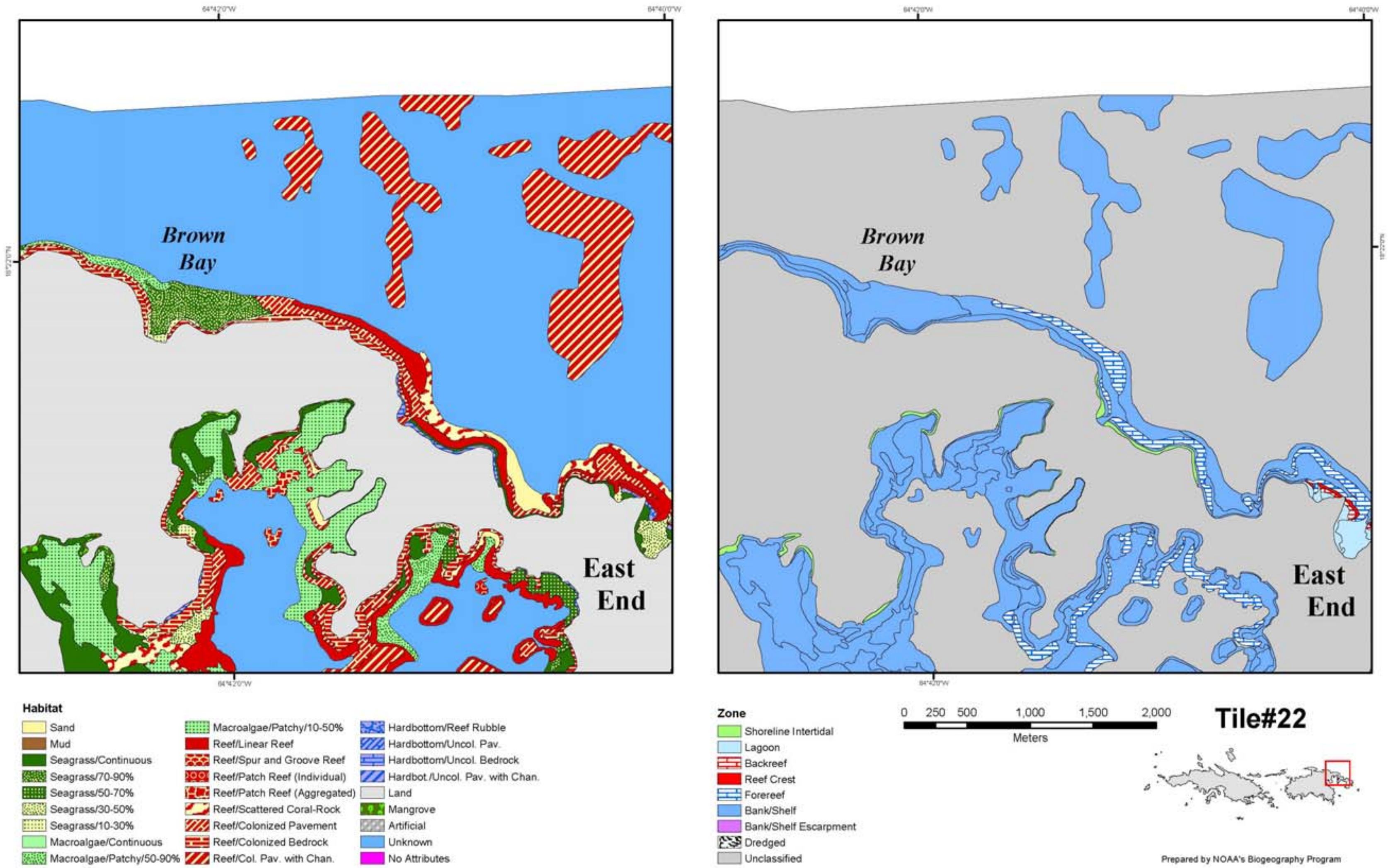

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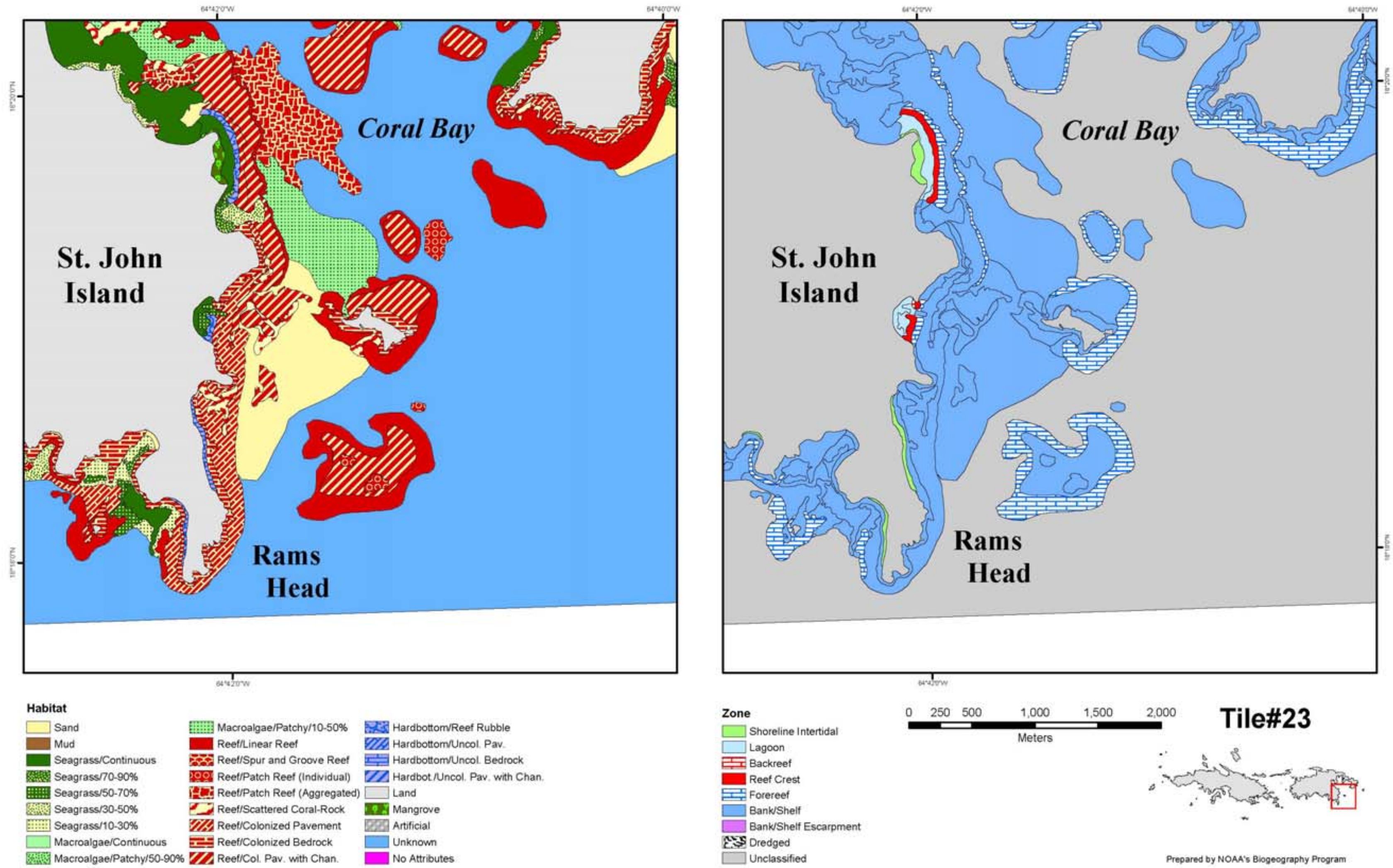

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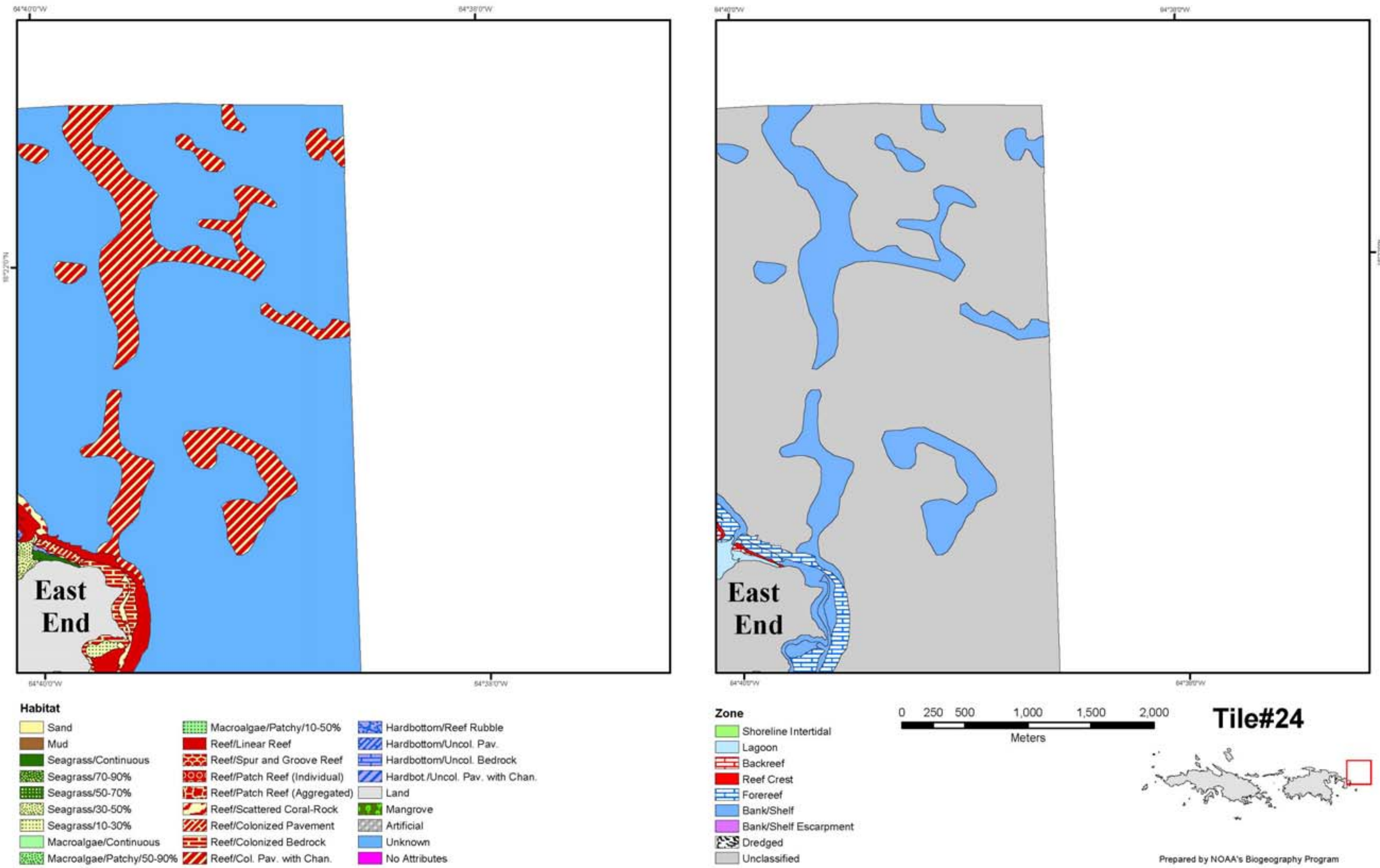

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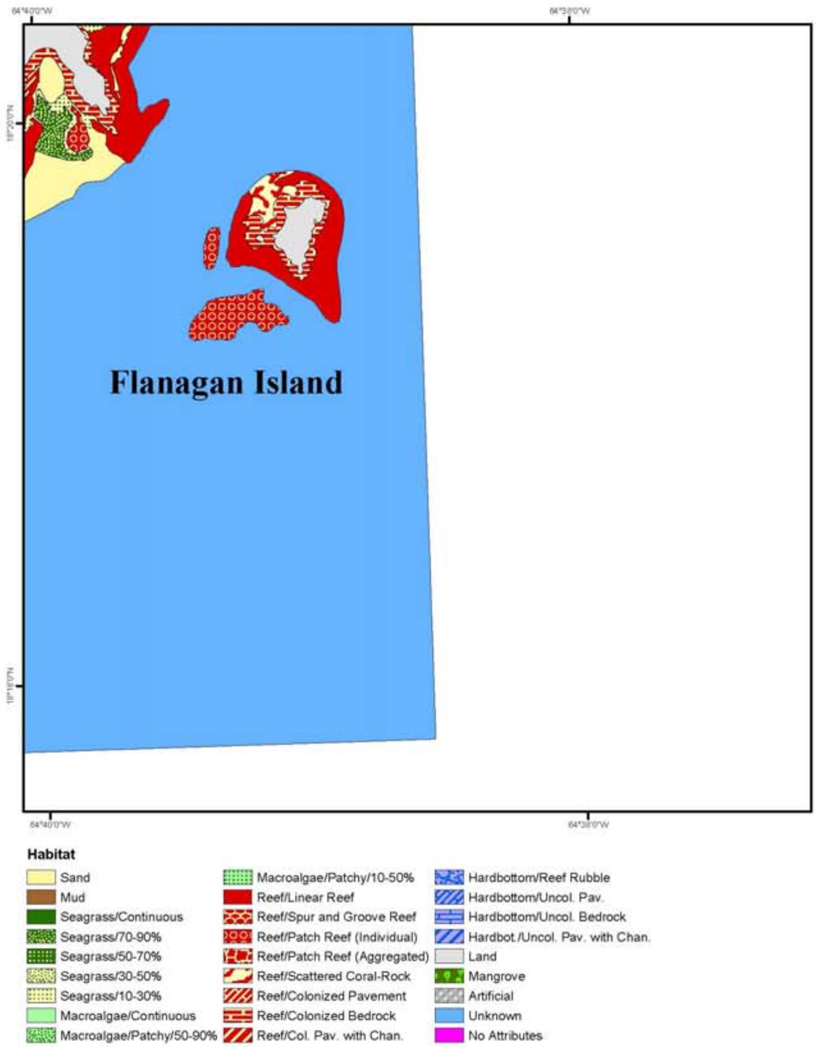

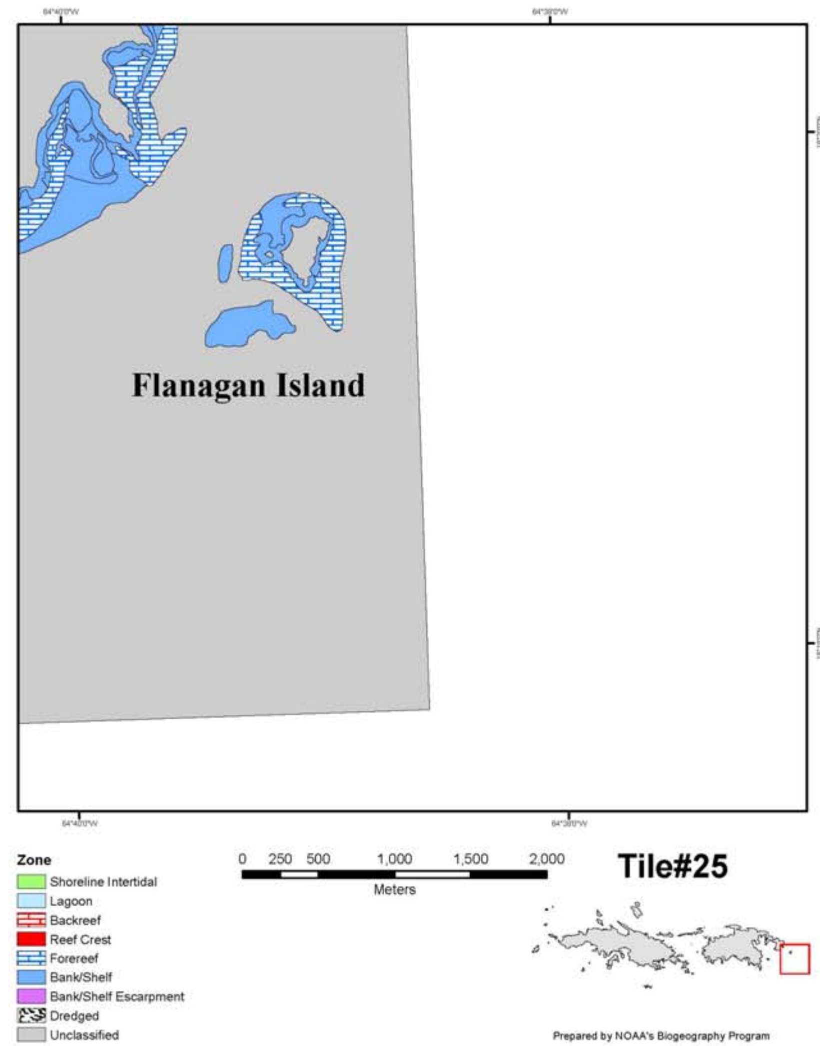

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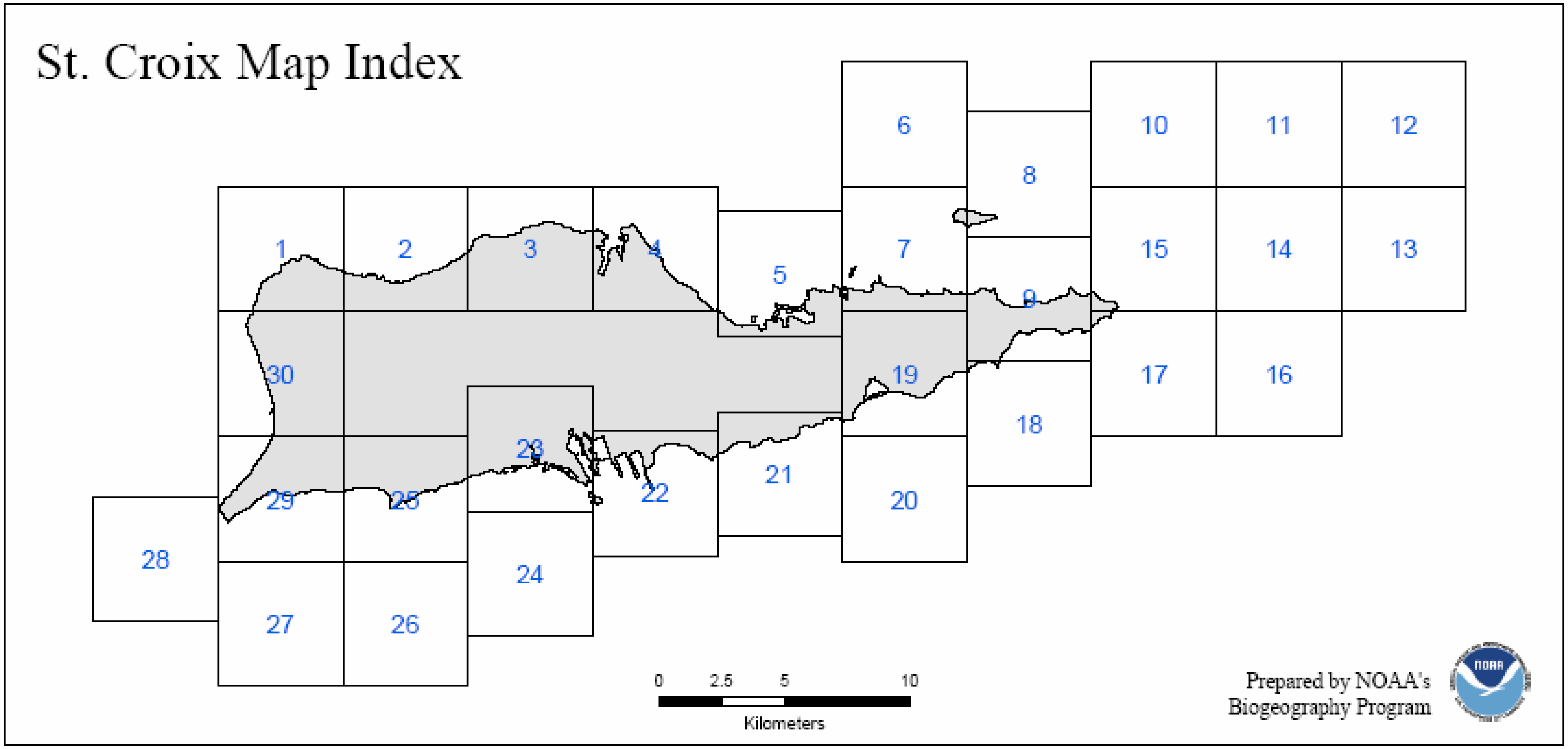

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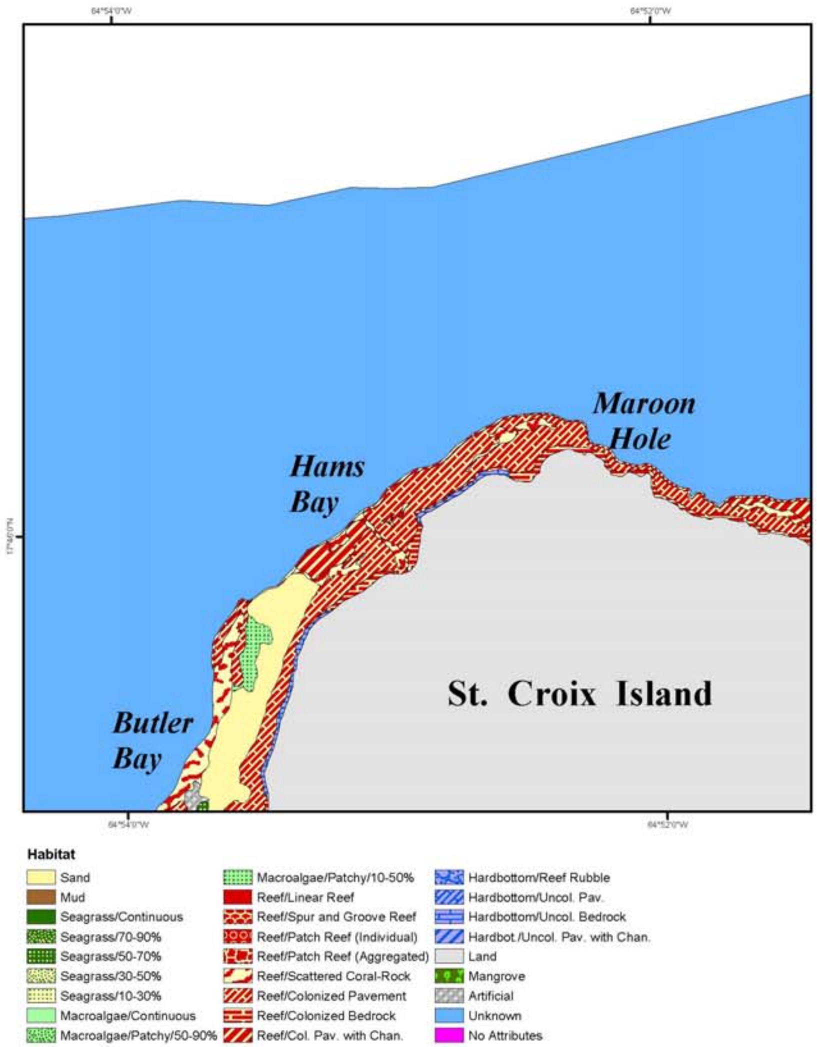

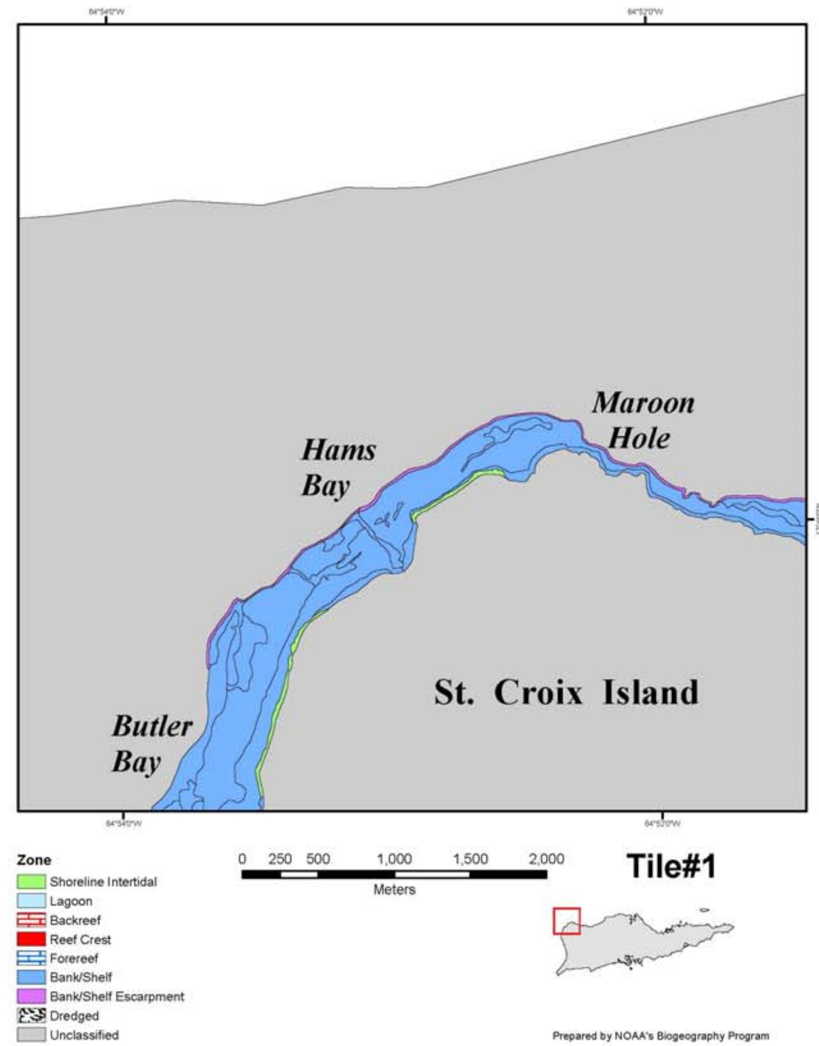

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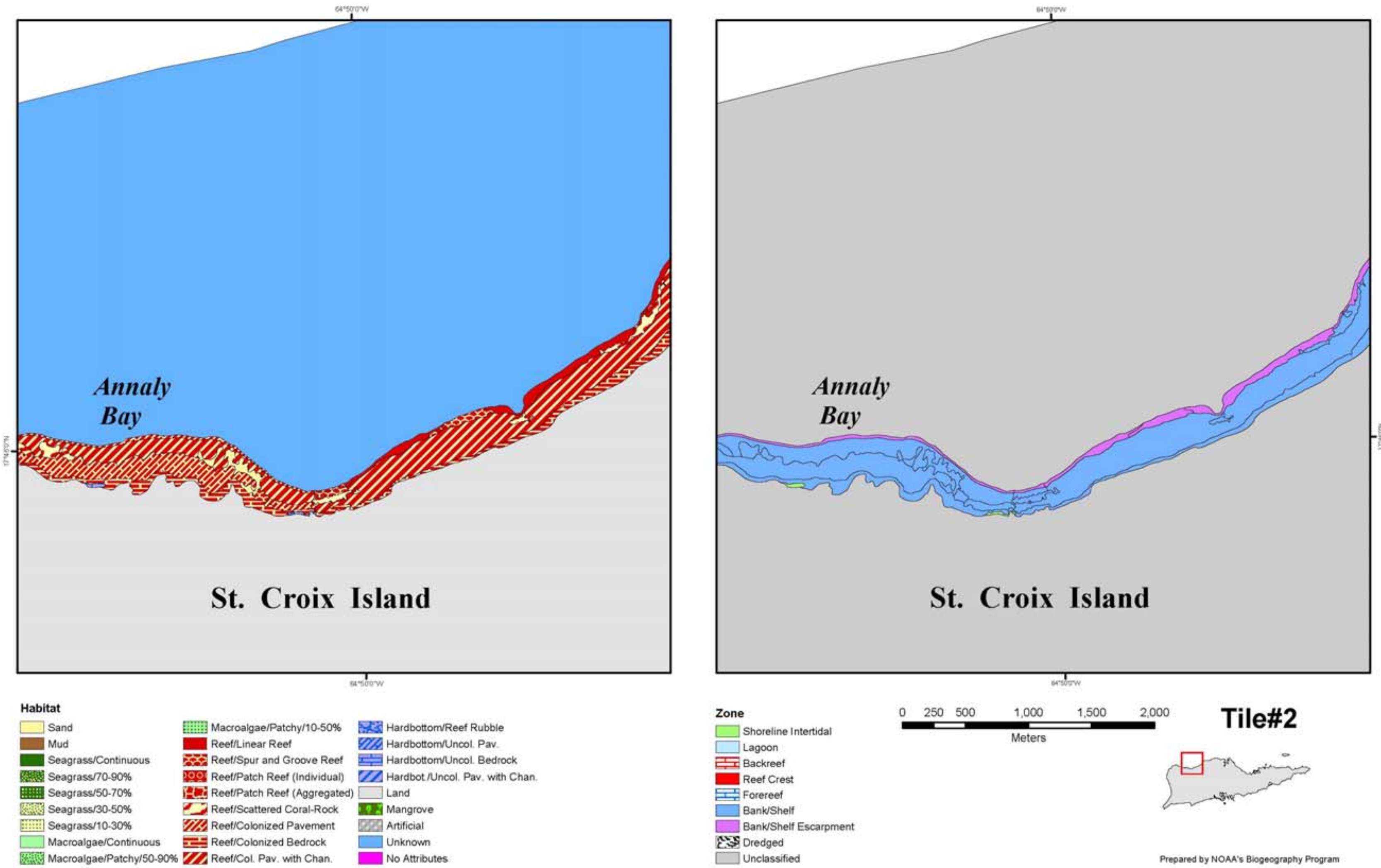

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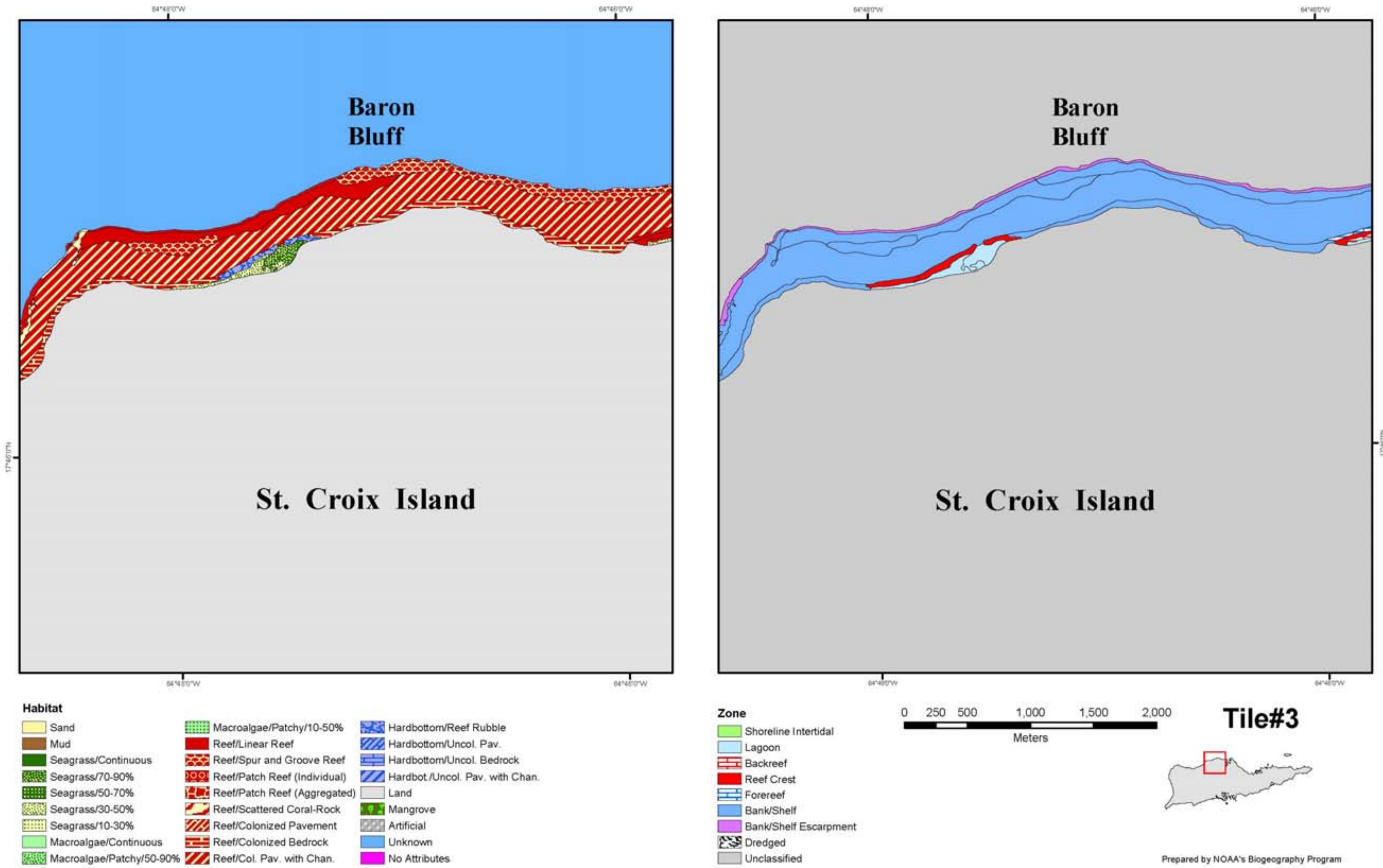

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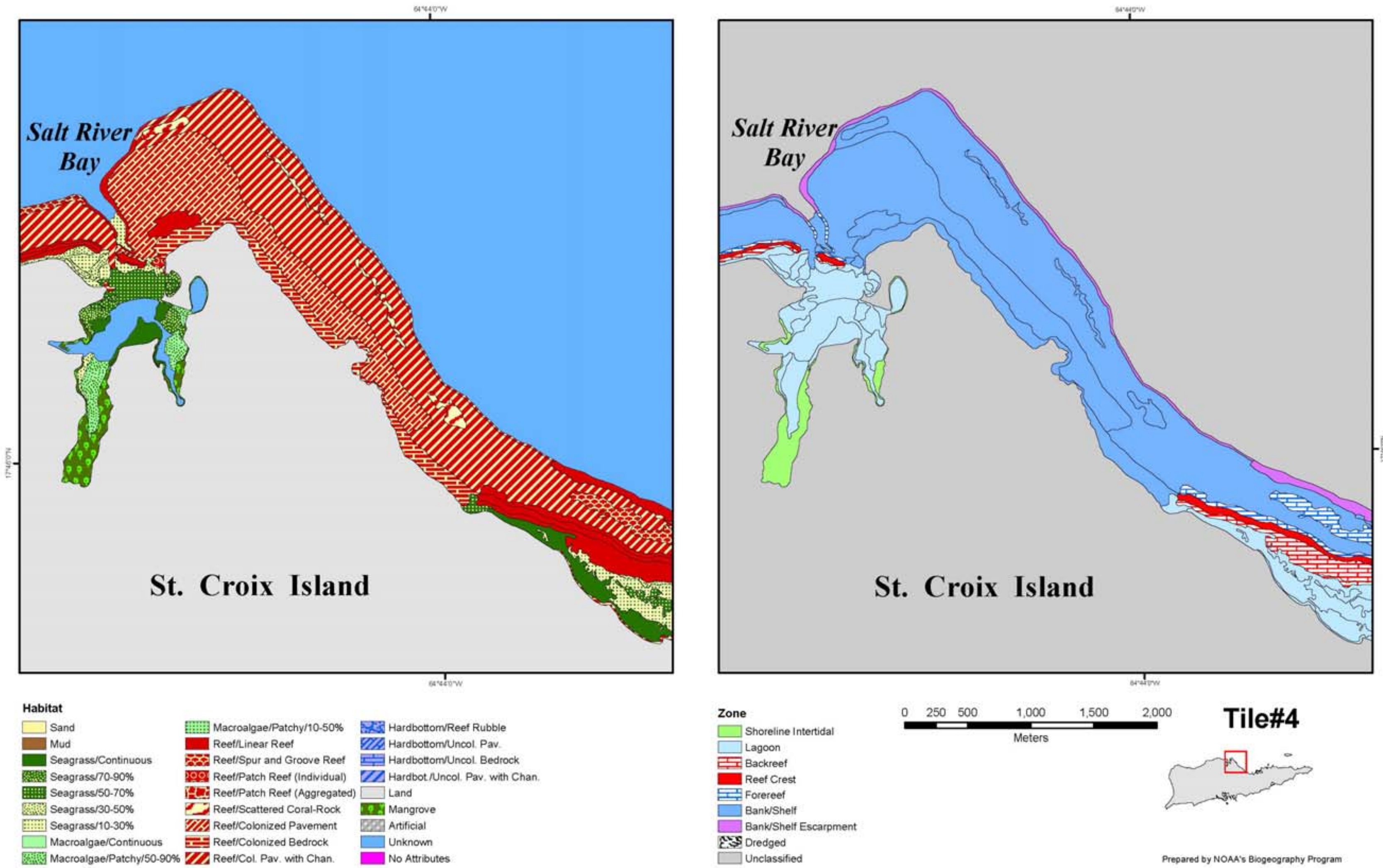

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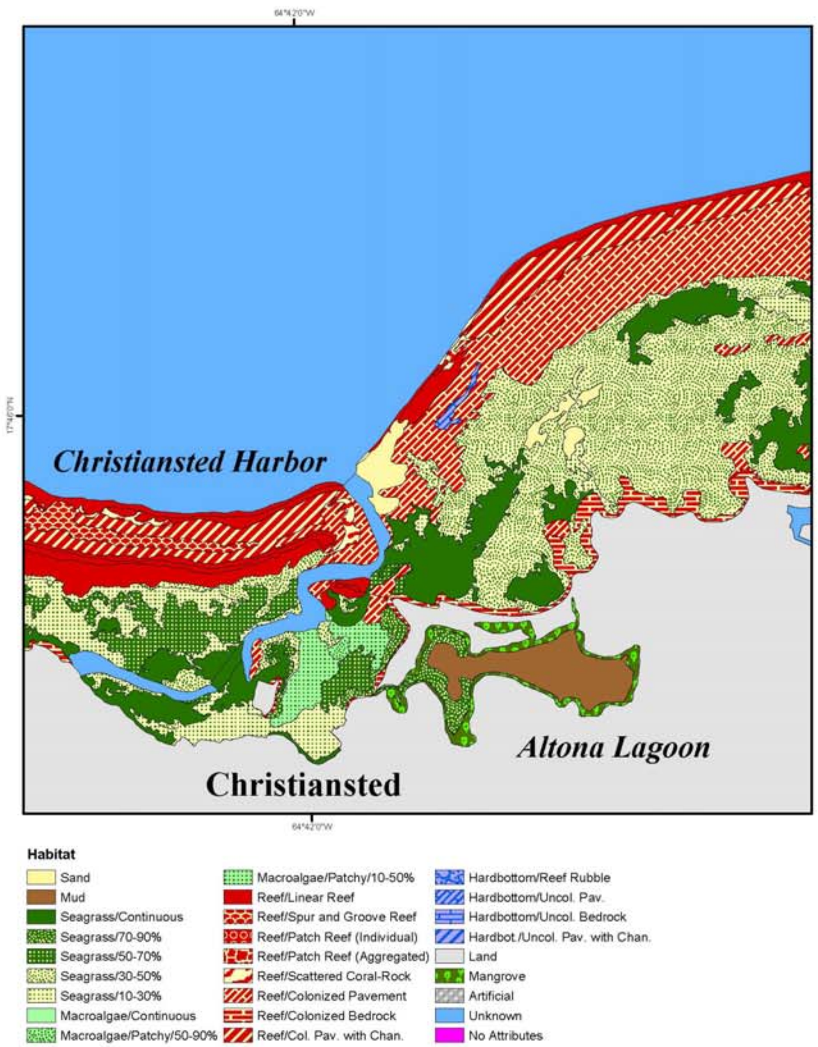

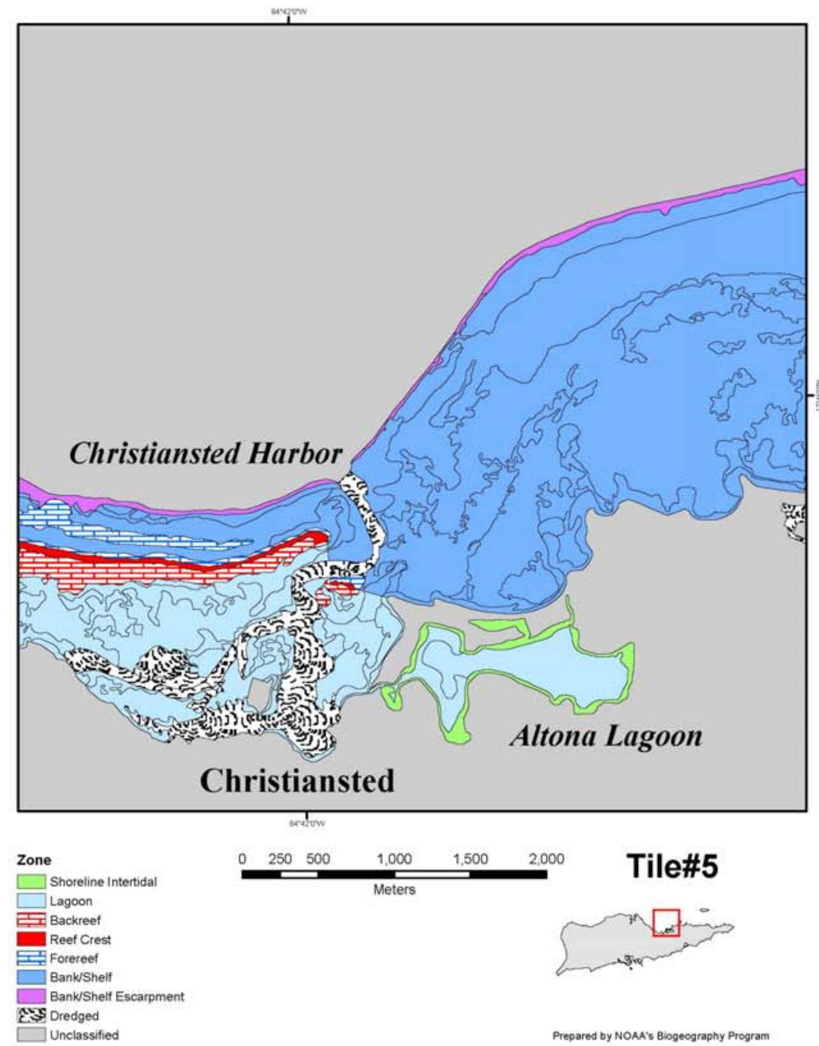

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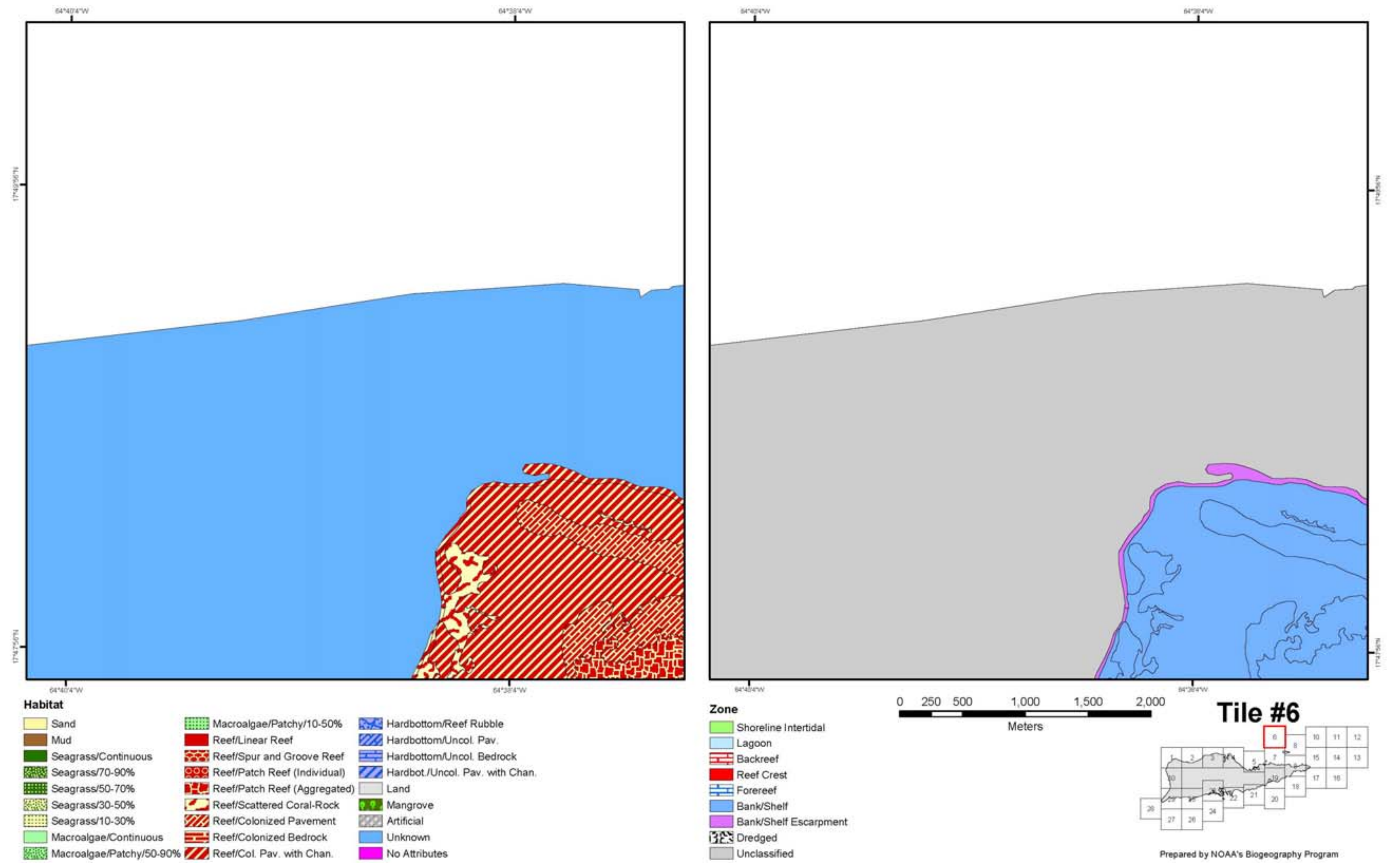

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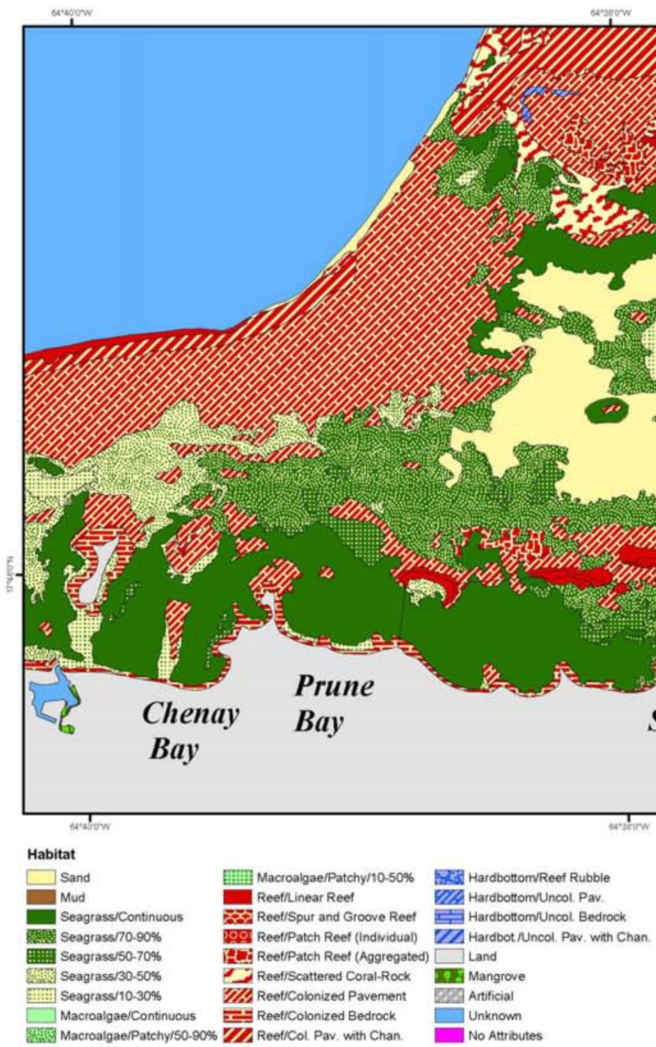

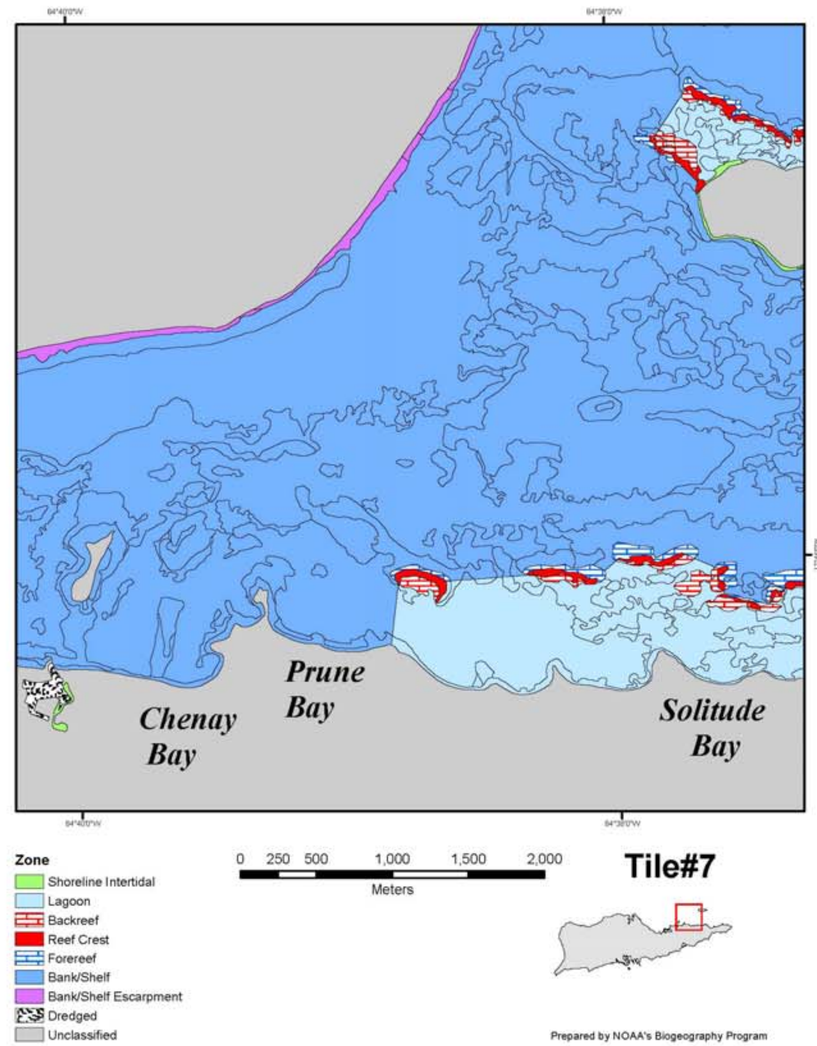

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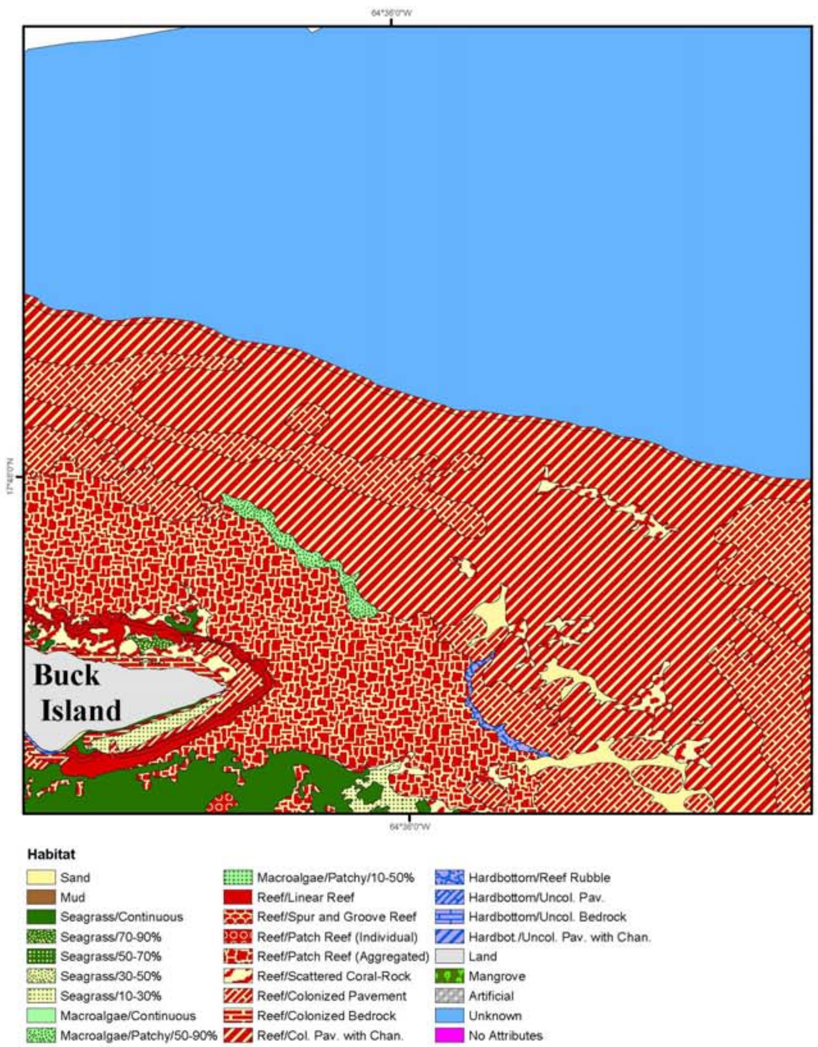

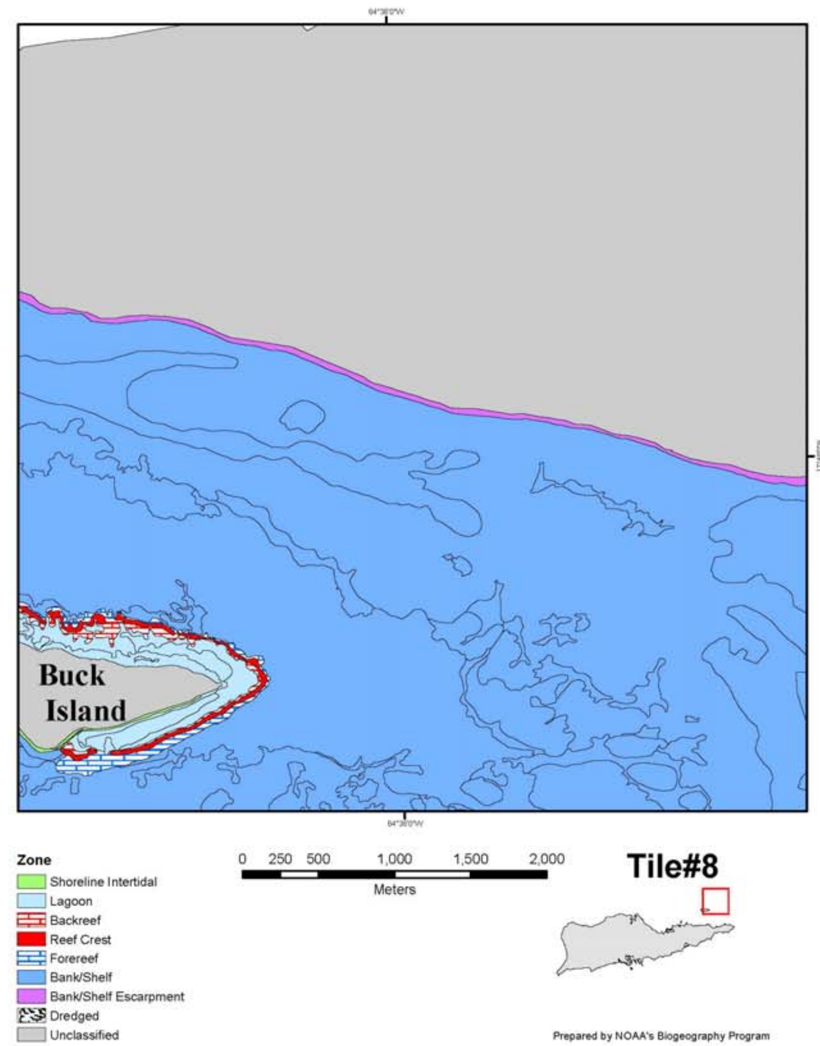

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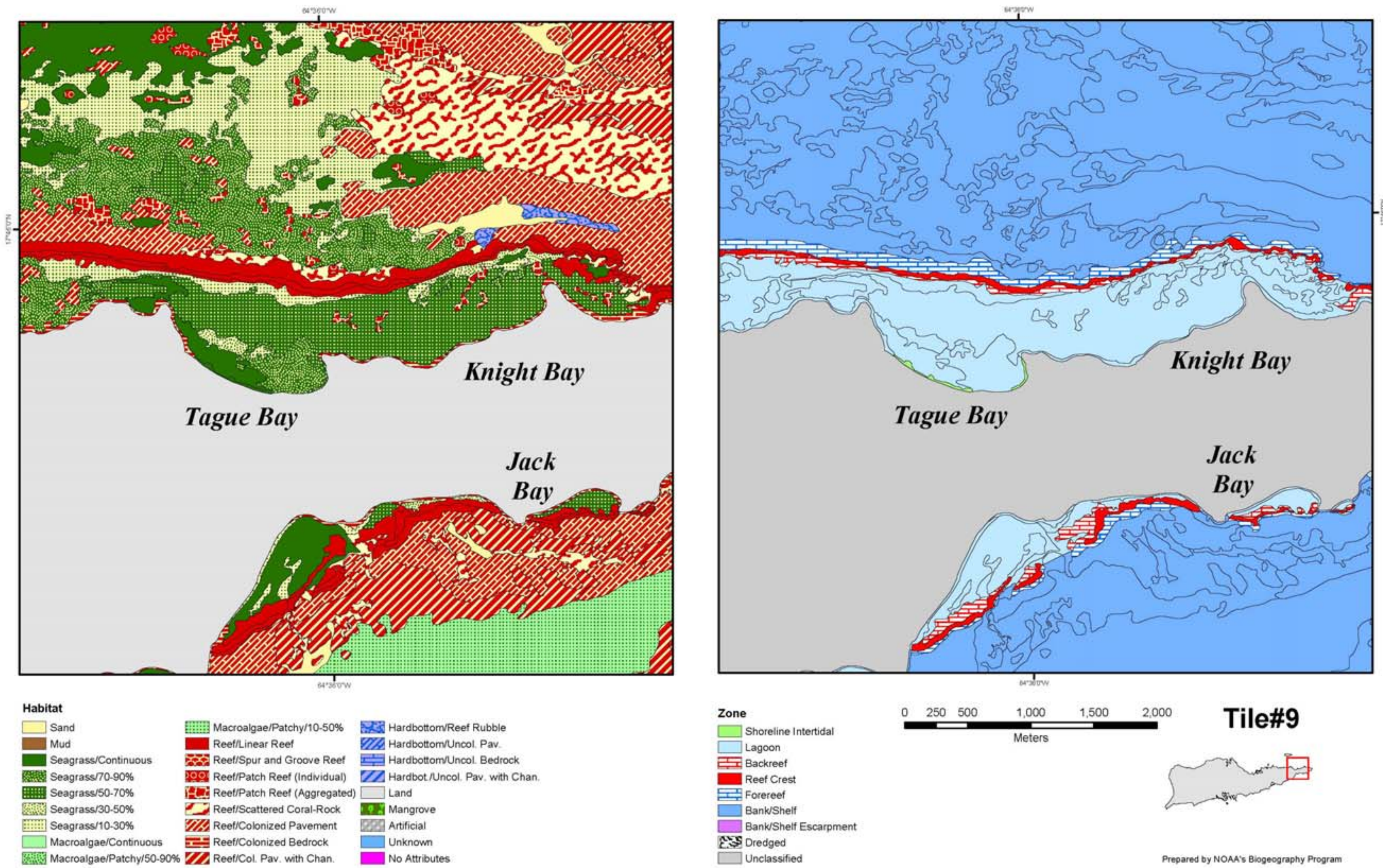

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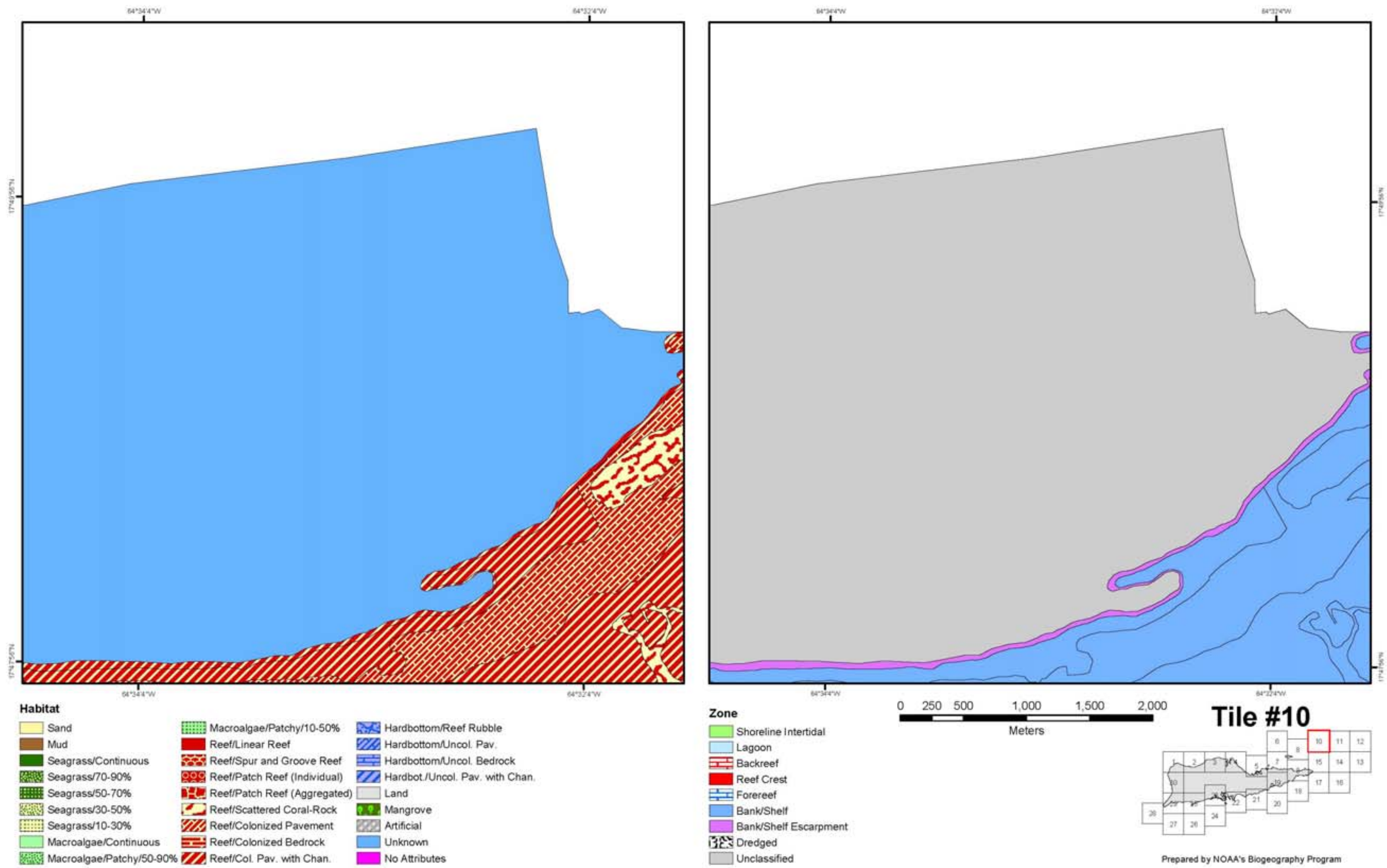

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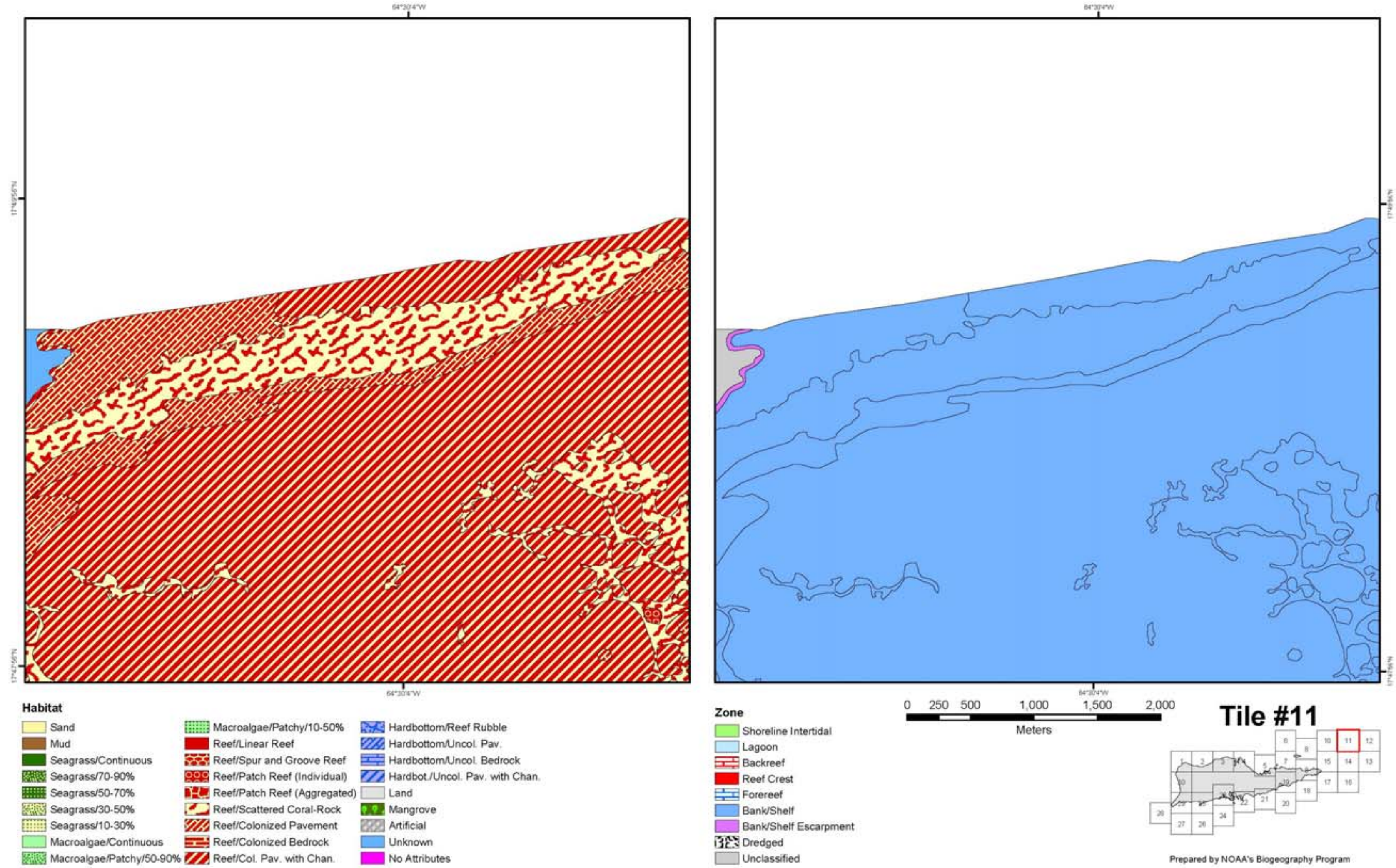

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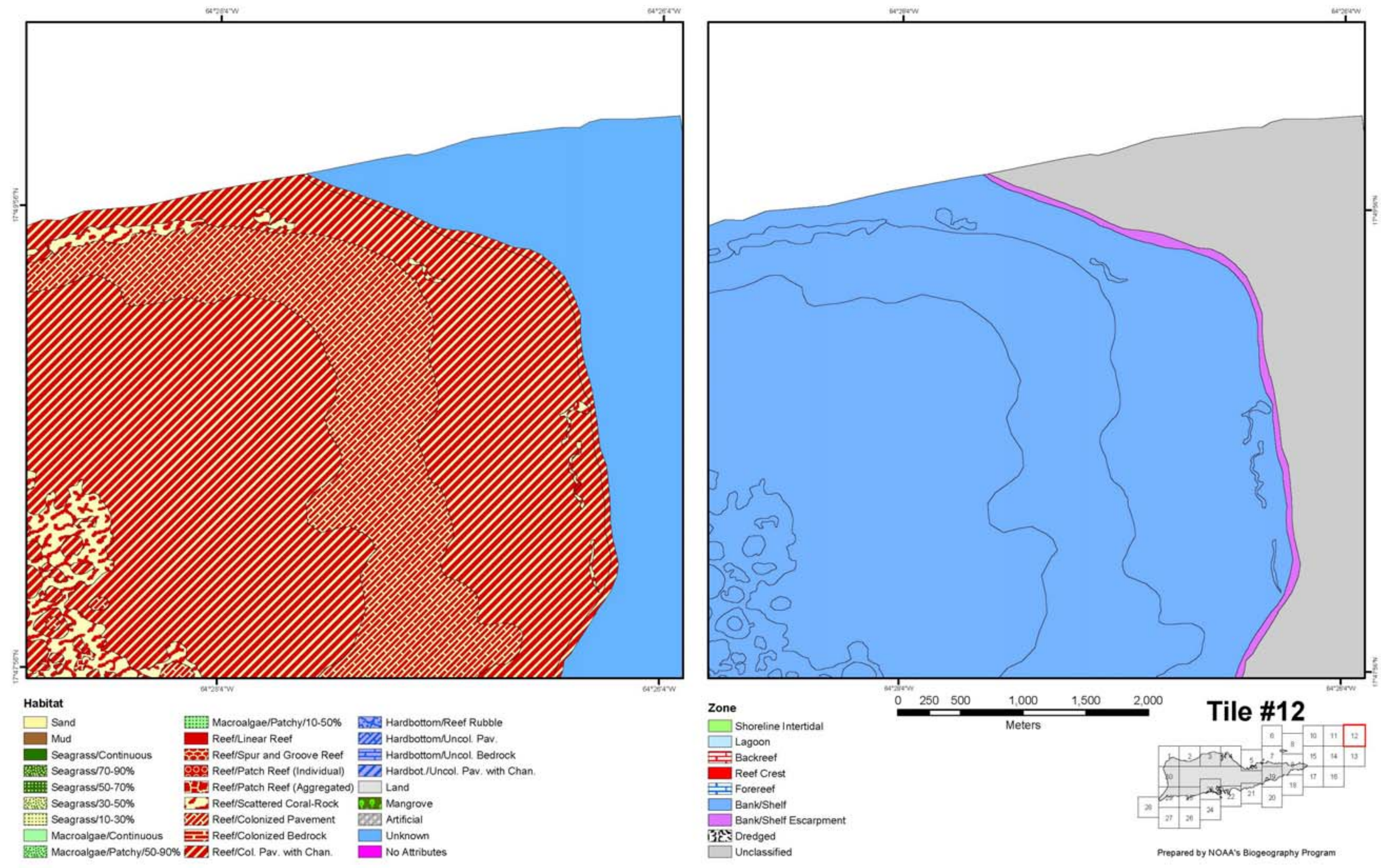

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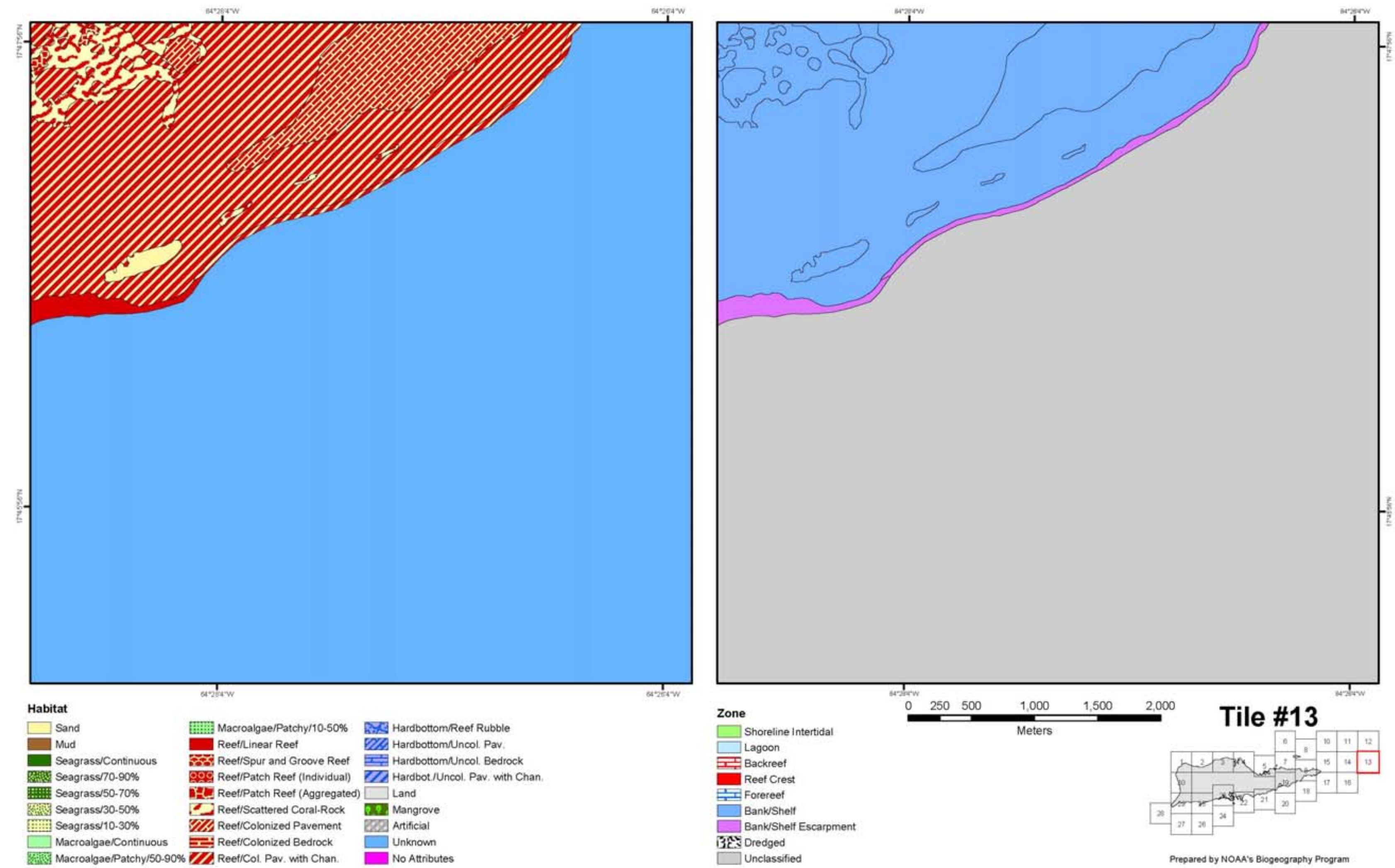

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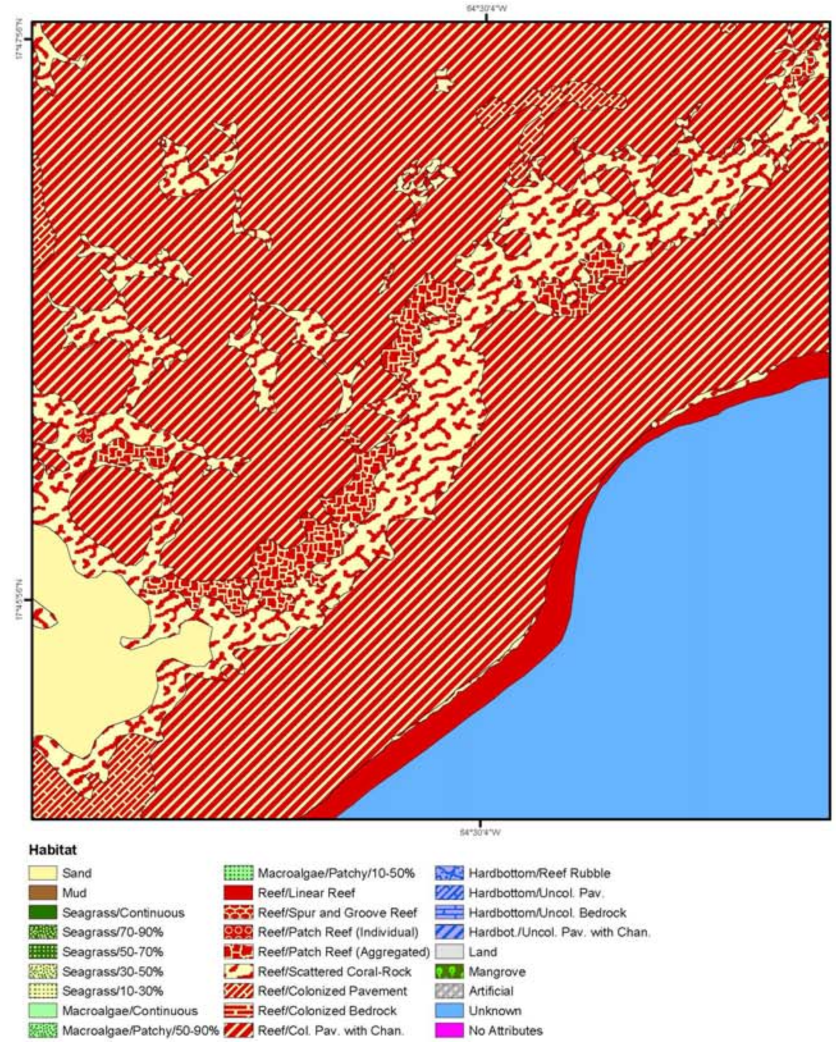

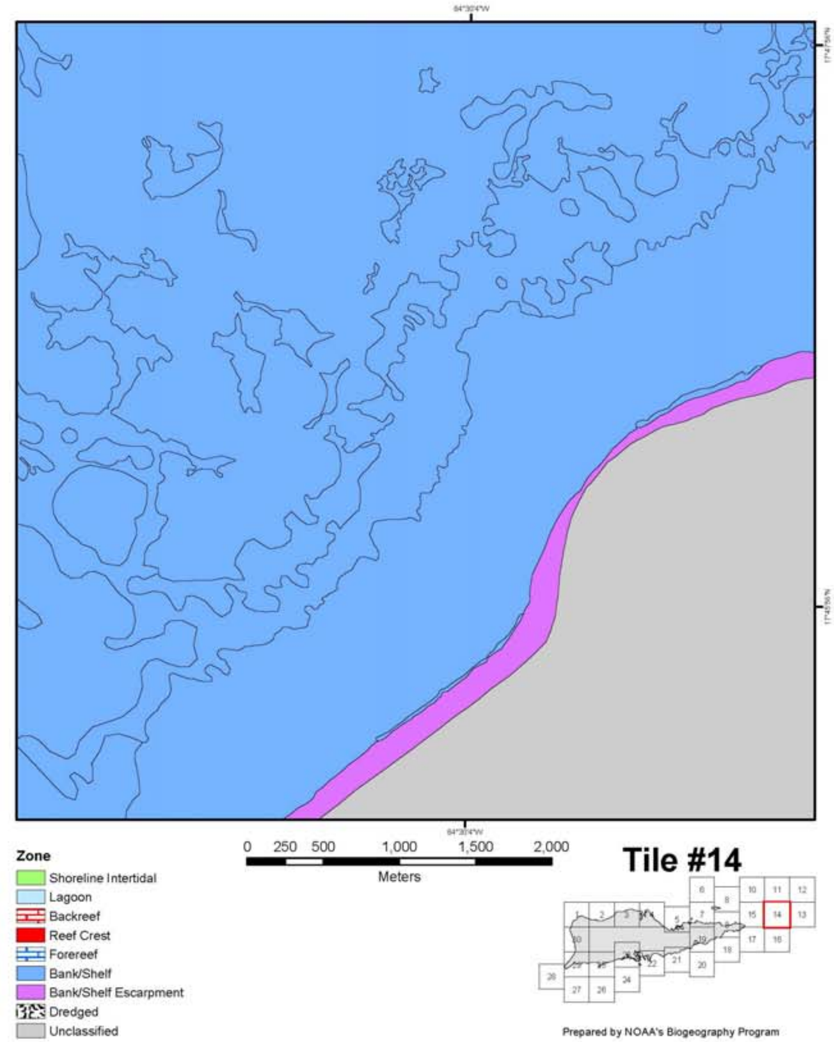

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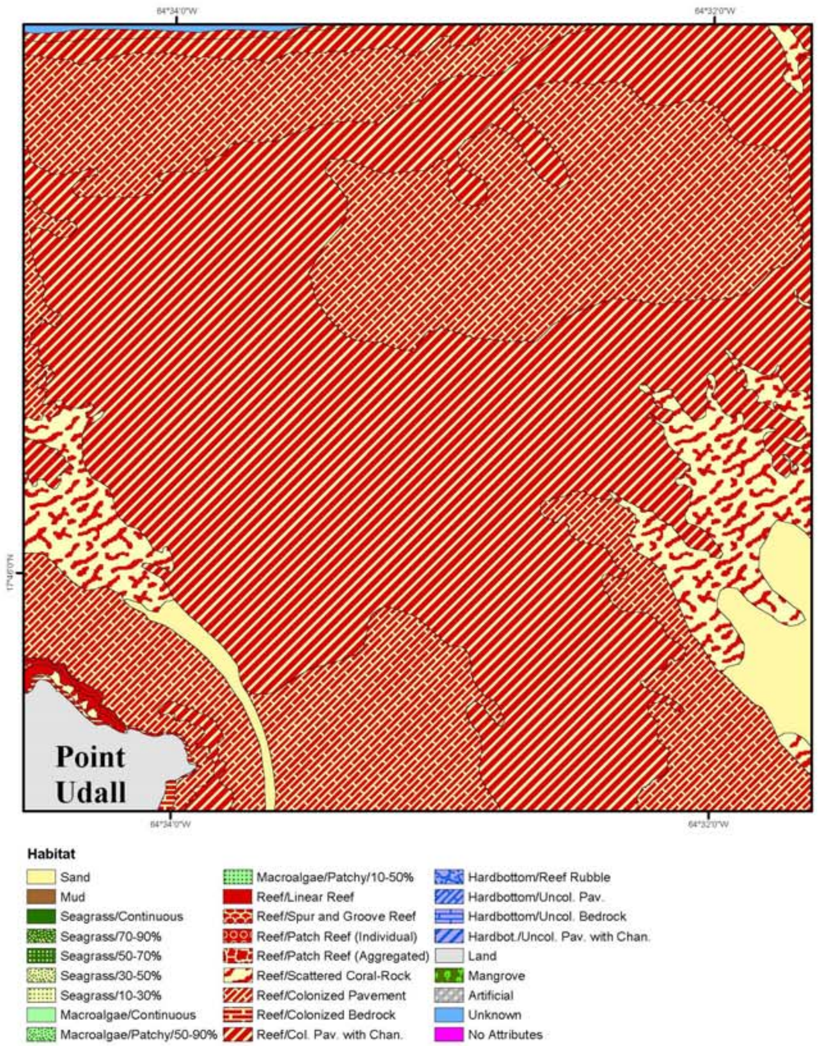

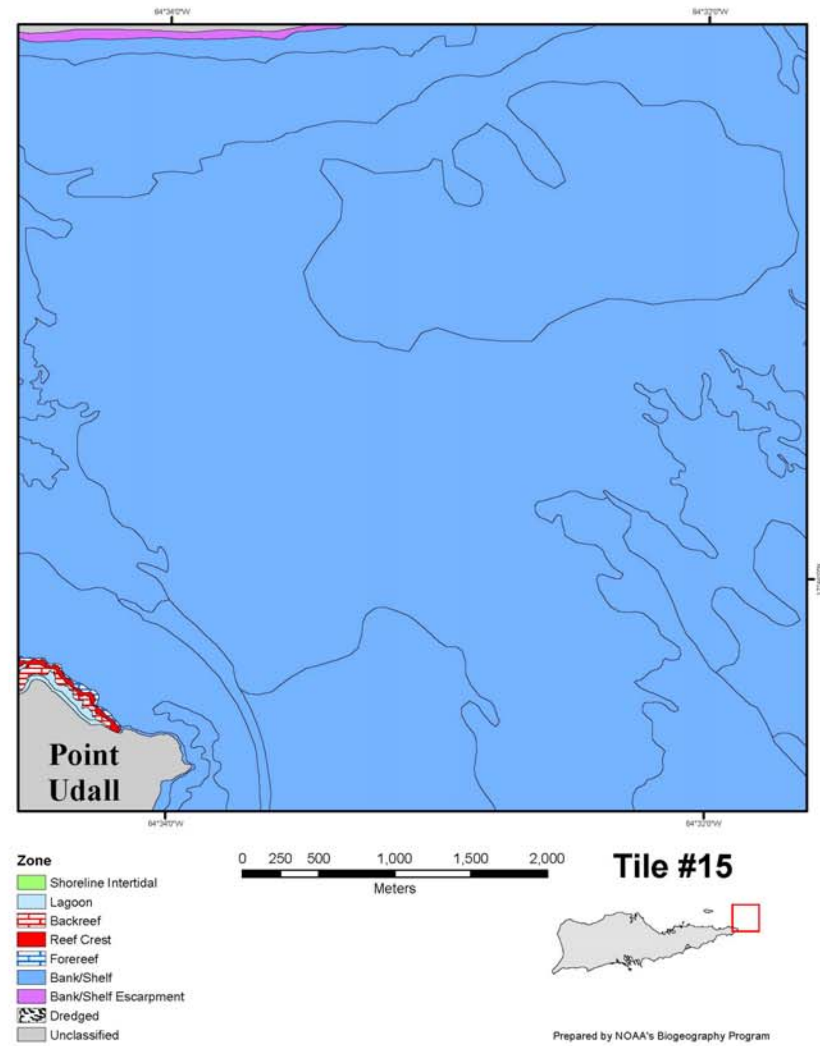

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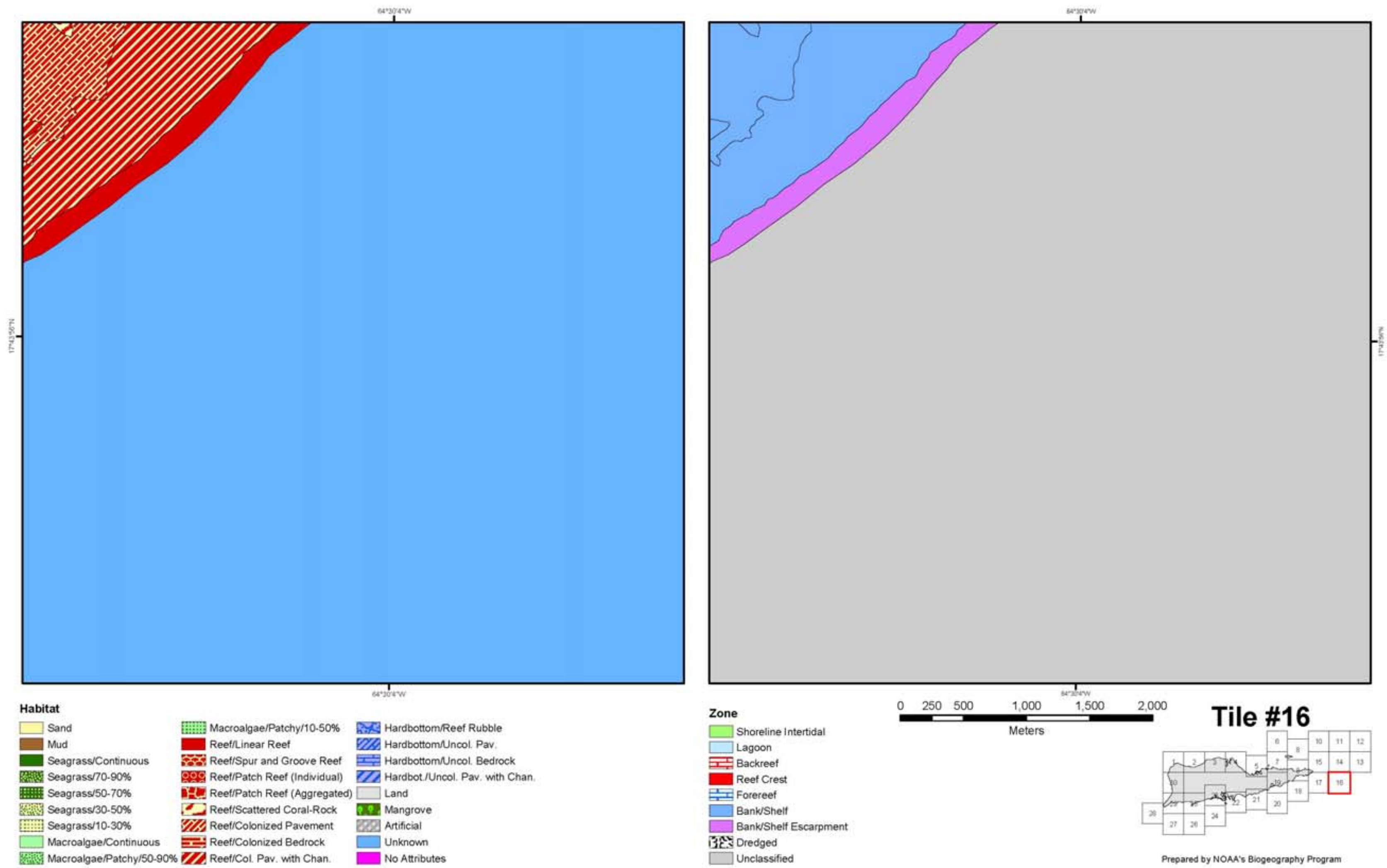

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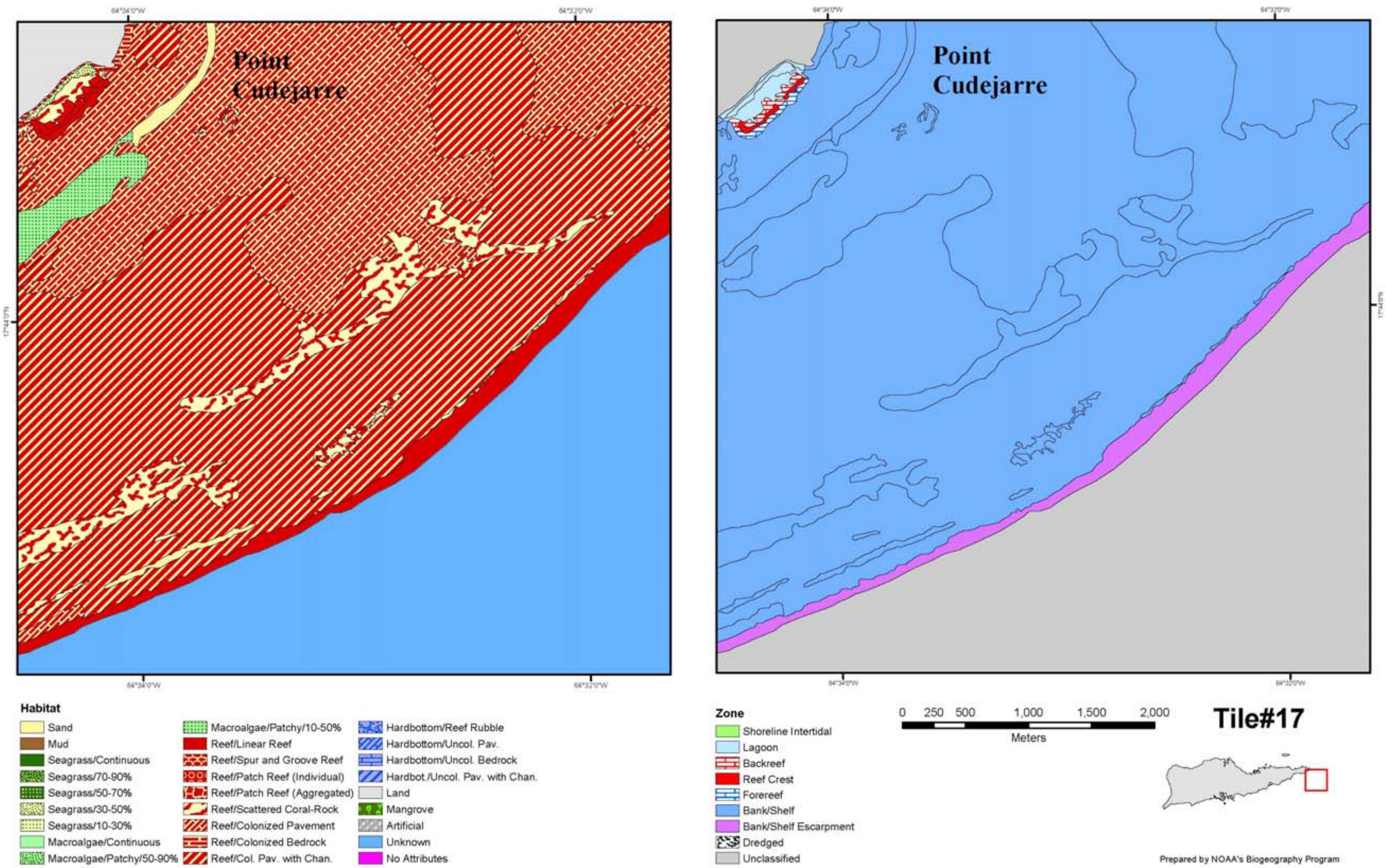

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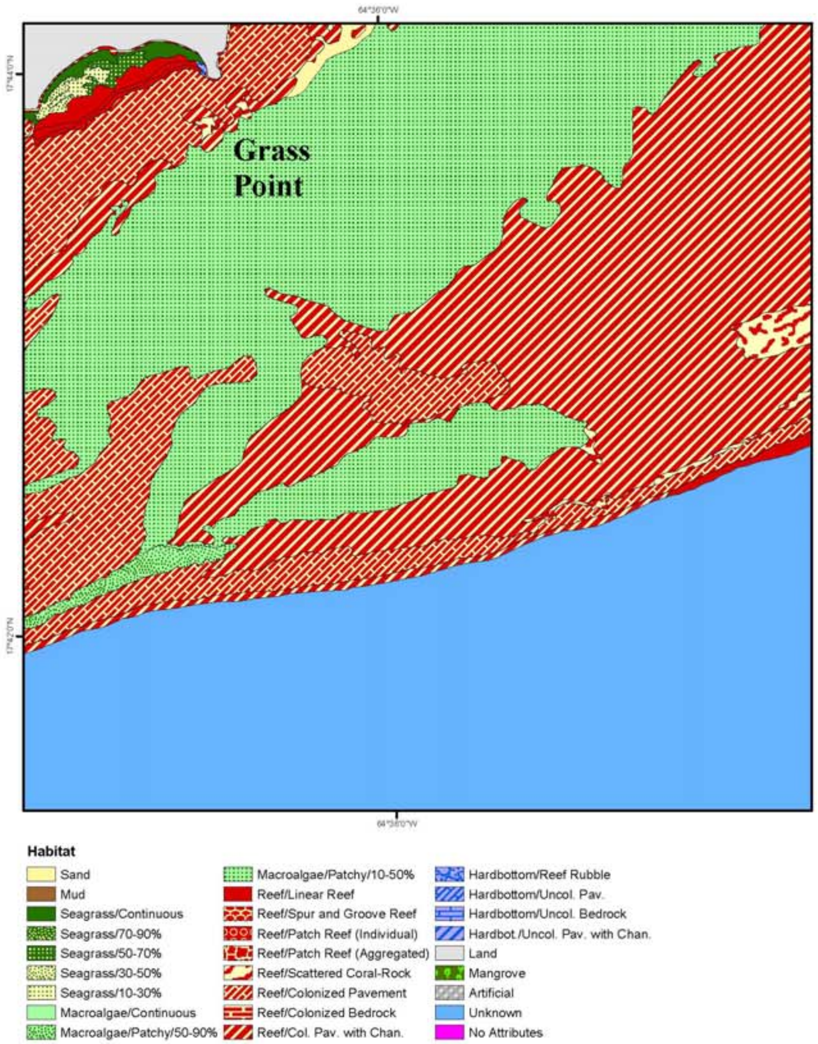

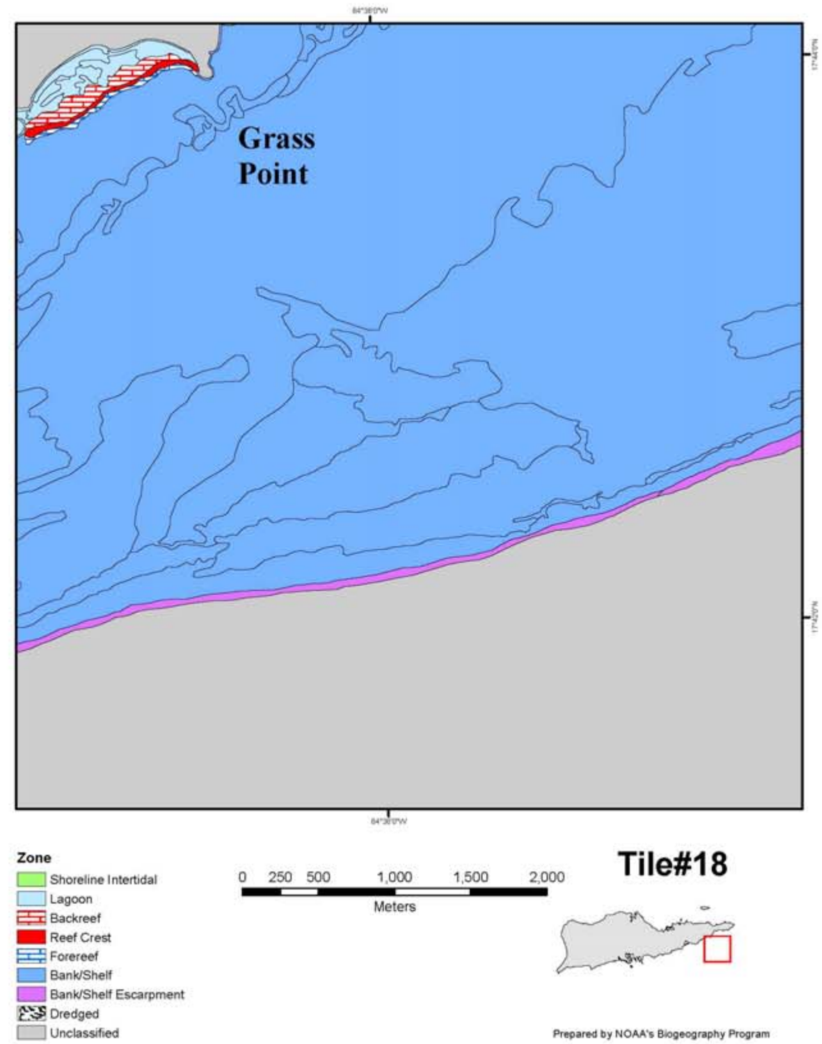

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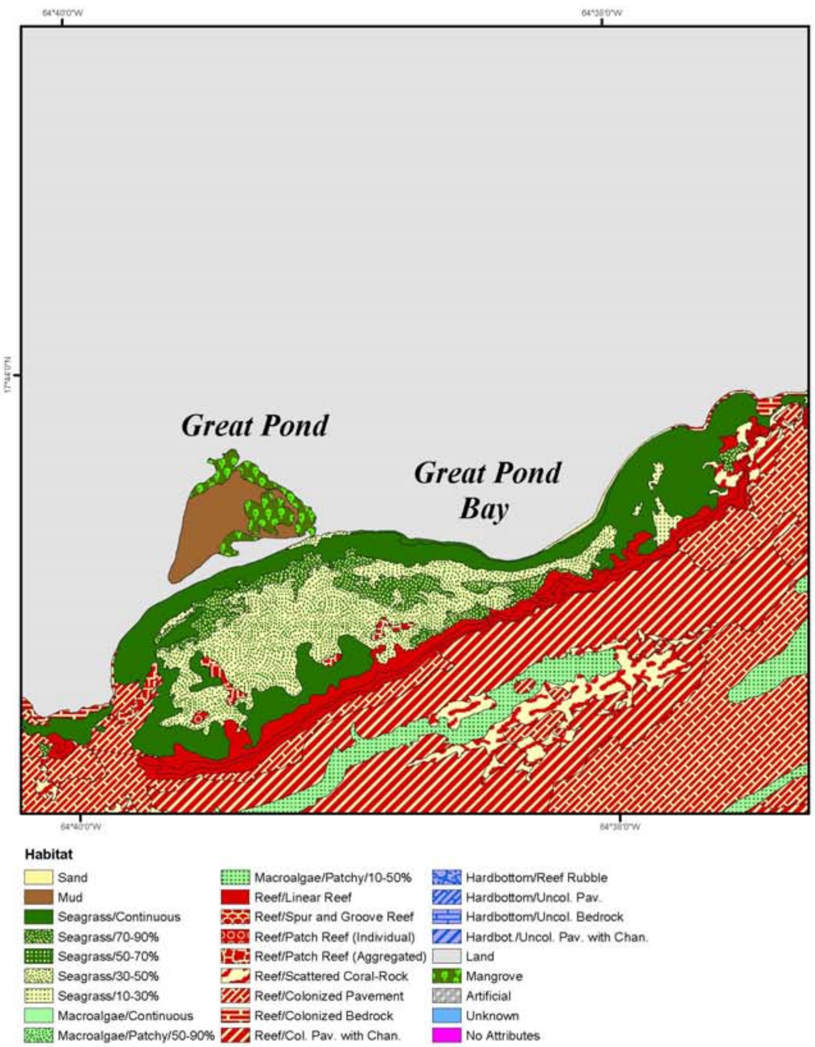

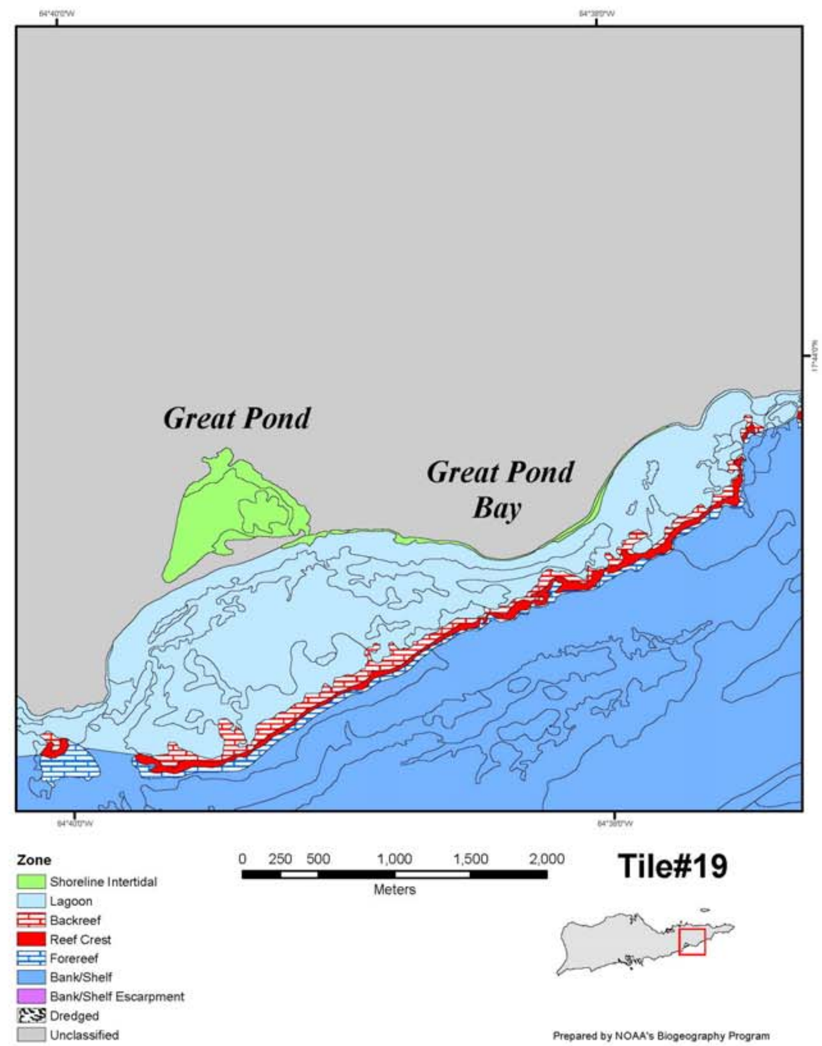

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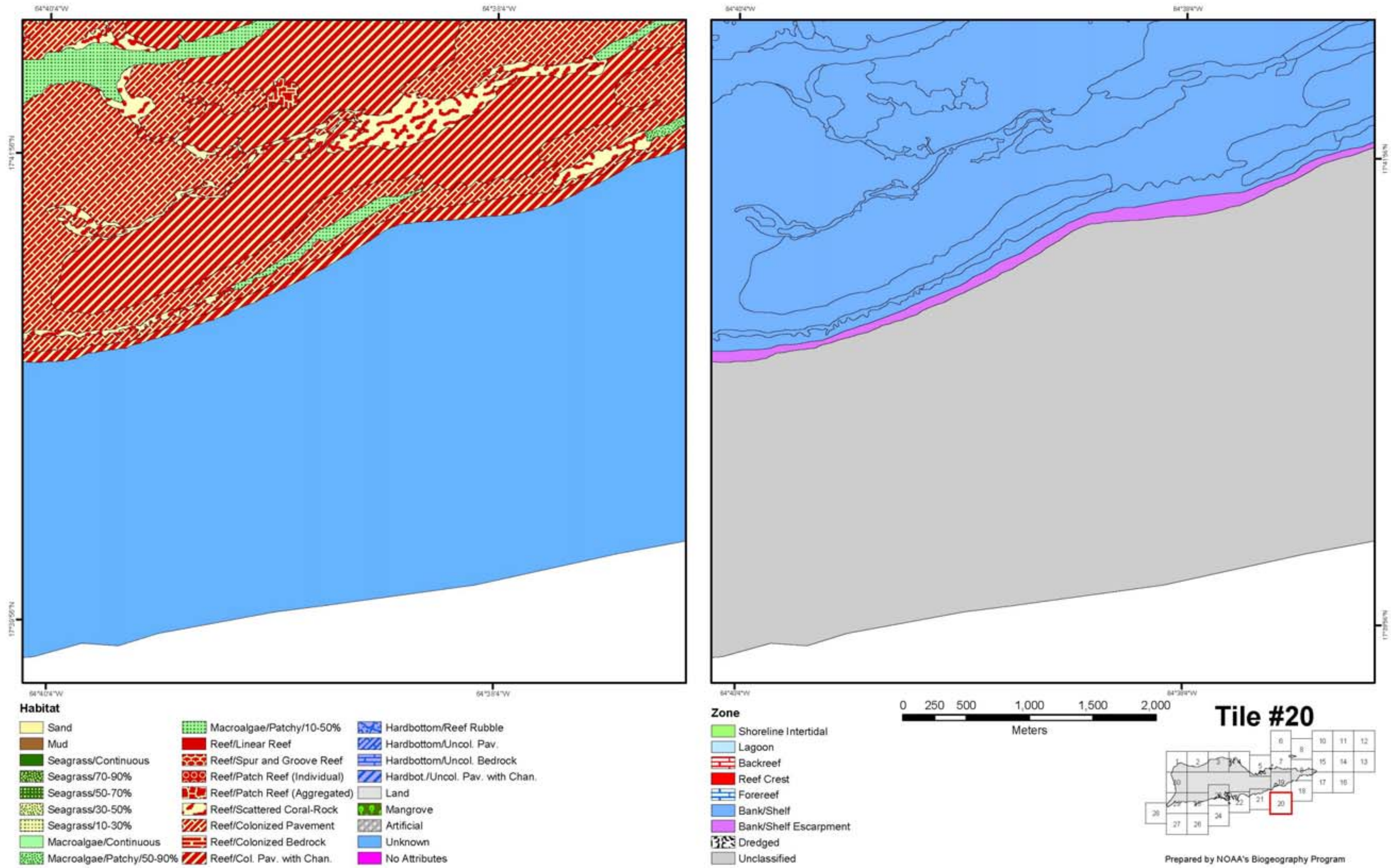

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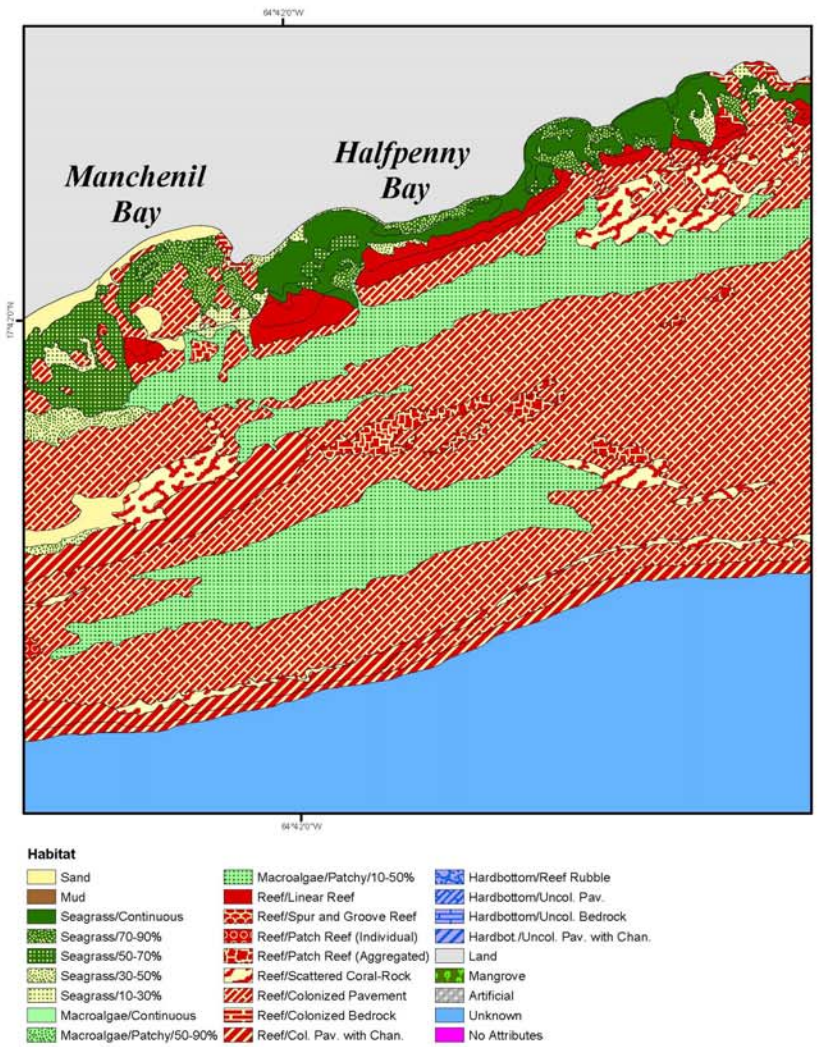

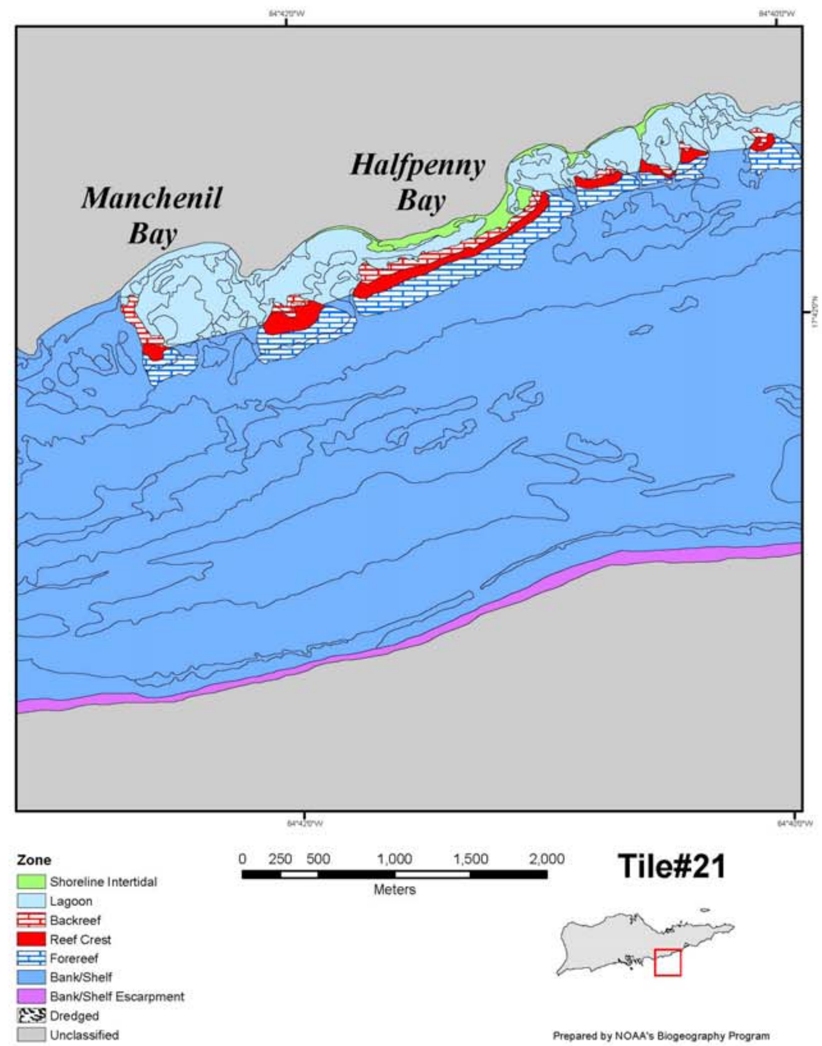

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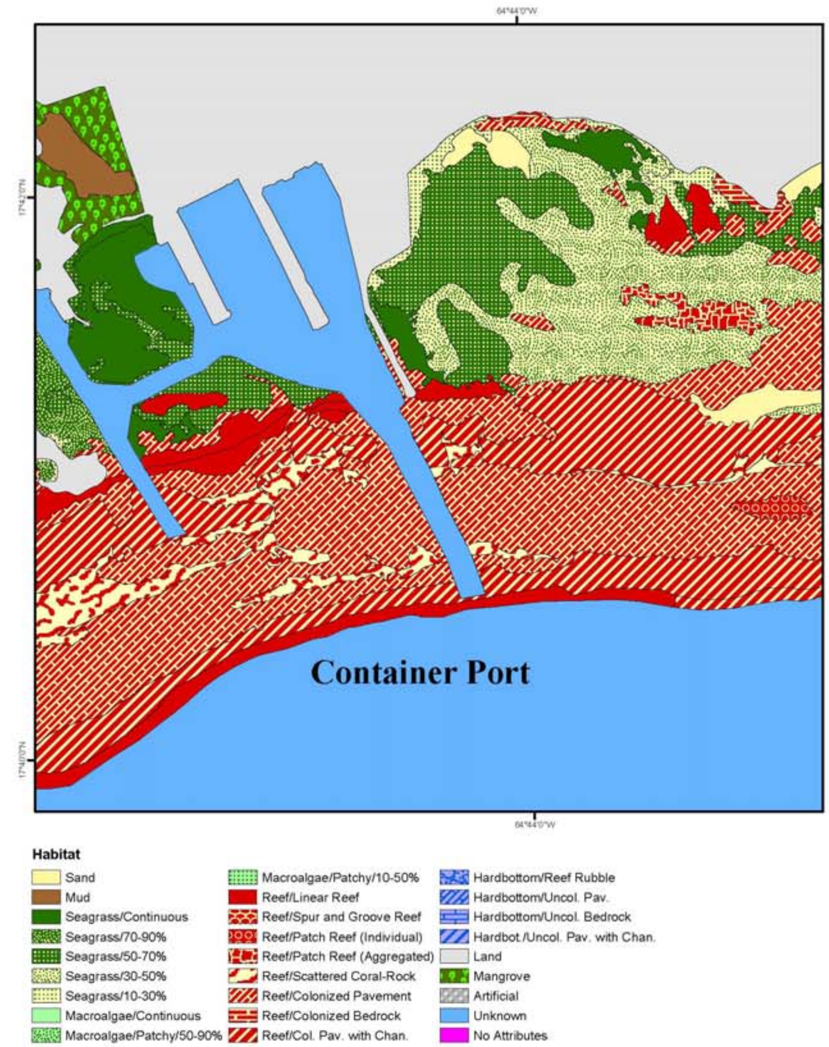

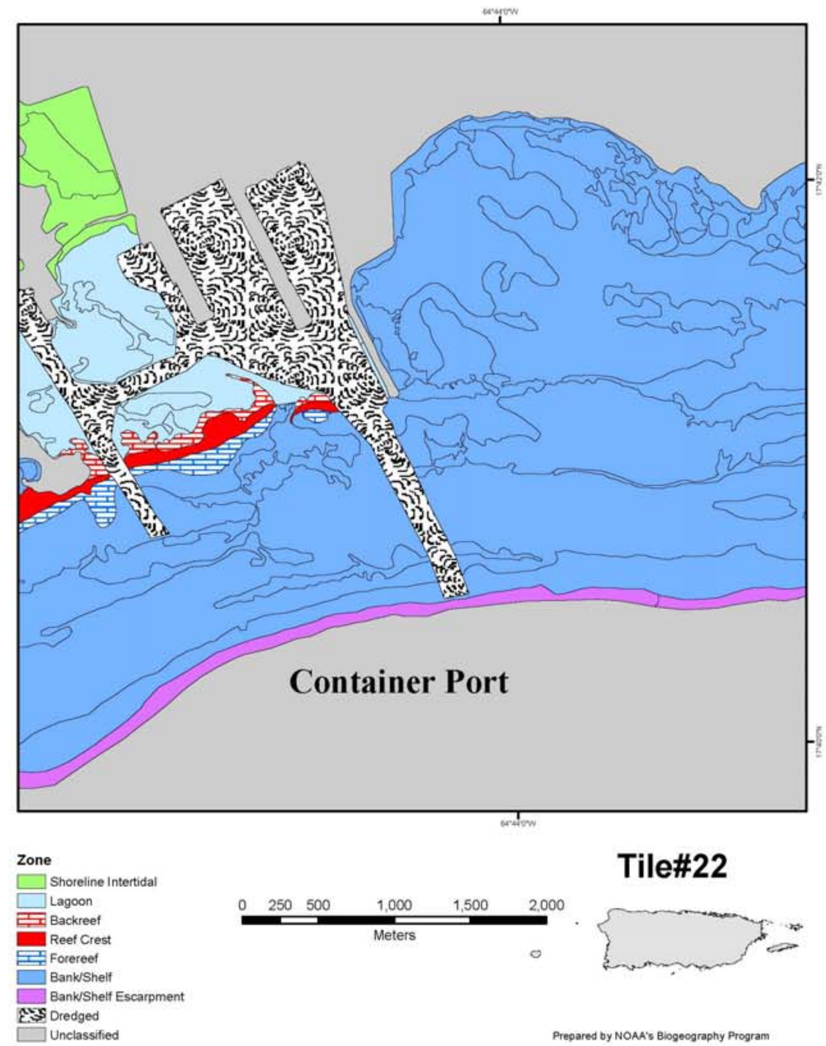

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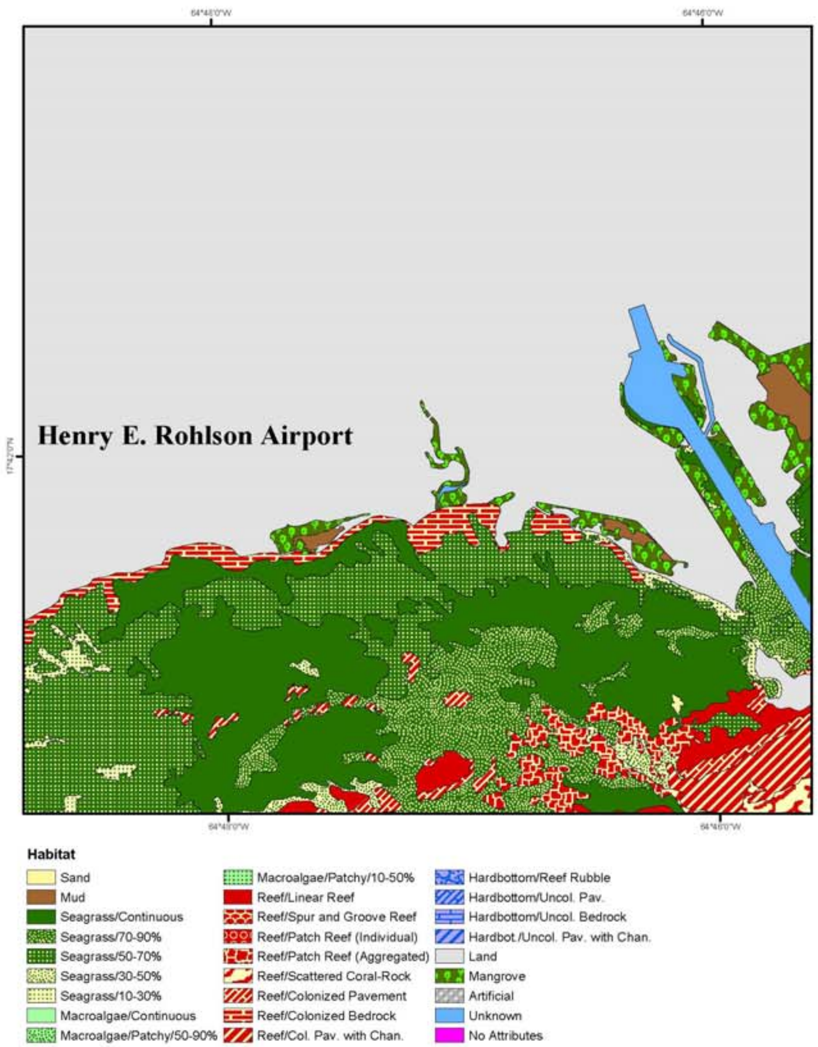

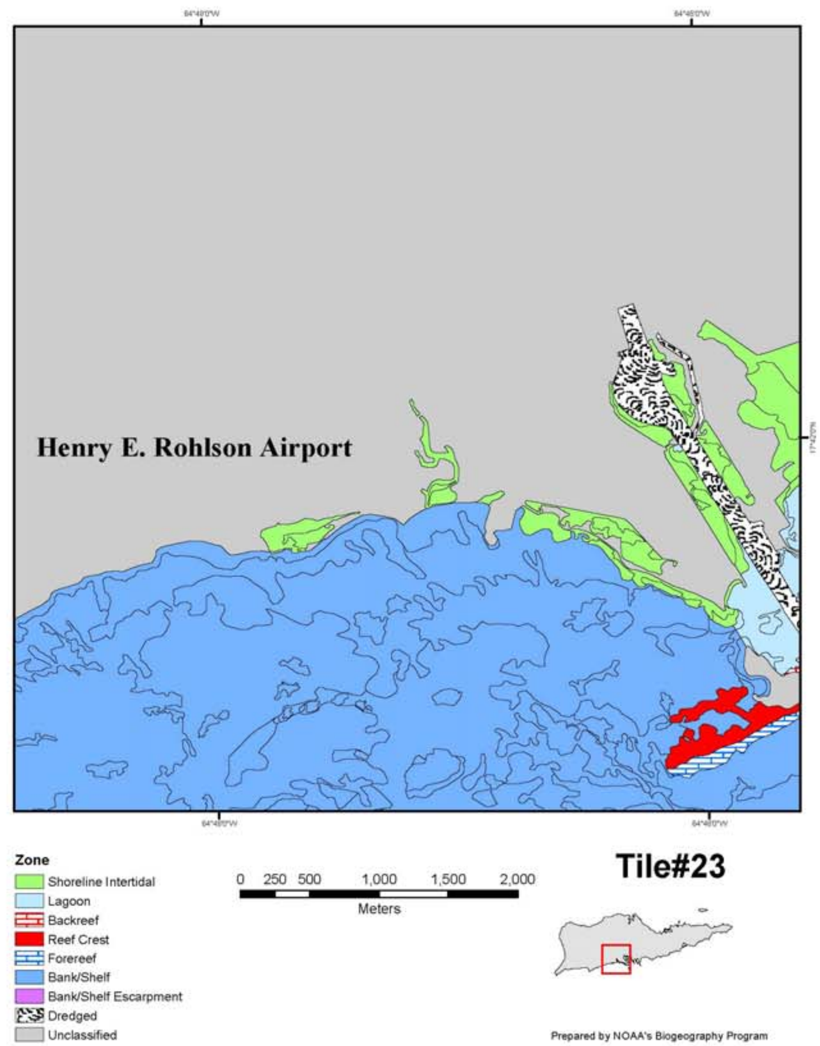

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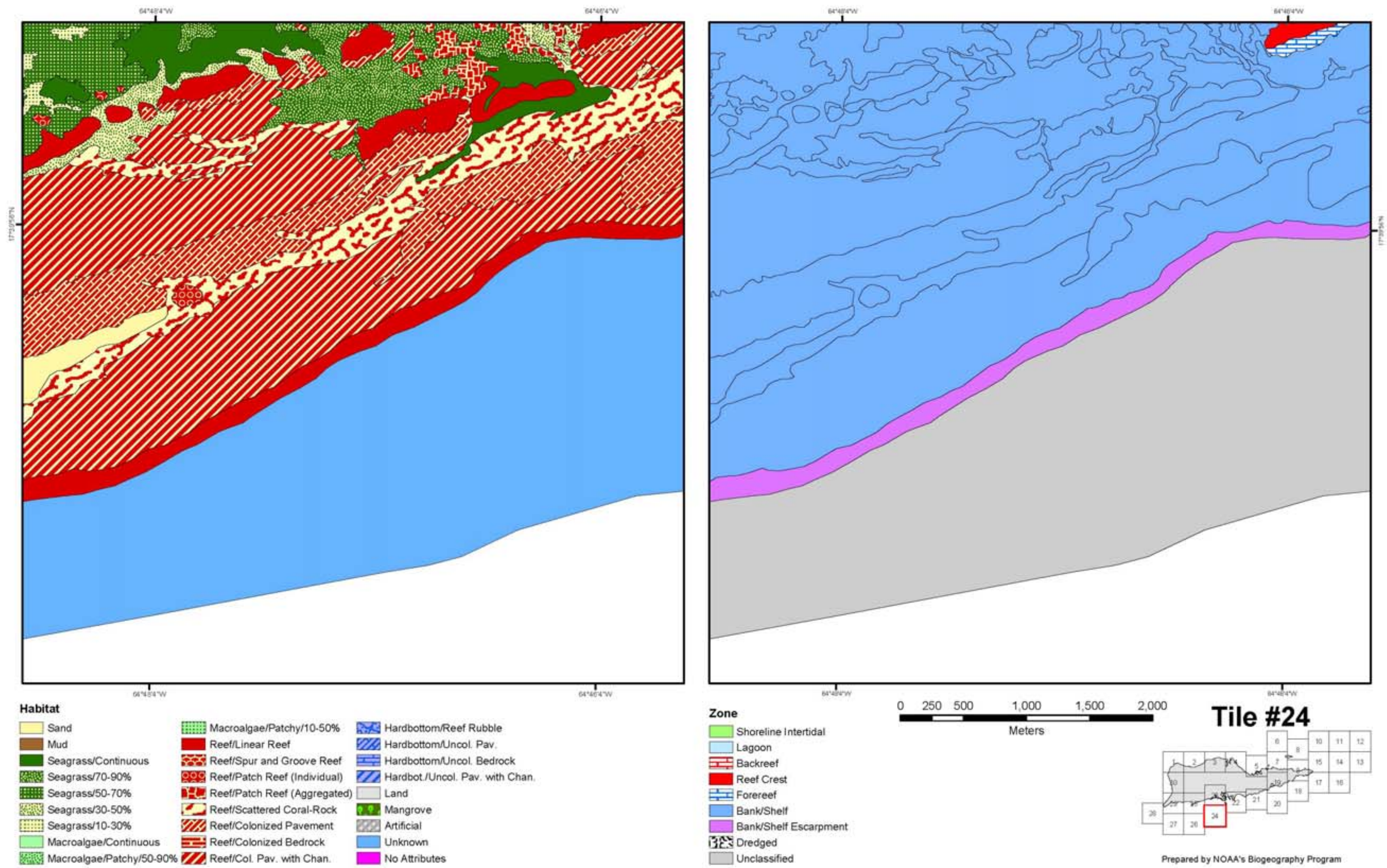

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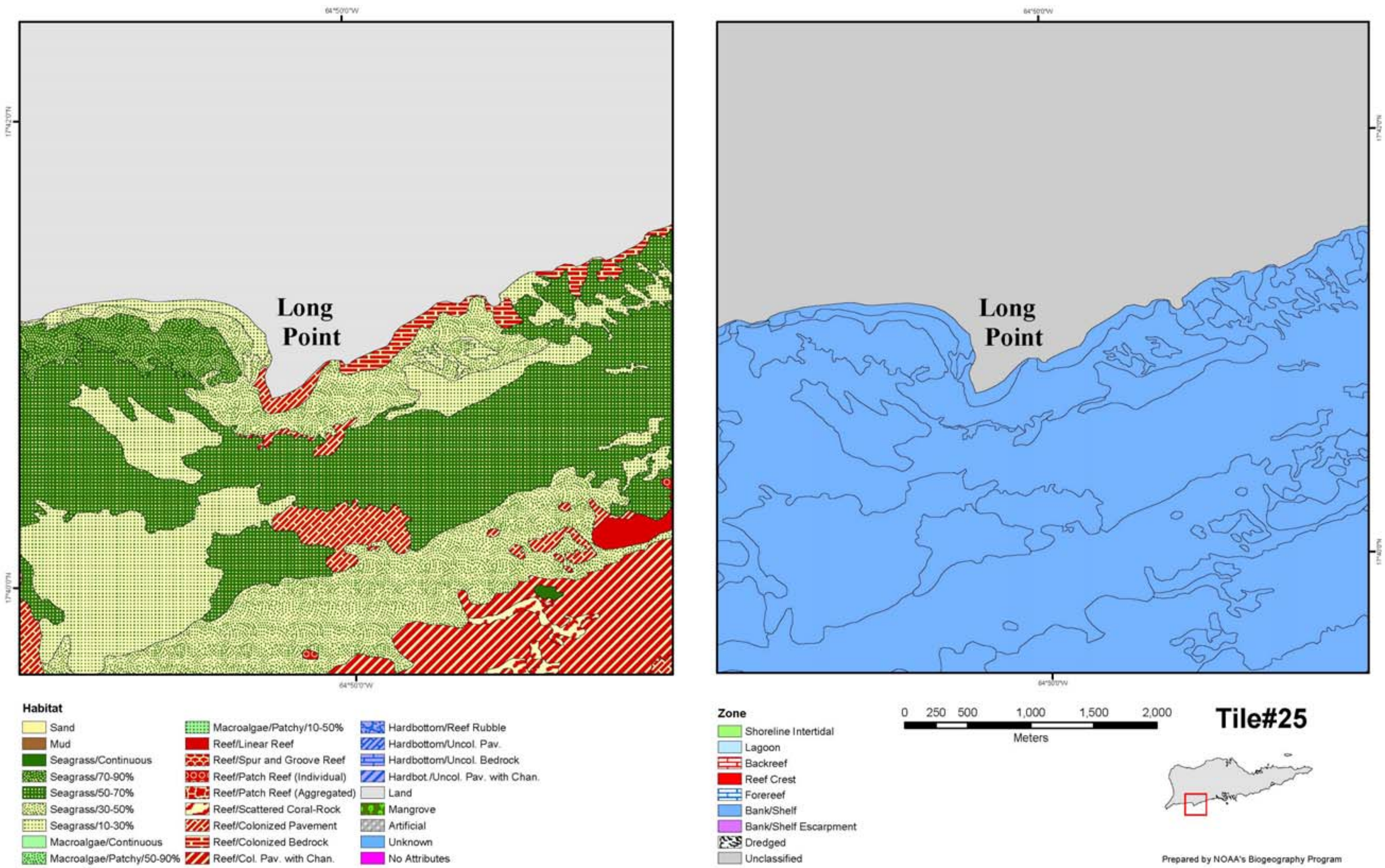

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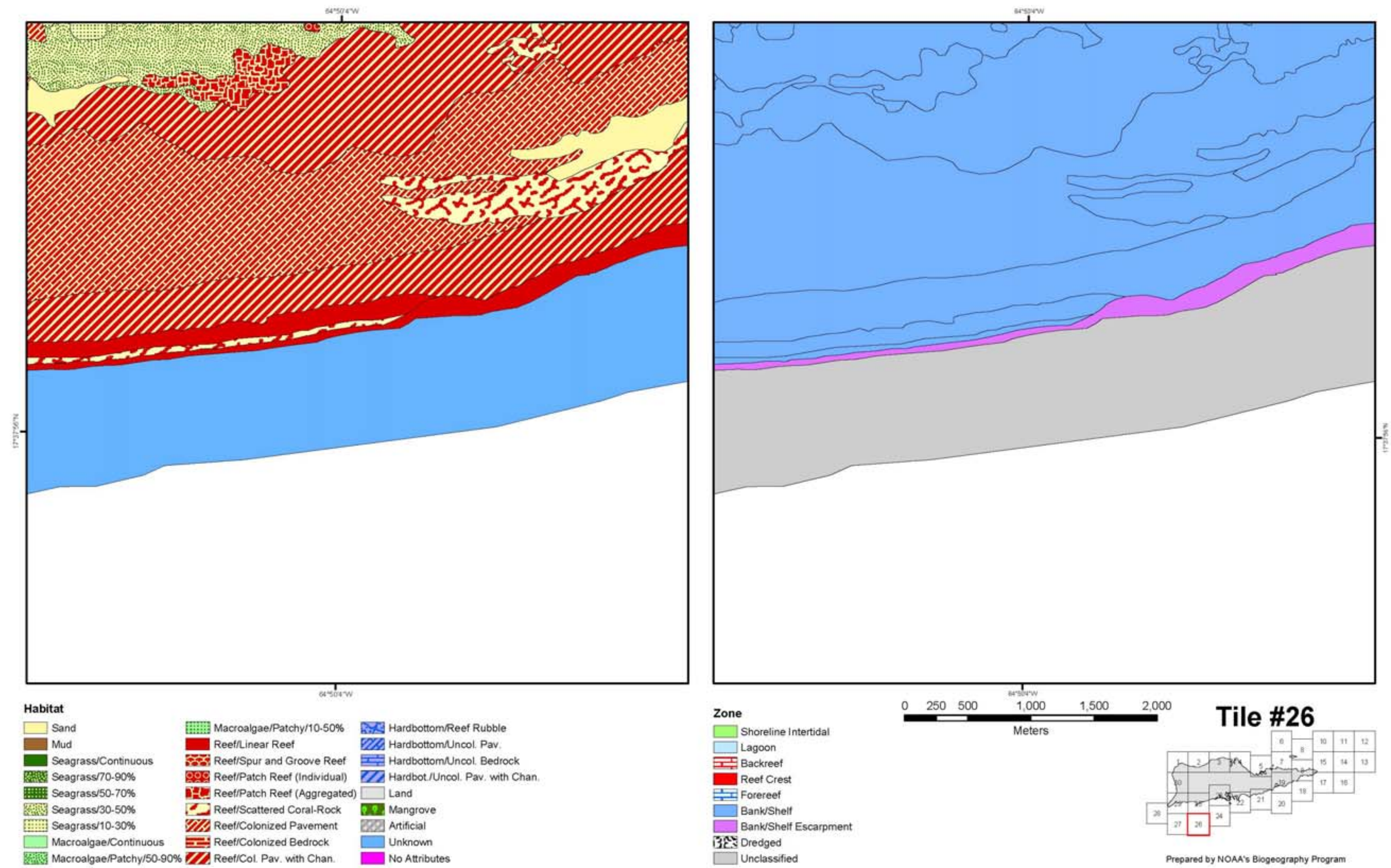

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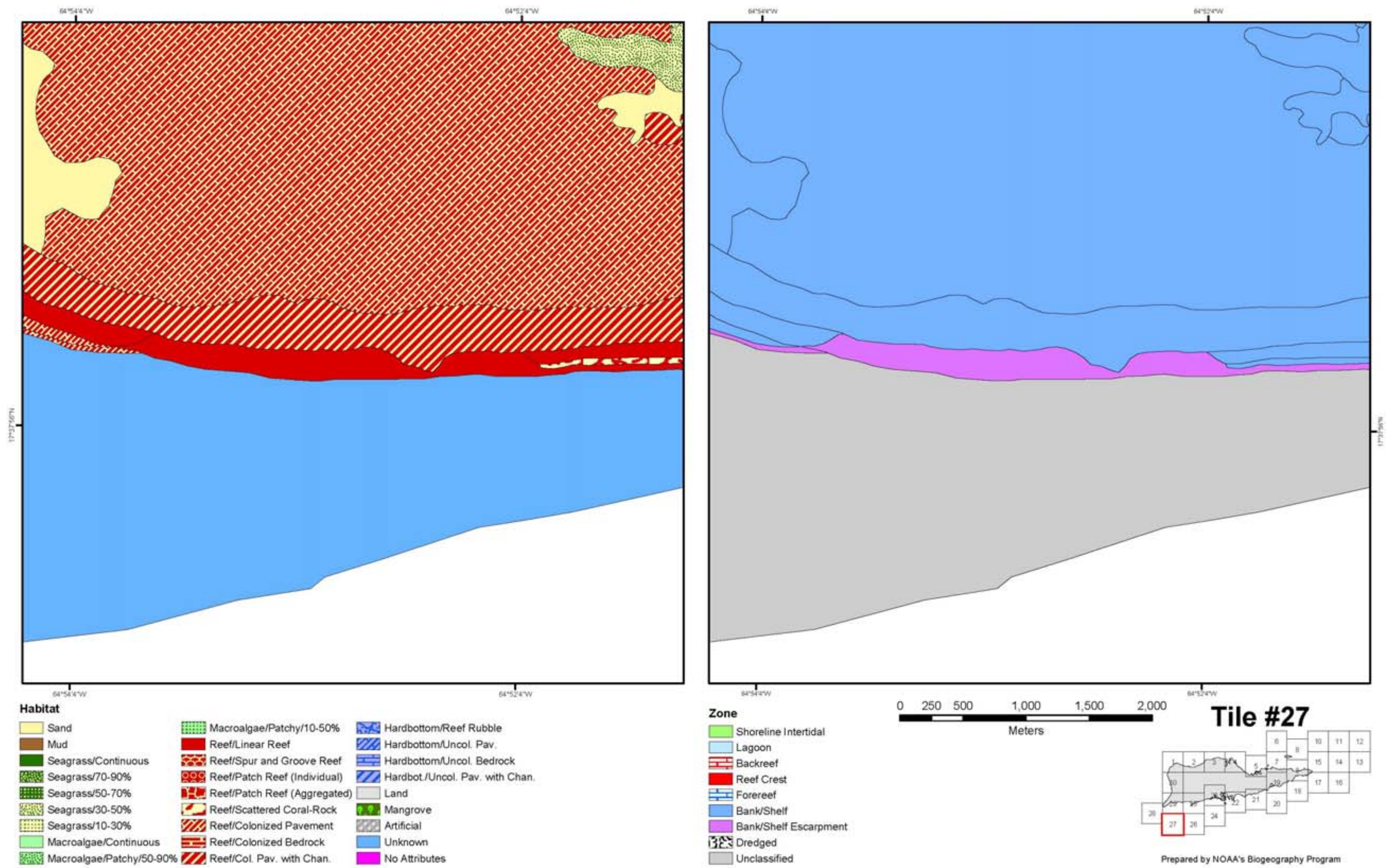

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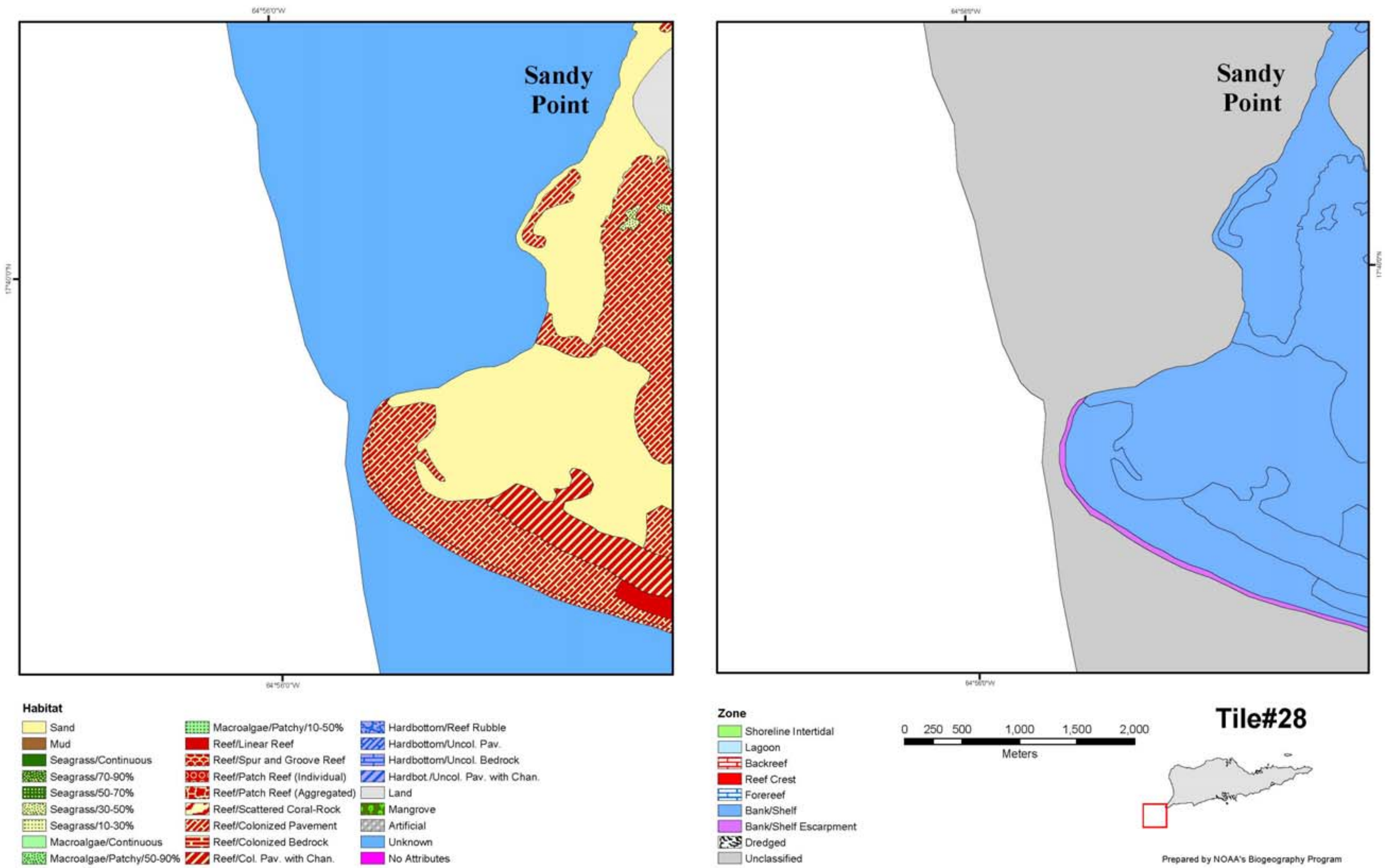

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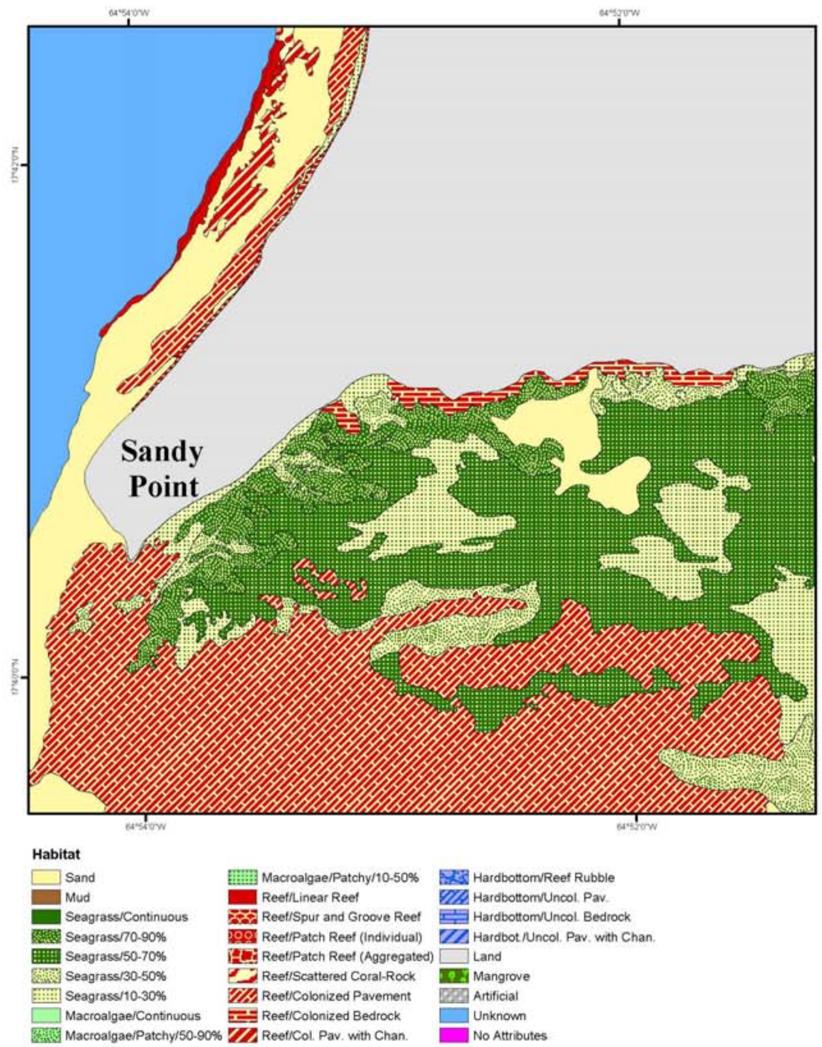

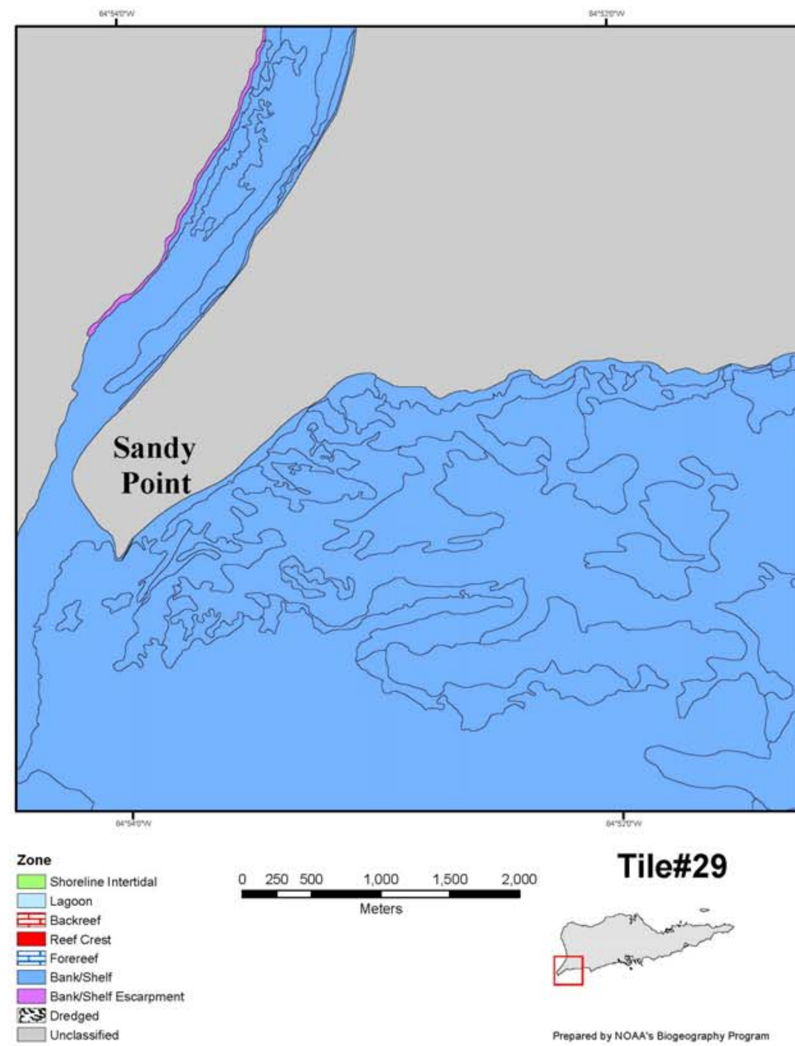

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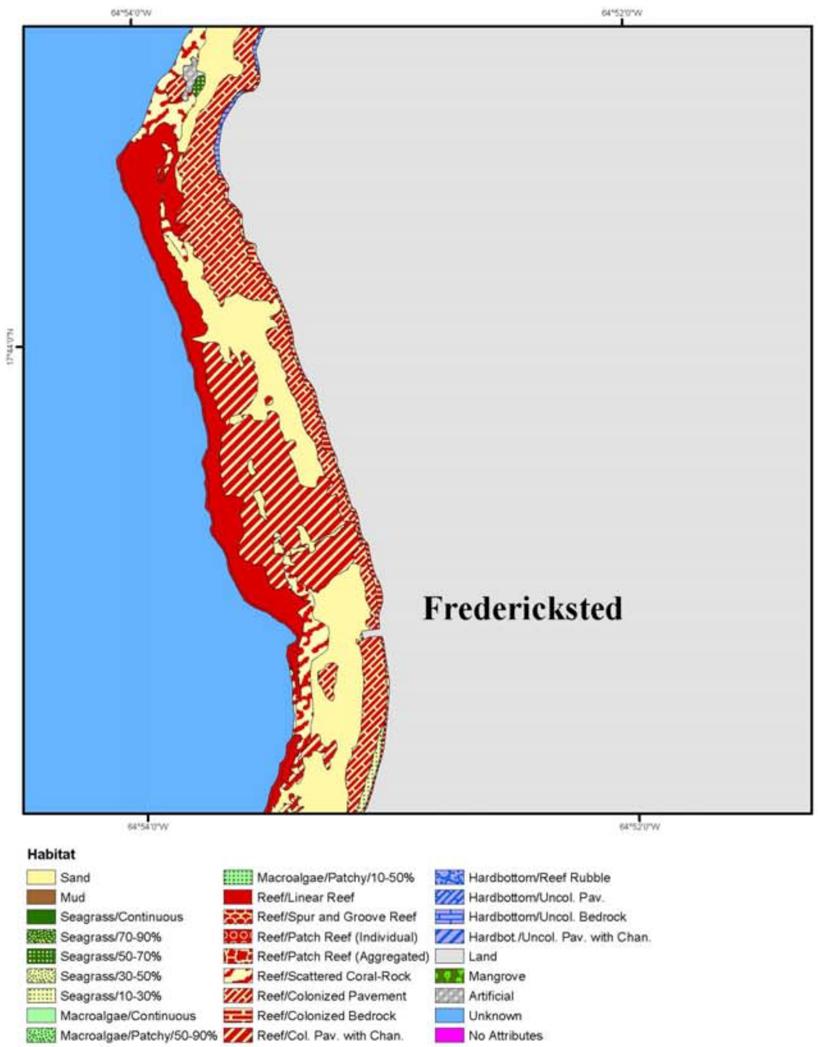
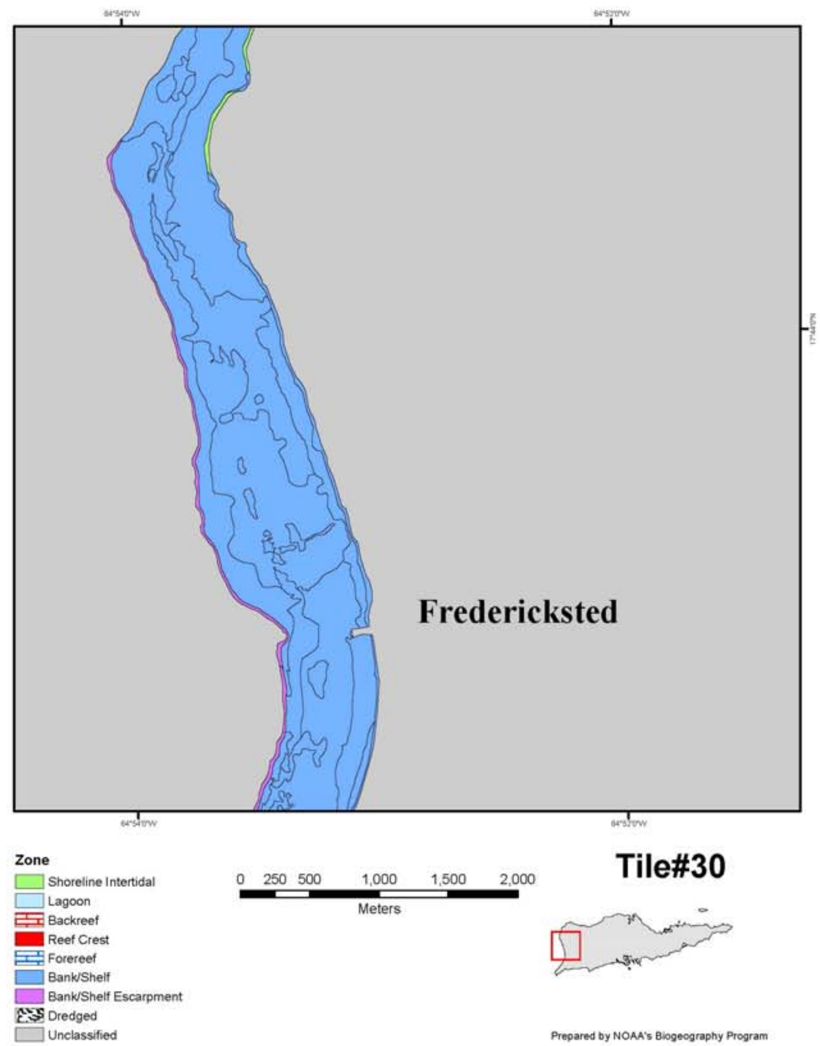




APPENDIX 3
SUMMARY OF MARINE RESOURCES AND FISHERIES REGULATIONS

A. TERRITORIAL REGULATIONS

Territorial waters extend from shore to 3 nautical miles offshore.

Table A3-1. Summary of USVI Territorial Fishing Regulations

	Subject	Summary of Regulation
1	**<u>Whelk:</u>**	
	Size Limit:	Minimum size of shell must be greater than 2 7/16 inches in diameter.
	Landing Restriction:	Must be landed whole in the shell.
	Closed Season:	April 1-September 30.
2	**<u>Conch:</u>**	
	Size Limit:	Minimum size of 9 inch shell length from the spire to the distal end, or 3/8 inch lip thickness.
	Harvest Quota:	No harvest of undersized conch. 150 conch per day per **permitted commercial fisher**. 6 conch per day per **recreational (personal use) fisher**; not to exceed 24 per boat per day.
	Landing Restriction:	Must be landed alive and whole in the shell at final landing site. No disposal of shell at sea before landing. Taking conch to offshore cays and islands for purpose of removing from shell is prohibited. Transport of conch meat out of shell over open water is prohibited.
	Sale Restriction:	No sale of undersized conch shell or meat from undersized conch. No sale of imported conch meat unless shipment is accompanied by a CITES export permit and shipment is cleared at the Port of Miami.
	Closed Season:	July 1 - September 30.

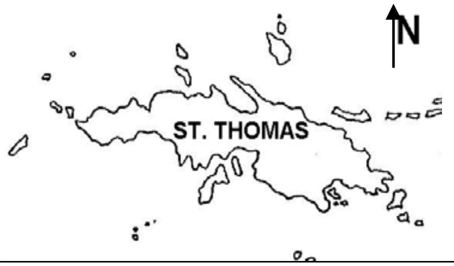
Table A3-1. Summary of USVI Territorial Fishing Regulations (continued)		
	Subject	**Summary of Regulation**
3	**Spiny Lobster:** Size Limit: Landing: Restrictions: Gear Restrictions:	 3 ½ inch carapace length. Must be landed whole No harvest of females with eggs. No spearfishing, hooks or gigs.
4	**Shrimp:**	No commercial harvest in Altona Lagoon and Great Pond. No sale. Recreational permit is required.
5	**Goliath Grouper (jewfish)**	Endangered species. Harvest prohibited; no possession.
6	**Billfish:**	Federal regulations for billfish apply in territorial waters.
7.	**Billfish, Swordfish, Tuna & Shark**:	Federal regulations and federal permit requirements apply in territorial waters.
8	**Mutton Snapper (Virgin Snapper):** St. Croix: Area:	 No harvest March 1 to June 30 within the Mutton Snapper Spawning area (see Appendix 4E map). All fishing is prohibited in the closed area during this period. Joint Territorial and Federal closure is between Long Point and the southwest tip of Sandy Point about 2 miles offshore and is 2.5 miles long and 1 mile wide (see Appendix 4E map).
9	**Sea Turtles**:	Endangered species. No harvest, no possession and no harassment of sea turtles or their eggs.
10	**Aquarium Collecting:**	Permit required from the Department of Planning and Natural Resources Division of Fish and Wildlife offices.

Table A3-1. Summary of USVI Territorial Fishing Regulations (continued)		
	Subject	**Summary of Regulation**
11	**Traps:**	
	District of St. Thomas/St. John	All fish traps must have minimum 2 inch square or 2 inch hexagonal as the smallest mesh used. All fish traps must be inspected and tagged by the Division of Environmental Enforcement.
	District of St. Croix	All old and new traps placed in Territorial waters must have a minimum of 1 ½ inch hexagonal mesh as the smallest mesh on two sides of the fish traps. All fish traps must be inspected and tagged by the Division of Environmental Enforcement.
	Both Districts: Gear Restrictions:	Each trap must have a minimum of one escape panel fastened by biodegradable material (for example, 1/8 inch untreated jute twine). Colors and license numbers must be displayed on each trap.
12	**Nets: Mesh Size** Gear Restrictions:	Haul seines must have mesh size greater than 1 ½ inch stretch mesh. Seines for catching baitfish must have a mesh size greater than 1 ¼ inch stretch mesh. Haul seines and bait seines may not be taken up to the shore or removed from the water to withdraw fish.
13	**Marine Reserves**:	No fishing or collecting of any kind is allowed except as noted below:
	St. James Reserve Boundary:	See Figure A3-1, area "C".
	Permitted Acts:	The use of a cast net with a minimum square mesh size of one quarter (1/4) inch to capture bait fish ("fry") within 50 feet of the shoreline. Cow and Calf Rocks (in area "C" on Figure A3-1 map) are off-limits and are not considered as shorelines. Hook and line fishing is allowed with a permit.
	Fishing Permits:	A special monthly permit obtained from the Division of Environmental Enforcement is required to catch baitfish or hook & line fish in the Reserve.

Table A3-1. Summary of USVI Territorial Fishing Regulations (continued)		
	Subject	**Summary of Regulation**
	Cas Cay/Mangrove Lagoon Reserve Boundary:	See Figure A3-1 map, area "B" and area "D".
	Permitted Acts:	The use of a cast net with a minimum square mesh size of one quarter (1/4) inch to capture bait fish ("fry") within 50 feet of the north and west shorelines of Cas Cay only.
	Fishing Permits:	A special monthly permit obtained from the Division of Environmental Enforcement is required to catch baitfish in the Reserves.
	Prohibited Acts:	In the Inner Mangrove Lagoon (see Figure A3-1 map, area "D"), no fishing, no traps, and no seines. In short, no take at all. Use of internal combustion engines is prohibited.
	Compass Point Marine Reserve and Wildlife Sanctuary, St. Thomas	See Figure A3-1 map, area "A". Designated September 24, 1992. No fishing, hunting or taking of any plant or animals within the marine reserve and wildlife sanctuary.
	Salt River Marine Marine and Wildlife Sanctuary, St. Croix.	Designated July 19, 1995. Regulations are pending that will prohibit fishing or harvest of fisheries resources within the Sanctuary. Contact the Division of Environmental Enforcement for up-to-date regulations at 773-5774.
	The Small Pond at Frank Bay Wildlife and Marine Sanctuary, St. John	Designated on March 24, 2000, signed on April 11, 2001. There are numerous specific prohibitions regarding the sanctuary. Those that relate to fisheries include the following: no hunting, fishing or harvest of fisheries or wildlife resources; the use of a motorized vessel is prohibited within Frank Bay Pond.
14	**Territorial Marine Parks**: St. Croix East End Marine Park	Designated on January 9, 2003. Regulations are pending that will designate certain restricted zones within the park boundaries. Contact the Division of Environmental Enforcement for up-to-date regulations at 773-5774 or the Marine Park Coordinator at 773-1082 extension 2204.

Table A3-1. Summary of USVI Territorial Fishing Regulations (continued)		
	Subject	**Summary of Regulation**
15	**Altona Lagoon and Great Pond Shrimp Management** a. All seine nets, gill nets and traps are prohibited in Altona Lagoon, Great Pond and their respective connecting channels to the sea. b. All seine nets, gill nets and traps are prohibited in Christiansted harbor within 100 yards of the mouth of Altona Lagoon channel. All seine nets, gill nets and traps are prohibited in Great Pond Bay within 100 yards of the mouth of Great Pond channel. c. No motorized vessels are allowed in Altona Lagoon, Great Pond and their respective connecting channels to the sea. d. A recreational shrimp fishing permit from the Division of Environmental Enforcement is required to harvest shrimp on St. Croix. The annual fee for this license is $10.00. e. Monofilament or nylon cast nets of 3/8 inch square mesh (3/4 inch stretch mesh) may be used to harvest shrimp in Altona Lagoon channel and Great Pond channel. Cast nets of knotless nylon netting are prohibited. f. Cast nets of 1 inch square mesh (2 inch stretch mesh) may be used to harvest fish in Altona Lagoon, Great Pond and their respective connecting channels to the sea. Cast nets of knotless nylon netting are prohibited. g. The sale of southern pink shrimp is prohibited. Vendors selling shrimp must possess a certificate of origin for the shrimp. h. The use of lights to attract shrimp for harvest is prohibited. i. Recreational handlining and rod and reel fishing are permitted in Altona Lagoon, Great Pond and their respective connecting channels to the sea.	

Figure A3-1. Southeast St. Thomas Marine Reserve and Wildlife Sanctuaries

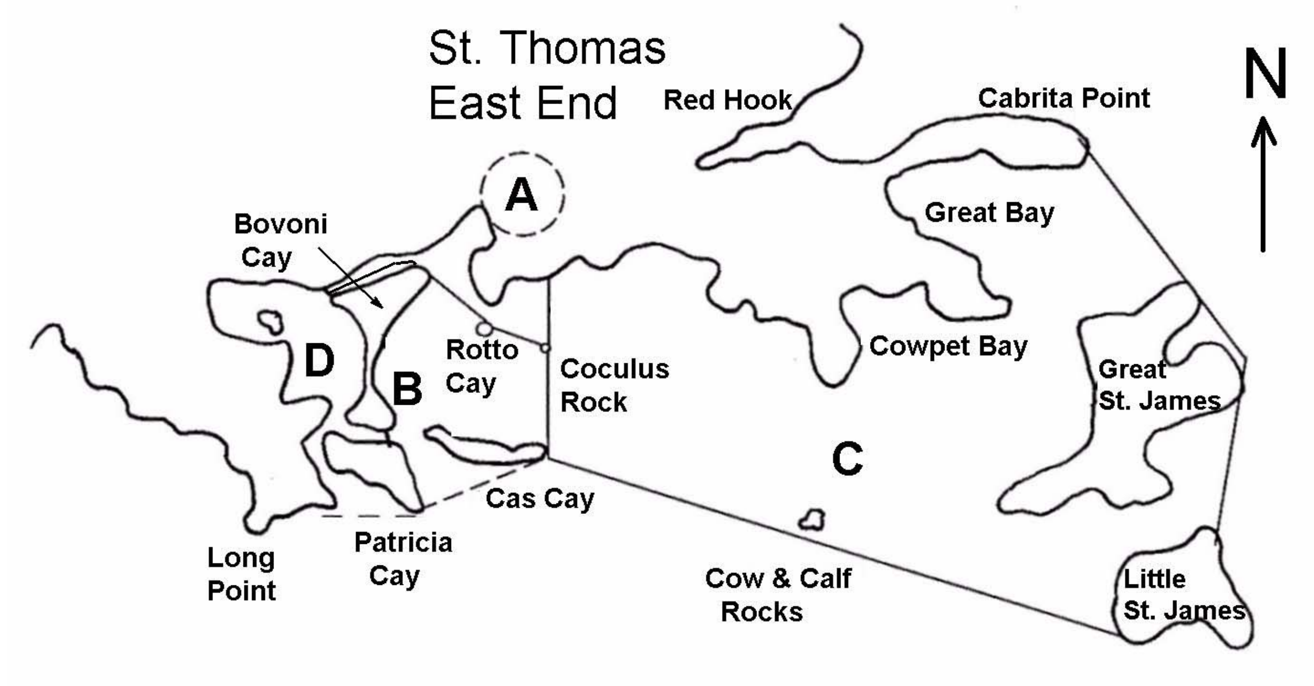


A. Compass Point Pond Marine Reserve and Wildlife Sanctuary

B. Cas Cay/Mangrove Lagoon Marine Reserve and Wildlife Sanctuary

C. St. James Marine Reserve and Wildlife Sanctuary

D. Inner Mangrove Lagoon (special restrictions)



B. FEDERAL REGULATIONS

Federal waters extend from 3 to 200 nautical miles offshore.

Table A3-2. Summary of Federal Fishing Regulations Applicable to the USVI.

	Subject	Summary of Regulation
1.	**Red Hind:**	
	St. Thomas:	No harvest year round at the Red Hind Marine Conservation District (MCD) southwest of Saba Island (see Figure A3-2 map). All fishing is prohibited in the MCD.
	St. Croix:	No harvest December 1 to February 28 within a 3.5 square mile area east of St. Croix at the head of Lang Bank (see Figure A3-3). All fishing is prohibited in the closed area during this period.
2.	**Mutton Snapper (Virgin Snapper):**	
	St. Croix:	No harvest March 1 to June 30 within the Mutton Snapper Spawning area (see Figure A3-4 map). All fishing is prohibited in the closed area during this period.
	Area:	Joint Territorial and Federal closure is between Long Point and the southwest tip of Sandy Point about 2 miles offshore and is 2.5 miles long and 1 mile wide.
3.	**Yellowtail Snapper:**	
	Size Limit:	12 inches total length.
4.	**Nassau Grouper:**	No harvest or possession.
5.	**Goliath Grouper (jewfish):**	No harvest or possession.
6.	**Seahorses:**	No harvest or possession.
7.	**Foureye, Banded, Longsnout Butterflyfishes:**	No harvest or possession.

Table A3-2. Summary of Federal Fishing Regulations Applicable to the USVI.		
	Subject	**Summary of Regulation**
8.	**Queen Conch:**	
	Minimum Size:	9 inch shell length from spire to the distal end of shell, or 3/8 inch lip thickness. No harvest of undersized conch.
	Harvest Quota:	**Commercial:** 150 conch per day. **Recreational:** 3 conch per day not to exceed 12 per boat.
	Landing Restriction:	Must be landed whole in the shell at final landing site. No disposal of shell at sea prior to landing. Taking conch to offshore cays and islands for purpose of removing from shell is prohibited. Transport of conch meat out of shell over open water is prohibited.
	Gear Restriction:	No use of hookah gear.
	Sale Restriction:	No sale of undersized conch or conch shell. No sale of imported conch meat unless shipment is accompanied by a CITES export permit and shipment is cleared at the Port of Miami.
	Closed Season:	July 1 – September 30.
9.	**Marine Aquarium Fish:**	May harvest only by a hand-held dip net or a hand-held slurp gun.
10.	**Billfish:** Minimum Size Regulations:	**No commercial harvest; no sale** Blue Marlin– 99"LJFL (Lower Jaw Fork Length) White Marlin – 66" LJFL Sailfish – 63" LJFL Swordfish – 47" LJFL (see #11 below) Long Bill Spearfish – Retention is prohibited.

Table A3-2. Summary of Federal Fishing Regulations Applicable to the USVI (continued)		
	Subject	**Summary of Regulation**
11.	**Billfish, Swordfish, Tuna & Shark:**	The NOAA - Fisheries, Highly Migratory Species Management Division, through the Magnusen-Stevens Fishery Conservation and Management Act and the Atlantic Tunas Convention Act, regulates billfish, swordfish, tuna, and sharks in all waters of the Atlantic Ocean, Gulf of Mexico and Caribbean Sea.
	Permits:	**All owners/operators of commercial and recreational vessels harvesting swordfish and certain species of tuna described below and all dealers of these species MUST obtain the required Federal permits**:
	Recreational:	The NOAA – Fisheries requires that all vessels involved in the recreational billfish fishery to register and purchase a Highly Migratory Species Permit (HMSP) to participate in billfish fisheries in the Atlantic, Caribbean, and Gulf of Mexico. The permit also covers tuna (excluding blackfin), sharks, and swordfish. Permit holders are required to report total landings of species covered by HMSP to NOAA - Fisheries.
	Commercial:	Commercial fishers must obtain a federal harvest permit to catch and keep yellowfin, bigeye, bluefin, skipjack and albacore tunas. Commercial fishers must obtain a federal dealer's permit to sell any of the above regulated tuna species. A commercial harvest permit does not allow participation in HMS Recreational tournaments.
	Permit Application:	Permit applications are available at the Division of Fish and Wildlife offices in St. Croix and St. Thomas. For permit information or questions regarding HMSP regulations, contact: Highly Migratory Species Management Office, NOAA-Fisheries 1 Blackburn Drive Gloucester, MA 01930-2298 Phone: 978-281-9260 or 888-872-8862 or Christopher Rogers, Chief Highly Migratory Species Management Division Office of Sustainable Fisheries, NOAA-Fisheries 1315 East-West Highway Silver Springs, Maryland 20910-3282 Phone: 301-713-2347

Table A3-2. Summary of Federal Fishing Regulations Applicable to the USVI (continued)

	Subject	Summary of Regulation
11.	**Billfish, Swordfish, Tuna & Shark:**	
	Size Restrictions:	The commercial and recreational minimum legal harvest size for yellowfin and bigeye tuna is 27" fork length. The recreational minimum for bluefin tuna is 27", however, check NOAA - Fisheries for current commercial bluefin limits.
	Bag Limit:	Recreational bag limit (possession) is 3 yellowfin tuna per person per day. No limit for bigeye, albacore, and skipjack tunas. Check NOAA - Fisheries for current bluefin limits.
12.	**Sea Turtles:**	Endangered species: No harvest, no possession and no harassment of sea turtles or their eggs.
13.	**Traps:**	
	Minimum mesh size:	1 ½ inch hexagonal bare wire or 2 inch if coated.
	Gear Restrictions:	Two escape panels of 1 ½ inch hexagonal or 2 inch square mesh located on two different sides of the trap excluding top, bottom or side containing trap entrance. Escape panels must measure not less than 8" x 8" and must be fastened by biodegradable material (for example, 1/8 inch untreated jute twine) and may not be wrapped or overlapped.
14.	**MARINE RESERVES:**	No fishing or collecting allowed except as noted below:
	Hind Bank Marine Conservation District	See Figure A3-2 map. Fishing for any species or anchoring of fishing vessels is prohibited year round within the Hind Bank Marine Conservation District.

Figure A3-2. Hind Bank Marine Conservation District, St. Thomas, USVI

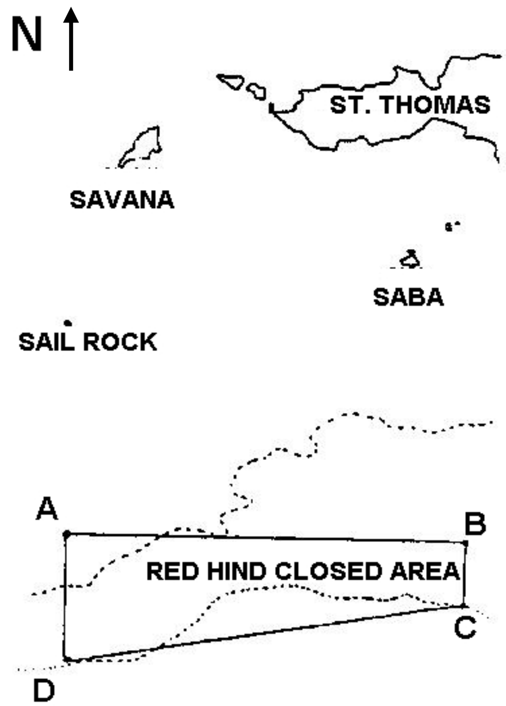
Public Notice	Map
HIND BANK MARINE CONSERVATION DISTRICT, ST. THOMAS, USVI THE RED HIND SPAWNING AREA IS CLOSED YEAR ROUND AS STATED IN THE FINAL REGULATIONS OF AMENDMENT ONE OF THE CARIBBEAN FISHERY MANAGEMENT COUNCIL SHALLOW WATER REEF FISH FISHERY MANAGEMENT PLAN. FISHING IS PROHIBITED IN THE 14 SQUARE MILE AREA SOUTH OF WESTERN ST. THOMAS. THE FOLLOWING POINTS DEFINE THE CORNERS OF THE CLOSED AREA: A – 18^0 13.2’N, 65^0 06.0’W B – 18^0 13.2’N, 64^0 59.0’W C – 18^0 11.8’N, 64^0 59.0’W D – 18^0 10.7’N, 65^0 06.0’W ANYONE CAUGHT FISHING OR ANCHORING IN THIS AREA WILL BE CONSIDERED IN VIOLATION OF THE CLOSED AREA AND MAY BE GIVEN A FEDERAL FINE UP TO $100,000.00 AND ONE YEAR IN JAIL	

Figure A3-3. Red Hind Closure, St. Croix, USVI

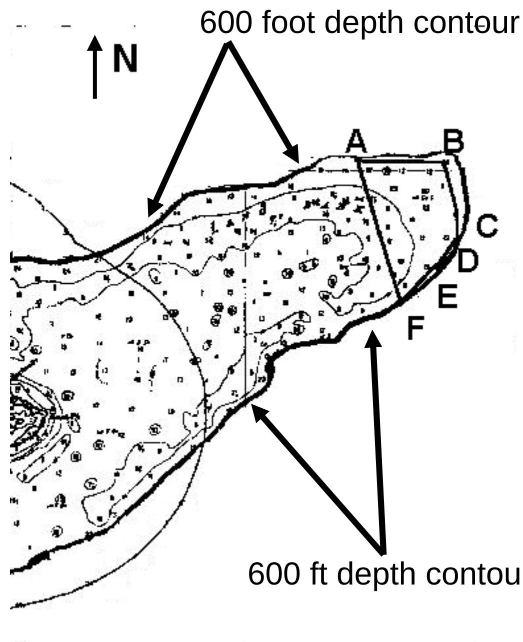
Public Notice	Map
RED HIND CLOSURE, ST. CROIX, USVI THE RED HIND SPAWNING AREA IS CLOSED DECEMBER 1 – FEBRUARY 28 AS STATED IN THE FINAL REGULATIONS OF AMENDMENT ONE OF THE CARIBBEAN FISHERY MANAGEMENT COUNCIL SHALLOW WATER REEF FISH FISHERY MANAGEMENT PLAN. FISHING IS PROHIBITED WITHIN THE APPROXIMATELY 3.5 SQUARE MILE AREA EAST OF ST. CROIX AT THE HEAD OF LANG BANK. THE FOLLOWING POINTS DEFINE THE CORNERS OF THE CLOSED AREA: A – 17^0 50.2'N, 64^0 27.9'W B – 17^0 50.1'N, 64^0 26.1'W C – 17^0 49.2'N, 64^0 25.8'W D – 17^0 48.6'N, 64^0 25.8'W E – 17^0 48.1'N, 64^0 26.1'W F – 17^0 47.5'N, 64^0 26.9'W POINTS 'A' THROUGH 'F' DEFINES THE 50 FATHOM DEPTH CONTOUR. ANYONE CAUGHT FISHING IN THIS AREA WILL BE CONSIDERED IN VIOLATION OF THE CLOSED AREA AND MAY BE GIVEN A FEDERAL FINE UP TO $100,000.00 AND ONE YEAR IN JAIL.	

Figure A3-4. St. Croix Mutton Snapper Spawning Area Closure, March 1 to June 30

<table>
<tr><th>Public Notice</th><th>Map</th></tr>
<tr><td>

ST. CROIX MUTTON SNAPPER SPAWNING AREA CLOSURE MARCH 1 TO JUNE 30

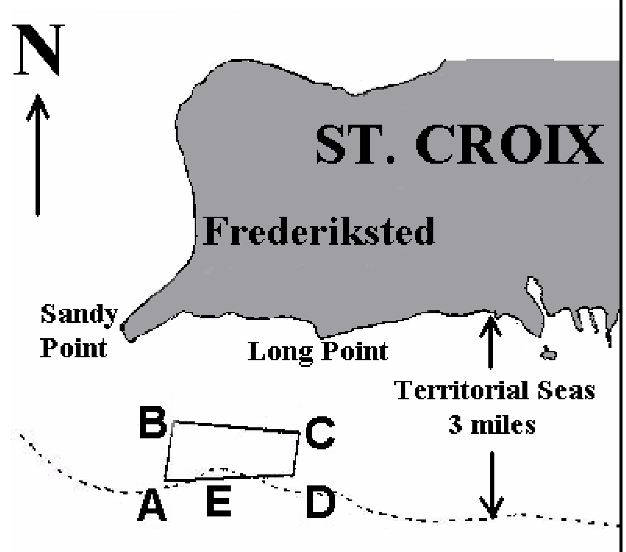
An annual closed season for mutton snapper (virgin snapper) has been established at a spawning aggregation area located off the southwestern coast of St. Croix between Long Point and the southwest cape of Sandy Point. The spawning aggregation area is partly in territorial waters and partly in federal waters. The area closure is 2.5 miles in length, about 1 mile in width, and starts 2.0 miles from shore (see map). Boundaries of the closure are determined by straight lines connecting the following coordinates:

A - 17^0 37.8'N, 64^0 53.0'W
B - 17^0 39.0'N, 64^0 53.0'W
C - 17^0 39.0'N, 64^0 50.5'W
D - 17^0 38.1'N, 64^0 50.5'W
E - 17^0 37.8'N, 64^0 52.5'W

Points D-E-A define the 100 fathom (600 foot) depth contour and mark the southern boundary of the closed area.

The closure commences on March 1 and ends on June 30 of each year. All fishing is prohibited within the closure area during this period. Mutton snapper in Federal waters within this area are protected under Amendment 2 to the Fishery Management Plan for the Reef Fish Fishery of Puerto Rico and the USVI, as prohibited in Federal Register 50 CFR Part 669, Vol. 58, No. 197, Rules and Regulations, pages 53145-53148.

</td><td>



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APPENDIX 4
DRAFT PLAN REVIEW COMMENTS

Most of the comments received by reviewers were incorporated into this plan. However, in some cases, comments made were difficult to incorporate into this plan. The following are comments on the draft management plan received from:

1. Robert McAuliffe, Fishermen's United Services Co-op of St. Croix,
2. David Olsen, St. Thomas Fishermen's Association (STFA), and
3. Jimmy Magner, STFA, to Dean Plaskett, Commissioner of DPNR.

DFW comments are included here as appropriate.

Robert McAuliffe's comments:

1. Any grievances expressed are not with the work of the authors but with the general attitude of the Government officials in denigrating the importance of the commercial fishing community. We will focus on work that is current and of great importance to the St. Croix community, gill and trammel net fishing. The main reference cited is Tobias, W. 2004. Netfishing overview – St. Croix, U.S. Virgin Islands management implications for restrictions on the use of gill and trammel nets.

   Rough time line - FAC records not accessible

   a) Early 2002 - Net fishermen request regulation and enforcement of gill net fishery
   b) Oct. 15, 2002 - FAC ban cited in paper
   c) Nov. 6, 2002 - Gill net proposal by Co-op
   d) Nov. 2002/present - No mention or record of Co-op net proposal
   e) May 2004 - Tobias paper date
   f) Nov. 29, 2004 - FAC letter in support of Net Ban
   g) Jan. 26, 2005 - Statement by Tobias at CFMC meeting to me that he read the Co-op net proposal when first presented and personally rejected it.

2. Even though the Overview in general supports the feasibility of a well regulated gill/trammel net fishery in the district of St. Croix, it recommends a complete ban. **Bias**

3. Because this paper does not fully explore the proposals presented by the affected fishermen on behalf of themselves and their clients it constitutes a **false assumption**.

4. (In reference to *page 197, Chapter 6 and page 228, Chapter 7; re: gillnet priority conservation strategies*) Commercial fishermen feel that a ban on gill and trammel net fishing is unnecessary and should, instead, be well-regulated and managed better.

   DFW comment: The gill and trammel net ban was a St. Croix FAC recommendation.

David Olsen's comments:

1. General comment: page i, Title Page - The problem with this entire plan is that a series of "greenie" DFW directors and Park Service scientists have created an anecdotal record of problems which do not, in fact, exist. Thus, you need to find a way to back track. This is not a plan, but an attempt to use the surveys as a substitute for planning.

   DFW comment: Priority issues and proposed strategies in the draft management plan were identified by various user groups, as manifested in opinion surveys, and through the use of available scientific literature.

2. General comment: page i, Title Page - You also need to address the fact that DFW/DPNR are, in fact, responsible for much of the problem in that you have not analyzed data, have not enforced regulations, and have not addressed major polluters. The lame surveys upon which you base the actions to be taken are of questionable validity and should not be used as a basis for planning.

   We suggest you sit down and say how to:
   1) Work with the major polluters to reduce their impacts over time.
   2) Completely revamp your own enforcement department so that it actually enforces regulations.
   3) Work harder at connecting with local interests which currently view DFW and DPNR as largely antagonistic and irrelevant.
   4) Reactivate DFW so that it carries out research and activities which generate meaningful information required for management.
   5) Address the lack of native born participation in DFW's activities.

   Additionally, there is entirely too much importation of information from outside the Virgin Islands.

   DFW comment: This list of suggestions has been noted on page 192, chapter 6.

3. General comment: page ii, Executive Summary - Congratulations, the term "overfishing" is only used 47 times in this document despite the fact that no evidence is presented to establish its presence.

   DFW comment: The questions in the surveys that solicited responses to fisheries problems and priority issues were open-ended. Respondents wrote in 'overfishing', and is the term used by the respondents in the opinion surveys, not DFW.

4. Page ii, Executive Summary, paragraph 7; re: public opinion surveys - We want to see copies of these surveys. Fishermen are unaware of any surveys.

   DFW comment: Copies have been provided to Dr. Olsen.

5. Page iii, Executive Summary, paragraph 1; re: CFMC identification of species of concern - You are aware of our objections to the CFMC identification of species of concern. The species identified by CFMC may be under pressure in Puerto Rico but no evidence exists to establish problems in the Virgin Islands.

   DFW comment: In this document, the species of concern list (p. 178, chapter 5) is a comprehensive list of species found in V.I. waters, whether identified as threatened/endangered or not. The species of greatest concern list (p. 188, chapter 5) are species that are currently under some sort of restriction in the V.I., or identified as threatened or endangered by various sources.

6. Page iii, Executive Summary, paragraph 2; re: suggestions for addressing USVI marine resource problems - Enhancement through aquaculture should be included in this list.

   DFW comment: This was added to the list of steps to help reduce overfishing in the draft text on page 200, chapter 6.

7. Page 1, Chapter 1 - There is too much emphasis here on closing down fishing and not enough on getting DPNR to do their job of protecting nearshore environment. We maintain that DFW does not know enough about any of the species to justify any of the closures. If you're going to try and do this, we'll go straight to the Senate and get them to require their approval before you submit this. We want a written commitment from DFW regarding this or we will proceed to politicize this issue.

   DFW comment: The closures were a Fisheries Advisory Council (FAC) initiative, not DFW. The distinction between territorial and federal management measures also needs to be made. This plan is a product of the territorial Virgin Islands government and predominately deals with management issues in territorial waters, from 0-3 miles offshore. Federal plans, such as CFMC's management plans, deal with management issues in federal waters, from 3 to 200 miles offshore. As such, fishing closures are primarily a federal management issue.

8. Page 1, Chapter 1, paragraph 2; re: habitat surveys - There is another survey that I did in about 78-80 of habitats. It is primarily of interest since it includes areas of the offshore that Monaco is showing as "unknown". I have probably done more diving in the offshore areas than most and much of Monaco's unknown areas are a calcareous algae rubble and algae habitat that is significant for juvenile settlement and which could be enhanced by additional structure.

   DFW comment: Olsen is probably referring to his paper entitled "An analysis of the St. Thomas fishery with special reference to the benthic communities on the shelf south of St. Thomas, USVI (Olsen et al. 1981). This has been cited.

9. Page 2, Chapter 1, paragraph 1; re: natural resources - Before going any further I want to comment on the circle jerk that is going on about resource status. If you actually read these papers, you will find that Beets made an unsubstantiated statement that Virgin

Islands resources were overfished. Since that time, there have been numerous citations of Beets as if it were fact and citations of subsequent papers which are in fact based upon the earlier unsubstantiated observations. None of these papers has any data or justification for comments regarding overfishing.

DFW comment: It's not clear which of Beets's papers Dr. Olsen is referring to, however Beets (1987) attributes the decline of USVI's fisheries resources to three major factors: 1) the harvest of spawning individuals, 2) the loss of fish habitat/nursery areas, including nearshore reefs and mangroves, due to overdevelopment or inadequate development practices and the resulting pollution, runoff, sedimentation, etc., and 3) the increase in fishing effort, especially in terms of fish trap numbers. With regard to the increase in fishing effort, Beets (1996b) cites several papers including Dammann (1969), Olsen and LaPlace (1978), CFMC (1985), and Appeldoorn et al. (1992).

10. Page 5, Chapter 1, paragraph 2; re: St. Thomas site specific marine resource management plans - There was a proposal for a National Marine Sanctuary in 1982 (?) which was opposed in a Public Hearing. An extensive EIA document was prepared for that proposal.

    DFW comment: See OCZM (1981).

11. Page 5, Chapter 1, paragraph 2; re: "The EEMP is being developed as part of the National Action Plan to Conserve Coral Reefs." - This is not known. We want to see the details of how a Territorial park will be constrained by Federal Regulations.

    DFW comment: See TNC (2002) and LAS (2004). The Local Action Strategy for fishing in St. Croix's EEMP is still in the draft stage.

12. Page 5, Chapter 1, paragraph 2; re: "The overall goal is to implement and expand the existing EEMP Management Plan…" - But you've already blown this by allowing that permit for the Golden Casino by default.

    DFW comment: This was a CZM permit (Application No. CZX-37-03L).

13. Page 7, Chapter 1, paragraph 2; re: CFMC management plans - You should comment on Public response to these plans and their failure to distinguish between Puerto Rico and the Virgin Islands.

    DFW comment: Public response to CFMC's management plans was noted in the draft text.

14. Page 7, Chapter 1, paragraph 5; re: the new Virgin Islands Coral Reef National Monument - You should include the Senate resolution opposing this action and the failure to follow NEPA required processes.

    DFW comment: This was noted in the draft text.

15. Page 8, Chapter 1, paragraph 1; re: "The new VICRNM was established, and existing BIRNM expanded, largely to restore depleted fish populations and protect reef ecosystems." - At no point has anyone established that fish populations are depleted. This language needs to be removed from the entire document.

    DFW comment: This statement was originally taken from the National Park Service (NPS) website ("Marine Reserves Promising Future for Parks") at: http://www1.nature.nps.gov/water/reserves.htm. The word "depleted" has been omitted.

16. Page 8, Chapter 1, paragraph 7; re: "This plan also provides a forum for public input regarding the priority issues of the USVI's marine resources and fisheries." - When and how is this input going to occur?

    DFW comment: User group opinion surveys, external reviews, public meetings, and availability of the draft plan online for public review and comment (http://www.vifishandwildlife.com).

17. Page 9, Chapter 1, paragraph 1; re: "The overall objective of this plan is to manage the fisheries and marine resources in a sustainable manner for the continued benefit of the people of the U.S. Virgin Islands." - Remember this. You have no idea what MSY is and yet you're going to try and manage fishery resources for sustainability.

    DFW comment: There is no reference to MSY here, but this is the <u>overall</u> objective of this plan.

18. Page 22, Chapter 2, paragraph 2; re: 3rd essential element—"Description of problems…" - This document needs to address DPNR's failure to take care of the coastal zone and key habitats that occur associated with the coastal zone.

    DFW comment: DFW is not a regulatory agency.

19. Page 23, Chapter 2, paragraph 2; re: "1) Solicit public and user group input to identify major fisheries and marine resource issues." - I'm not seeing much public input.

    DFW comment: This plan was based largely on user group opinion surveys. In addition, external reviews and input from public meetings were utilized, and the draft plan has been available online for public review and comment (http://www.vifishandwildlife.com).

20. Page 23, Chapter 2, paragraph 2; re: "9) Solicit public and professional comments on this plan." - You should be able to identify necessary studies. This plan should include a research plan for the period covered.

    DFW comment: Public comments were solicited through public meetings and on DFW's website where the draft plan was posted for review by the public. Review comments for the draft plan were also solicited from local professionals involved with fisheries and marine resource issues in the USVI (see page 10 of the preface—Acknowledgements).

21. Page 27, Chapter 2, paragraph 2; re: opinion surveys - My reading of DFW's relationship to the commercial fishing sector is that none of these results can be considered as a valid sampling of user group opinions. DFW is uniformly viewed with suspicion.

    DFW comment: Your opinion is noted.

22. Page 33, Chapter 3, last paragraph; re: colonized hardbottom - I had a NOAA/USGS grant to map habitats west of the airport in about 1980. This included some offshore work in the areas Monaco shows as "unknown". I have seen that study cited as Olsen and McCrain, 1982(?), a DCCA report. Also Kumpf and Randall mapped habitats around St. John in the 60s.

    DFW comment: See Olsen et al. (1981) and Kumpf and Randall (1961).

23. Page 52,Chapter 3, paragraph 3; re: "the main threats to coral reefs in the USVI…fishing…." - Note that the NOAA guy doing the studies of damage from fish traps said that "Damage from fish traps was not as bad as we thought and that it recovers". I don't think that you should just reproduce that alarmist language.

    DFW comment: Opinion noted.

24. Page 54, Chapter 3, paragraph 1; re: "Coastal development that destroys or degrades critical coastal habitats such as estuaries, mangroves, and seagrass beds is a major problem." - This needs to be highlighted more and the DPNR responsibility for not doing anything about it brought out.

    DFW comment: DFW is not a regulatory agency.

25. Page 54, Chapter 3, paragraph 4; re: Fishing activities as an overlooked threat to coral reefs - Note that the NOAA guy doing the studies of damage from fish traps said that "Damage from fish traps was not as bad as we thought and that it recovers". I don't think that you should just reproduce that alarmist language.

    DFW comment: This refers to the fishing activities of <u>all</u> marine resource users, not just trap fishing.

26. Page 54, Chapter 3, paragraph 5; re: "Numerous protected areas have been established world-wide to protect reefs and reef-associated habitats." - Note that Beets and Rogers say that the National Park has not succeeded in protecting resources despite 50 years of protection. Also Monaco, in his mapping study, says that there are more diverse, and bigger, fish outside of the protected areas.

DFW comment: Olsen is probably referring to Rogers and Beets (2001). Also see Beets (1992, 1996a, 1996b), and Beets and Rogers (2000).

27. Page 58, Chapter 3; re: Ship grounding/propeller scour - And yet the tourist boat that parks against the beach and runs its engines is allowed to do exactly this.

    DFW comment: Comment noted, but not added to text.

28. Page 58, Chapter 3; re: Destructive fishing methods - Note that the NOAA guy doing the studies of damage from fish traps said that "Damage from fish traps was not as bad as we thought and that it recovers". I don't think that you should just reproduce that alarmist language. Don't make these statements.

    DFW comment: DFW participated in this study. On St. Thomas unmarked, illegal traps were often placed on reefs. Marked commercial traps were typically located away from reef areas.

29. Page 60, Chapter 3, paragraph 4; re: "bio-statistical data from USVI commercial fisher port sampling program have been collected for reef fish landings on St. Croix for over 20 years." - Why weren't any of these data used in developing the CFMC plan? That plan assumes that PR and the VI landings have the same species make up.

    DFW comment: The problem was that 40% of the bio-statistical data was missing from the Trip Interview Program (TIP) database. This has subsequently been rectified.

30. Page 61, Chapter 3, paragraph 4; re: "BIRNM and VINP both have formal monitoring programs dating to the early 1980s." - Not true. The monument doesn't date back that far.

    DFW comment: Buck Island Reef National Monument (BIRNM) was established in 1961 and expanded in 2001 from 880 acres to over 19,000 acres. In 1988, the NPS initiated a long-term ecological monitoring program at Buck Island (Bythell et al. 1992). This has been corrected in the draft text.

31. Page 61, Chapter 3, paragraph 5; re: "These habitat maps could be the basis for establishing a number of permanent sites as part of a long-term monitoring program." - Still a lot of shelf area labeled as "unknown".

    DFW comment: NOAA digitally mapped benthic areas to a depth of 20 meters. Much of this "unknown" area is deeper than that.

32. Page 63, Chapter 3, paragraph 1; re: "From March 1 to June 30 each year, NOAA and the V.I. Government prohibit all fishing within the Mutton Snapper Spawning Aggregation Area." - My mapping shows that as outside of VI Territorial Sea.

DFW: Most of the Mutton Snapper Spawning Area is within territorial boundaries, with a small portion falling in federal waters. Refer to Figure VI-4 on page 203, Chapter 6.

33. Page 68, Chapter 3, paragraph 3; re: "The preliminary results show an incredible diversity of species in healthy (deepwater) coral reef communities that are worth preserving for future generations." - If DPNR doesn't just let them get buried in sediment run off.

DFW comment: Opinion noted.

34. Page 68, Chapter3, paragraph 4; re: "These areas are thought to be fish spawning aggregation sites for groupers, snappers, and other fish species." - You don't really know this.

DFW comment: These areas have been identified as spawning aggregation sites in ReefKeeper International's spawning aggregation database (Rielinger 1999), which further cites Olsen and LaPlace (1978) and Beets and Friedlander (1992) as source documents. Also see Beets and Friedlander (1998), Nemeth et al. (2004), Nemeth (2005), and Luckhurst (2003).

35. Page 69, Chapter 3, paragraph 1; re: "The implementation of a one-time trammel and gill net buyback program…". - I don't think you have really thought this restriction through. A change in gear from one permanently in the water to one put in and removed is not necessarily a bad thing.

DFW comment: Comment noted, but not added to the text.

36. Page 72, Chapter 3, paragraph 2; re: mangroves as nursery areas - My 1971 study specifically addresses juvenile use of the mangrove lagoon in St. Thomas.

DFW comment: Olsen (1972 and 1973) were cited.

37. Page 83, Chapter 3; re: Current USVI mangrove management measures - I've overheard someone who has a permit to cut mangroves to make charcoal.

DFW comment: Only trimming permits are routinely given. Cutting mangroves to make charcoal is not permitted.

38. Page 85, Chapter 3, paragraph 2; re: environmental studies of Mangrove Lagoon/Benner Bay - Olsen 1971.

DFW comment: DFW is not familiar with Olsen (1971). Olsen (1972)—A survey of the fisheries of the St. Thomas Mangrove Lagoon area, and Olsen (1973)—The ecology and diversity of fishes in two U.S. Virgin Islands mangrove lagoons were cited in the text.

39. Page 173, Chapter 5; re: identification of priority issues through opinion surveys - Given that all of these surveys were undertaken with the background that the surveyors believed that overfishing existed, we suspect the results. They should not be used as a backdrop to setting priorities. On the other hand, recent positions of the St. Thomas Fishermen's Association are totally absent from this discussion. Given the fact that the CFMC responded positively to these positions, credibility must be given to them. We feel that priority must be attached to:
    1) The failure of the local government to collect data and develop management actions based upon analytical results.
    2) Lack of local fishermen input to the FAC and CFMC.
    3) Absence of enhancement and habitat rehabilitation plans and projects for important fishery habitat and resources.
    4) Failure of DPNR enforcement to enforce existing fishery regulations.
    5) Failure of DPNR to enforce sediment control requirements of construction permits.
    6) Failure of DPNR to address sewage and industrial pollution issues.

    DFW comment: Three of the opinion surveys solicited responses from commercial fishermen (Uwate et al. 2001; Gordon and Uwate 2003; and Kojis 2004). The last four priorities in the above list are addressed in the draft management plan. The first two were not generally identified as priority issues in the opinion surveys. This list has been noted in the draft text on page 175, chapter 5.

40. Page 175, Table V-1, Chapter 5; re: survey response identifying gillnets as a priority fisheries issue on St. Croix - We feel that this is an issue being fabricated by DPNR staff on St. Croix. Our information indicates that the recent "discovery" of net bycatch on St. Croix was, in fact, planted by DPNR staff and an FAC member.

    DFW comment: Management measures regarding gill/trammel nets were a St. Croix FAC initiative, not a DFW initiative.

41. Page 176, Table V-2, Chapter 5; re: survey response identifying pollution as a priority marine resource issue - And yet the Commissioner trots out that EPA finding that things are just fine here. He has also been quoted as saying that the "ocean heals itself".

    DFW comment: These are the results of an opinion survey. There is a perception that pollution is a problem.

42. Page 177, Chapter 5; re: longlining as a fishery problem in the USVI - Who is using longlines? Don't address problems that don't exist.

    DFW comment: Longlining as a fishery problem was identified by opinion survey respondents, not DFW.

43. Page 184, Chapter 5; re: species currently under territorial management - Given DPNR's failure to address management issues, the STFA has set up management committees for

lobster, trap, line, and seine net fishing which will develop management recommendations.

DFW comment: This was added to the draft text.

44. Page184, Chapter 5; re: whelk - Is there a study of whelk that formed the basis of the closed season?

DFW comment: No.

45. Page 184, Chapter 5; re: queen conch - At some point you need to address the MSY analyses used by the CFMC. Despite ----'s survey, our 1985 paper indicates that St. Croix conch densities are less than the northern islands. Thus DFW has maneuvered the CFMC into putting St. Croix resources at risk.

DFW comment: Gordon (2002) shows that conch densities are greater in St. Croix than in St. Thomas/St. John.

46. Page 185, Chapter 5; re: species under federal management—yellowtail snapper - They (CFMC) have moved these to an unknown category.

DFW comment: However, there are still federal regulations regarding this species.

47. Page 186, Chapter 5; re: Table V-4. List of species of possible concern - All of this is bull---- and should not be included here. You need to distinguish between IUCN generalities and local realities. The VI should not be held hostage to problems which do not occur here and this document needs to reflect that.

DFW comment: The list of species of possible concern (Table V-3) was used as a starting point for a list of species of greatest concern and included all species currently under some sort of regulation or restriction here in the USVI, as well as those species that were identified, globally or locally, by various sources as threatened or endangered.

48. Page 186, Chapter 5; re: Table V-4. Status of Nassau grouper—"U.S. Caribbean stock is overfished, but not experiencing overfishing" - What the hell kind of statement is this?

DFW comment: These determinations are based on definitions of overfished and overfishing that were approved under pre-SFA (Sustainable Fisheries Act) guidelines. Under these definitions, the stock would be overfished when the transitional SPR (spawning potential ratio) is less than 20% SPR. Overfishing is defined as a fishing mortality rate in excess of that corresponding to a 20% SPR level.

49. Page 187, Chapter 5; re: statement that queen conch stock in the U.S. Caribbean is overfished and undergoing overfishing - The CFMC plan itself disputes this comment for the northern VI and yet supports it for St. Croix.

DFW comment: The status of queen conch in the U.S. Caribbean was taken from NMFS (2002).

50. Page 190, Chapter 6; re: conservation strategies - If we are not assured that our input will be included, we will be down at the legislature to make sure that this thing is not sent off until it is included. The problem with this entire situation is that a series of “greenie” DFW directors and Park Service scientists have created an anecdotal record of problems which do not, in fact, exist. Thus, you need to find a way to backtrack.

DFW comment: Proposed strategies in the draft management plan are based on user group input in the opinion surveys, where they identified issues and proposed solutions.

51. Page 194, Chapter 6; re: Pollution priority strategies—oil pollution and dispersants - These should be listed in order of priority. Certainly, industrial and sewage pollution swamp everything else, followed by land-based sources of pollution.

DFW comment: Pollution, in general, was identified as a priority issue (Chapter 5) by respondents to the opinion surveys. More specific issues or types of pollution were not listed in any special order of priority.

52. Page 196, Chapter 6; re: toxic and thermal pollution - In terms of impact, this should be first. You have major industrial pollution sources on St. Croix but your “plan” leaves these largely unaddressed. You know these sources. What about the desal and generation plants?

DFW comment: Desal and generation plants have been noted in the text.

53. Page 196, Chapter 6; re: stop discharge of industrial waste to the sea - Given the VI’s dependence upon these industries, DPNR’s little lame enforcers are unlikely to have any impact. They probably cannot even schedule a meeting.

I suggest higher levels of government negotiate a European Union type of environmental audit/long term remediation plan with the relevant industries. This has the additional benefit of all parties being positive rather than the negative enforcement approach.

DFW comment: Comment noted, but not added to the text.

54. Page 196, Chapter 6; re: lack of enforcement priority strategies - In the past, enforcement worked. Clearly the problem is one of motivation and personnel.

DFW comment: Comment noted, but not added to the text.

55. Page 197, Chapter 6; re: gillnet priority conservation strategies - This is an issue that has been created by DFW. You need a completely different approach, especially if it is proved that ---- faked this recent discovery of bycatch.

DFW comment: This was a St. Croix FAC initiative, not a DFW initiative.

56. Page 198, Chapter 6; re: overfishing priority conservation strategies - These actions should all be undertaken because they are positive (the "precautionary principle"). They don't need to have the backdrop of "overfishing". We oppose the constant use of this term since it gives the impression that overfishing is a current, rather than a hypothetical, issue.

DFW comment: "Overfishing' is a term used by respondents in the user group opinion surveys with regard to priority issues and conservation strategies.

57. Page 199, Chapter 6; re: overfishing priority conservation strategies - Other fishery enhancement activities such as lobster settlement devices, enhancement aquaculture, etc., should be listed as well.

DFW comment: This was added to the list of steps to reduce overfishing in the draft text.

58. Page 199, Chapter 6; re: moratorium on issuance of new commercial fishing licenses by the Commissioner of DPNR, at the request of St. Croix commercial fishermen - So he closed St. Thomas/St. John even though these fishermen didn't request it?

DFW comment: Correct.

59. Page 200, Chapter 6; re: closure of 30% of the EEZ - You need to rework this in view of the recent CFMC meeting and the Delegates bill to extend the Territorial sea to 9 miles.

DFW comment: CFMC is no longer considering permanent area closures, but are now considering seasonal closures. This has been added to the text.

60. Page 200, Chapter 6; re: fishing effort reduction - You need to include the STFA management committee actions.

DFW comment: DFW is not aware of the STFA management committee actions other than David Olsen's earlier comment that "the STFA has set up management committees for lobster, trap, line, and seine net fishing which will develop management recommendations".

61. Page 200, Chapter 6; re: marine protected areas as a conservation/management strategy - However, after 50 years the VI National Park has not achieved any resource benefits.

DFW comment: Comment noted. See Beets (1992, 1996a, and 1996b), Beets and Rogers (2000), and Rogers and Beets (2001).

62. Page 201, Chapter 6; re: references for more discussion on MPAs, their potential benefits, and use in the USVI - This is an enormous circle jerk. Beets hypothecated overfishing in

1992/96 with no data or analysis. All of the rest of them just recited this hypothesis as if there had been some analytical basis.

DFW comment: It's not clear which of Beets's papers Dr. Olsen is referring to, however Beets (1987) attributes the decline of USVI's fisheries resources to three major factors: 1) the harvest of spawning individuals, 2) the loss of fish habitat/nursery areas, including nearshore reefs and mangroves, due to overdevelopment or inadequate development practices and the resulting pollution, runoff, sedimentation, etc., and 3) the increase in fishing effort, especially in terms of fish trap numbers. With regard to the increase in fishing effort, Beets (1996b) cites several papers including Dammann (1969), Olsen and LaPlace (1978), CFMC (1985), and Appeldoorn et al. (1992).

63. Page 201, Chapter 6; re: references for more discussion on MPAs, their potential benefits, and use in the USVI -Needs to include the Grammanik Bank closure.

DFW comment: This was included in the draft text.

64. Page 203, Chapter 6; re: the need to monitor and assess the condition of the local fishery using commercial catch reports and bio-statistical catch surveys - Which are unanalyzed.

DFW comment: Comment noted, but not added to the text.

65. Page 204, Chapter 6; re: trap priority conservation strategies - See STFA management committee comments.

DFW comment: While DFW is not aware of STFA management committee actions, the fact that the STFA has set up management committees to develop management recommendations has been noted in the draft text. See *Fishing Effort Reduction* on page 204. Also see the list of suggestions in Dr. Olsen's second comment on page 513.

66. Page 205, Chapter 6; re: the longline fishing controversy involving Asian fishing vessels in the Caribbean - There was a big effort into the Caribbean by the U.S. swordfish/tuna fleet following our Saltonstall/Kennedy project in the early 80s.

DFW comment: DFW could not find any citable documentation on this subject, however DFW does have some records concerning public hearings taking place at the time (1987) on the situation of longline fishermen who were operating in V.I. waters and ports. The Caribbean swordfish fishery was practically unknown to U.S. fishermen until 1983. That year, two commercial longliners operated successfully in this area. In 1984, around nine U.S. longliners visited the Caribbean. The number increased in 1985 to 35 longliners that operated under proper authorization, but there were claims that as many as 65 U.S. boats were in the area. There was no official information available at the time regarding the number of foreign vessels fishing in the Caribbean, however, based on unconfirmed information and personal observations, it was estimated that over 125 longliners were operating, at any given time, in the Caribbean. These were mainly Koreans, Taiwanese, and U.S. vessels. Even if the fisheries were directed mainly to the tunas and swordfish, a substantial number of gamefishes and many other species of commercial value were incidentally caught. This situation was believed to be impacting both the commercial and recreational fisheries of the U.S. Virgin Islands and Puerto Rico.

67. Page 205, Chapter 6; re: projects to implement benthic mapping - You don't think NOAA mapping is enough?

DFW comment: Current maps based on aerial photography are only good to a depth of about 60 feet. This may be adequate for St. Croix, but, since the shelf around St. Thomas/St. John is deeper than that, the NOAA maps are not really adequate for that area.

68. Page 209, Chapter 6; re: habitat conservation strategies - What about algal plains? These offer significant possibilities as sites for artificial reefs. If you dive these areas, every little rock or feature has juvenile fish. Enhancement could be a significant contributor to fisheries resources.

DFW comment: The problem with artificial reefs in shallow water is movement or burial during storm events.

69. Page 209, Chapter 6; re: algal plain habitat conservation strategy - What I know as algal plain is that huge area of calcareous algal nodules which covers much of the offshore and which certainly should be addressed differently than inshore habitats.

DFW comment: DFW staff have also observed this.

70. Page 211, Chapter 6; re: strategies for addressing species of concern - Needs to include recent CFMC meeting and agreement to harmonize VI and Federal regulations.

DFW comment: Noted and added to the draft text on page 190, Chapter 5 and on page 234, Table VII-1, Chapter 7.

71. Page 211, Chapter 6; re: Table VI-3. List of species of greatest concern - No discussion of yellowtail. Clearly the second most important species.

DFW comment: Yellowtail snapper are discussed in Appendix 1A.

72. Page 211, Chapter 6; re: information on this species in the USVI is limited - Not true. Randall did work on them. Also you should know by now that these are the most important aspect of local landings.

DFW comment: Noted. See Idyll and Randall (1959) and Randall (1961, 1963, undated).

73. Page 212, Chapter 6; re: overfishing of triggerfish - Data presented by the STFA to the CFMC indicates that these are being fished in an optimal manner.

DFW comment: Noted and added to the text on page 211.

74. Page 215, Chapter 6; re: conch populations for St. Croix - There is no way to reconcile ----'s claims for St. Croix with the 1982 work we did. Additionally, subsequent studies indicate conch densities within the same range as our earlier one. ---- is either incompetent, dishonest, or both. We'll get him in the Council since his study is the only basis for leaving the conch fishery open on Lang Bank.

DFW comment: Dr. Olsen contends that conch densities on St. Croix are not as high as reported in Gordon (2002). Also see Wood and Olsen (1982).

75. Page 216, Chapter 6; re: final report for whelk survey - Can I see this report? If you look at whelk landings, it looks like they are being harvested a long way above optimum yield/recruit.

DFW comment: This report (Toller and Gordon 2005) has been provided to Dr. Olsen.

76. Page 216, Chapter 6; re: spiny lobsters - You need to analyze the catch reports. There is some bad news there.

DFW comment: In March 2005, 30 years of catch report data entry and proofing was completed. Preliminary analysis is ongoing.

77. Page 226, Chapter 7; re: conservation strategies for oil pollution - Is there no oil spill prevention plan in effect in the VI?

DFW comment: Yes, there is, though DEP, not DFW, is the primary agency implementing the oil spill response plan, when the spill occurs in territorial waters.

78. Page 228, Chapter 7; re: banning of gillnets - This is another case where you are taking the wrong direction. Gill nets should be managed, not banned.

DFW comment: Opinion noted.

79. Page 229, Chapter 7; re: compatible fishing regulations between Federal and Territorial Governments - This is now overcome by events. The deal cut with the CFMC is that there will be compatible regulations in VI and Federal waters. Neither the FAC nor DFW should do anything but go forward with regulations harmonized with the relevant seasonal closures as set out in the last CFMC meeting.

DFW comment: Noted and added to the draft text on page 187, Chapter 5 and on page 229, Table VII-1, Chapter 7.

80. Page 230, Chapter 7; re: proposed closures as a fishing reduction strategy - Note the rejection of most of the proposed closures at the last CFMC meeting. Note also that this was accomplished by the STFA without any involvement by DPNR or the FACs.

DFW comment: Noted, but not added to the text.

81. Page 230-238, Chapter 7; re: implementation of identified strategies subject to availability of funds - This is bull----. You have a management responsibility to manage VI fisheries. If you think you can duck it, you're wrong.

DFW comment: The USVI Government provides no funding for DFW. DFW is funded by a variety of grants from a variety of agencies. Each grant has specific requirements.

82. Page 231, Chapter 7; re: fisheries data used in stock assessments and data analyses - We want these data. We have instituted management committees to take the initiative in managing the resources. If you withhold the data from us, it will affect our decision making. We are already working with the Legislature to get these data. You may want to think about how much heat you want to take.

DFW comment: It is up to NOAA Fisheries to provide this data due to a confidentiality agreement, nor is data that reveals individual information for public use. Only in summary form can it be made available.

83. Page 262, Chapter 9; re: review period) In view of the controversy surrounding fisheries at this time, an immediate review would be appropriate.
1) Federal intervention in VI fisheries has the possibility of generating legal action.
2) Clinton's reserves are working their way into the courts.
3) The fact that this plan and the CFMC amendment have been prosecuted without any analysis of local data, creating serious questions regarding their validity, alone, should be reasons for either not putting this plan forward or having it challenged by the VI Legislature.
4) A Gubernatorial election in two years will likely lead to a change in philosophy within DPNR and the current plan should not preclude review by a new administration.

DFW comment: Comment noted, but not added to the text.

84. Page 263, Chapter 9; re: repeating various opinion surveys of different user groups - There is a definite tendency by DFW and Federal Agencies to use surveys of questionable validity as a substitute for technical analysis. Technical analysis of the resources and user groups should precede any action, including the current plan.

DFW comment: Public participation in the development of this plan was one of the main requirements as set forth in the Comprehensive Wildlife Conservation Strategy (CWCS) guidelines for review and recommendation of acceptance (see p. 22, Chapter 2…eight essential elements). Public participation in this case came mainly in the form of user group input from opinion surveys that were used to identify problems and possible solutions concerning fisheries and marine resources issues.

85. Page 263, Chapter 9; re: review of the success in implementation of this plan and availability of Federal funding to address priority issues in the USVI) DFW has abandoned its independence and advocacy of local priorities. This is a cop out and I don't believe it is true.

DFW comment: Since DFW is dependent on grant funding, flexibility is limited.

86. Page 264, Appendix 1A; re: marine species overview - I recognize that including this makes for some easy text. But it is filled with prejudicial statements and questionable information.

DFW comment: Comment noted, but not added to the text.

87. Page 264, Appendix 1A; re: Caribbean reef fish - We maintain that DFW does not know enough about any of the species to justify any sort of closures. If you're going to try and do this, we'll go straight to the Senate and get them to require their approval before you submit this.

DFW comment: DFW does not close anything. The V.I. Code mandates that the Commissioner of DPNR has that authority.

88. Page 264, Appendix 1A; re: Appeldoorn et al. (1992) noted, at that time, 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 - I maintain that he is wrong and that we have provided more than "anecdotal" evidence that the fishery is not overfished (in the Virgin Islands). Analysis of the total landings data (1974-2003) for MSY further support our contention. I don't like this language at all.

DFW comment: Comment noted, but not added to the text.

89. Page 266, Appendix 1A; re: <u>first</u> key factor (no-take zones) critical to the long-term preservation of parrotfish in the Virgin Islands - You have no basis to propose restrictive management for parrotfish or any other species.

DFW comment: This section is primarily background information and factors that The Nature Conservancy considers critical to the long-term preservation of parrotfish in the Virgin Islands.

90. Page 266, Appendix 1A; re: <u>second</u> key factor that there needs to be a strong effort to conserve the critical nursery habitats - This should be the major emphasis of proposed management.

DFW comment: Comment noted, but not added to the text.

91. Page 267, Appendix 1A; re: Aggregating fish predators - Many fish aggregate.

DFW comment: Comment noted, but not added to the text.

92. Page 267, Appendix 1A; re: red hinds - Nemeth's data show recovery of the red hinds. There should now be discussion about managed fishing there (i.e. aggregation sites).

DFW comment: Comment noted, but not added to the text.

93. Page 267, Appendix 1A; re: statement that tiger grouper fishery is locally extinct - There never was a tiger grouper fishery. The Nassau (grouper) breeding aggregation fishery provided the major portion of Nassau (grouper) landings. Since it has been closed for 14 years and these landings have gone, the appearance of "extinction" has occurred. Next year we will visit the Nassau (grouper) bank and see whether or not they have gone.

DFW comment: Comment noted, but not added to the text.

94. Page 268, Appendix 1A; re: statement that relatively little is known about the life histories of juvenile snappers and groupers - Bull----! My study of the mangrove lagoon, I understand, was redone in the 80s. This shows the importance of the mangrove lagoon as juvenile habitat.

DFW comment: Comment noted, but not added to the text.

95. Page 268, Appendix 1A; re: statement that, in most cases, known aggregation sites have gone extinct due to overfishing - The Grammanik Bank was fished in 1975 and has continued to be fished until this year.

DFW comment: Comment noted, but not added to the text.

96. Page 268, Appendix 1A; re: reference to divers spearing aggregating fish - I've never heard of spearfishing breeding aggregations in the VI. Not in 20 fathoms of water. You need to quit parroting the CFMC statements that apply to PR.

DFW comment: These statements were removed from the draft text.

97. Page 268, Appendix 1A; re: making known fish aggregation sites off limits to fishing during aggregation times - DPNR's total lack of enforcement makes any sort of enforcement-related management impossible.

DFW comment: Comment noted, but not added to the text.

98. Page 269, Appendix 1A; re: <u>First</u> key factor—establishment of no-take zones—critical to the long-term preservation of snapper and grouper populations - We oppose no-take zones for this and every other species.

DFW comment: This section is primarily background information and factors that The Nature Conservancy considers critical to the long-term preservation of snapper and grouper populations in the Virgin Islands.

99. Page 269, Appendix 1A; re: Third key factor that spawning aggregations must be located and designated as no-take areas with proper enforcement - This statement is unjustified. Also, fishermen will never show you aggregation sites following what has happened thus far.

DFW comment: Comment noted, but not added to the text.

100. Page 269, Appendix 1A; re: Fourth key factor that there must be educational outreach to local fishermen discussing the benefits of no-take areas and protection of breeding aggregations - Give me a break!!!

DFW comment: Comment noted, but not added to the text.

101. Page 271, Appendix 1A; re: statement that no estimate of approximate life span or natural mortality is available for ocean surgeonfish - Go see FishBase (online reference source).

DFW comment: This statement was removed from the draft text.

102. Page 275, Appendix 1A; re: statement that the queen triggerfish is often one of the most popular fishes to be taken artisanally and used for subsistence or local commerce - The triggerfish is 30% of VI landings (Olsen 1988). Think about this stuff before you cut and paste it.

DFW comment: This statement was removed from the draft text.

103. Page 276, Appendix 1A; re: the 1996 IUCN Red List of Threatened Species that lists the queen triggerfish as “vulnerable”, indicating that it faces “a high risk of extinction in the wild in the medium-term future” - Note the information we presented at the CFMC hearing. We dispute this.

DFW comment: Comment noted, but not added to the text.

104. Page 318, Appendix 1A; re: Size of yellowtail snapper at maturity is estimated in Froese and Pauly (2002) as 42.5 cm TL - I have 21 and 26 cm from FishBase. I think you’re wrong. You need to recheck this. I think that it says 76 is the maximum FL from Randall but that Randall’s tag-recapture study gave a figure of about 53 cm.

DFW comment: Comment noted. See Randall (1961).

105. Page 351, Appendix 1A; re: CFMC (1985) reports size at sex reversal as 35 cm TL - You can’t use them as a reference since they only aggregate references.

DFW comment: Comment noted, but not added to the text.

106. Page 352, Appendix 1A; re: The status of the red hind has not been assessed relative to the pre-SFA definitions of overfished and overfishing - And yet they went ahead and closed the Hind Bank.

DFW comment: Comment noted, but not added to the text.

107. Page 355, Appendix 1A; re: Olsen et al. (1984) reference reporting that Nassau grouper can be ciguatoxic - I'm not aware of this reference.

DFW comment: This citation was removed from the draft text.

108. Page 356, Appendix 1A; re: The lack of occurrence in sampling and catches prior to the prohibition on catch in Federal waters implemented in 1990 indicated that Nassau grouper was severely overfished at that time - Most of the landings of Nassaus (grouper) took place during the breeding aggregation.

DFW comment: Comment noted, but not added to the text.

109. Page 356, Appendix 1A; re: There is no evidence of recovery in this fishery despite the long-standing moratorium - Because no one has looked.

DFW comment: Comment noted, but not added to the text.

110. Page 356, Appendix 1A; re: In its 2001 report to Congress on the status of U.S. fish stocks, NOAA Fisheries reports that the Nassau grouper is overfished, but is not experiencing overfishing. - What a comment!!

DFW comment: These determinations are based on definitions of overfished and overfishing that were approved under pre-SFA (Sustainable Fisheries Act) guidelines. Under these definitions, the stock would be overfished when the transitional SPR (spawning potential ratio) is less than 20% SPR. Overfishing is defined as a fishing mortality rate in excess of that corresponding to a 20% SPR level.

111. Page 358, Appendix 1A; re: The status of the yellowfin grouper 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.) Again, nobody has this information.

DFW comment: Comment noted, but not added to the text.

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Jimmy Magner, STFA, letter to Dean Plaskett, Commissioner of DPNR.

St. Thomas Fishermen's Association

Protecting our Natural Heritage and Culture

9 May 2005

Dean Plaskett, Esq.
Commissioner, DPNR

Dear Commissioner;

We are writing in regards to today's public meeting on the Division of Fish and Wildlife USVI Marine Resources and Fisheries Strategic and Comprehensive Conservation Plan.

STFA wishes to acknowledge that DFW, by rescheduling this meeting, has responded to our concerns that the Virgin Islands Public was being excluded from providing comment on this plan and we hope that tonight's response will be taken seriously.

In this regard, the STFA have spent considerable time commenting on the above document with the comments being provided to DFW in the MSWord document so that they could be easily incorporated into changes. We have repeatedly requested a meeting with DFW staff to go over our comments and ensure that appropriate changes were made. We have had no response to that request and can only assume that our efforts are being ignored.

The plan itself is filled with anti fisherman positions and language and continues your agency's antipathy towards the local fishing industry. This antipathy was clearly demonstrated at the recent CFMC meeting when you abstained from voting on the Sustainable Fisheries Act amendment because "you became aware in the past few days of the concerns of the St. Croix fisherman." This clearly shows the disconnect between yourself and your department from the fishing community. Change is required.

In addition to its general anti-fishermen tone, the plan completely fails to address the major threat to the Territory's marine resources, the failure of DPNR to carry out its assigned mission. The DFW plan should center on strategies for DPNR to change and become an effective environmental management agency instead of pointing fingers at fishermen.

Examples of DPNR failures abound;

Lack of support for fishermen
The only efforts coming out of the DPNR lead to regulation and restriction. Every time any representative of DPNR who speaks cries out, hat in hand, for more money. The DFW document is filled with additional begging and is an embarrassment to the Territory. DPNR has had many millions of Territorial and Federal dollars over the years and yet there is very little to show. It is no wonder that Territorial and Federal agencies are reluctant to provide additional funding.

- DPNR should concentrate on using its funding effectively rather than embarrassing the Territory by always begging for more.

- The CFMC has restricted local fishermen, in many cases without any data to show the need for restriction. DFW has been funded for years to gather data. Why should restrictions have been required if they DFW been doing their jobs?

- Projects such as the Fredericksted Pier and the Frenchtown Fish House continue to languish despite DPNR's promises. It should not take public outrage to get DPNR to carry out projects which are already funded.

- There are currently no commercial fishermen on the St. Thomas Fishery Advisory Committee despite our repeated requests for our members to be appointed.

- DFW looks the other way while game fishermen land large quantities of fish and sell them in direct competition with local fishermen. There are no licenses, no catch reports, nothing. Why?

- The STFA have repeatedly requested to meet directly with the Commissioner. There has been no response to these requests. Perhaps, since the Commissioner has been quoted as saying "The Ocean heals itself" he thinks that our grievances will just correct themselves. He is wrong.

Enforcement

- Fishermen consistently list the failure of enforcement as a major issue. In the past three years, the only arrest of any consequence was that of a DPNR officer for involvement in and compromising prosecution of a drug arrest.

- STFA members wait months for inspection of their traps while a DPNR enforcement officer hands out tags from his bar in Frenchtown to his friends without ever seeing the traps.

- The recent theft of two engines from Hull Bay was only solved through fishermen's effort. The DPNR "investigation" was ridiculed by local Public Safety officer as being "unprosecutable".

- There is no point and putting management rules in effect if they are not going to be enforced. Enforcement officers, who are notoriously rude and unpleasant, have totally failed to understand their role as Public Servants and the fact that fishermen can be their best allies in policing offshore waters.

Sewage

- Perhaps more than anyone, local fishermen are aware of the numerous sewage inputs into the sea.

- It is shameful that the Territory is inputting raw sewage in this day and age. Your excuse that DPNR was the driving force behind the EPA consent order is laughable. Progress is measured by results, not paper.

- It is also laughable that the EPA congratulated the Territory on its water quality instead of citing the serious deterioration that has taken place over the past several decades.

- DPNR has totally failed to protect important nursery grounds by allowing sewage plants to be built in inappropriate locations such as the back of Red Hook which used to be one of St. Thomas' major lobster nursery grounds.

- DPNR should be the driving force for:

- Regular monitoring of all sewage input.
- Improvement of government sewage plants to secondary treatment.
- Requirements for tertiary treatment of all plants serving neighborhoods and private developments.
- Requirements for on-site tertiary treatment for all new developments.
- Development of deep outfalls, particularly for St. Croix.

Industrial Pollution

- The south coast of St. Croix has become so polluted has become that fishermen have a difficult time selling fish from there.
- DPNR should develop a partnership with the polluting industries rather than just ignoring the problem. There should be an "audit" of all environmental impacts followed by a plan to reduce negative impacts while increasing positive impacts.
- DPNR and Public Works should analyze the feasibility for a deep outfall off the edge of the shelf and require that the polluting industries route their effluent through that outfall.

Permitting

- Development permitting and Coastal Zone Management are clearly in crisis. CZM was originally a driving force for the environment through requiring new development to minimize its negative environmental and social impacts.
- CZM has become a joke where significant environmental resources such as Vessup Bay and Great Pond are put under threat because CZM staff cannot meet deadlines and permits are granted by default. This should never happen.
- Developers should be held to high standards and should be brought into a partnership whereby the Territory can realize the benefits of economic development while still maintaining the high level of environmental quality that attracted them here in the first place.

Sediment Control

- We constantly hear about how coral reefs are threatened by our fishing activities and yet available scientific information fails to demonstrate that our fisheries are overfished or that fishing damages the reefs.
- Fishing can never impact the reefs to any degree comparable to the constant influx of sediment from development on the shoreline. One only has to dive or snorkel around the islands to see the amount of silt coming to the sea, killing the reefs.
- Sediment control plans are not taken seriously and are not enforced. Particularly in the Coastal Zone, DPNR should have regular permit compliance inspections and should issue Notice of Violations and Cease and Desist orders if developers fail to control sediment.

- There should be consideration given to regulating development during rainy periods.

Planning

- The Comprehensive Land and Water Use Plan is an absolute requirement for managing the Territory's environmental resources, even with its many shortcomings. It has lost momentum, in part because the Public doubts DPNR's abilities to carry out its provisions.

- Additionally, the "Comprehensive Planning" unit is neither Comprehensive nor Planning. There are many planning issues which should be addressed throughout the Territory and this unit should be upgraded and reprioritized.

Capacity Building

This year the Daily News treated us to a 20 page expose about how DPNR foolishly spent nearly $500,000 for GIS services with a sham company run by a part time taxi driver. The Virgin Islands is too small a place to assume that this was a mistake on DPNR's part.

- That money, with the help of local experts from the Eastern Caribbean Data Center, could have provided the necessary services <u>and</u> created GIS capability within DPNR so that this powerful tool could be utilized effectively within the Department.

- This is a shining example of a general trend within the Department. Instead of advancing the skill of Native Virgin Islanders, DPNR continues to rely on Consultants and Continental expertise.

- The time has come for DPNR to become a home for the Virgin Islands' 'best and brightest', people with an investment in these islands who will lead it forward, reversing the environmental deterioration that might one-day cost us our tourism and injure the health of our people.

These are the comments of the St. Thomas Fishermen's Association. This plan, instead of attempting to lead strategy away from DPNR failures by once again pointing the finger at fishermen, should be completely redirected to strategies for improving its own performance across the board.

Regards;

Jimmy Magner
President, STFA
2-12 Demerara
St. Thomas, VI 00803

APPENDIX 5
PUBLIC ANNOUNCEMENTS AND PUBLIC MEETINGS

Public Announcements and Press Releases

The Daily News 3/11/05

Short Reports

DPNR releases marine plan

A draft of the V.I. Comprehensive and Strategic Marine Resources and Fisheries Conservation Management Plan is now available on the V.I. Department of Planning and Natural Resources Web site at www.vifishandwildlife.com/fish.htm.

DPNR Commissioner Dean Plaskett announced the draft plan's release Thursday.

Once adopted, the plan will provide a blueprint for the assessment and management of fish and wildlife resources within the Virgin Islands. It will describe the Division of Fish and Wildlife programs in terms of the status of their resources, objectives, programs and issues or opportunities and management strategies.

The Virgin Islands must have the plan in order to be eligible for federal grants.

Public comments will be accepted until March 31. Send comments to: Division of Fish and Wildlife, Attention: Ron Sjoken, Fisheries Biologist II; 6291 Estate Nazareth; St. Thomas 00802. Comments may be sent via e-mail to ronsjoken@hotmail.com.

St. Thomas Source—March 18, 2005

Fish and Wildlife Has New Plan to Manage Fisheries

by Lynda Lohr

March 18, 2005 — The Department of Planning and Natural Resources' Division of Fish and Wildlife Monday has set a series of public meetings on a proposed Marine Resources and Fisheries Strategic and Comprehensive Conservation Plan.

The first meeting will be held from 7 to 9 p.m. at the Legislature building in Cruz Bay.

Subsequent meetings will be held April 7 at the V.I. Gamefishing Club in Red Hook, St. Thomas and April 8 at the University of the Virgin Islands Research Extension room on St. Croix. Those meeting will also run from 7 to 9 p.m.

The department must develop a plan to manage the territory's fisheries and marine resources if it expects to get grants from the U.S. Fish and Wildlife Service. It currently has no plan.

The department has developed a draft plan on whichRoger Uwate, chief of Fisheries, will make a 40-minute presentation. The public will then be able to comment on the plan.

"Anybody who's interested," chief of Fisheries Roger Uwate said Friday.

The 492-page plan is filled with lots of charts as well as text.

The department surveyed various user groups as well as the public when developing the plan. According to the plans' executive summary, those surveyed listed eight problems to be addressed. They are pollution, lack of enforcement, gill nets, over fishing, traps, long lines, habitat degradation, and lack of moorings.

Suggestions for addressing problems included improve enforcement, more education, pollution control, deploy more Fish Attracting Devices, develop more artificial reefs, and develop and improve boat and public access.

Uwate said that lots of the solutions are outside the scope of Fish and Wildlife, and the plan lists each department, division or agency that is responsible for implementing solutions.

"We can't tell Enforcement what to do," he said, referring to Planning's Enforcement Division.

However, he said that shedding light on the problems may help the Enforcement Division, as well as other departments find solutions.

Uwate said the plan must go to the federal Fish and Wildlife Service for its approval.

"But so far, Fish and Wildlife likes what we've done," he said.

ST. THOMAS SOURCE

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Local News

No One Shows Up for Public Meeting On Fisheries Plan

by Source staff

March 21, 2005 — Education, enforcement and conservation will go a long way toward preserving the territory's marine resources and fisheries, Ron Sjoken said at a meeting Monday held by the Fish and Wildlife Division of the Planning and Natural Resources Department.

Sjoken, a fisheries biologist with Fish and Wildlife, spoke about the division's proposed Marine Resources and Fisheries Strategic and Comprehensive Conservation Plan at the St. John Legislature building.

He made his Power Point presentation to the only person who showed up for the meeting — a Source reporter.

Sjoken said he expects a bigger turnout, particularly from fishermen, at the St. Thomas and St. Croix meetings.

They will be held April 7 at the V.I. Gamefishing Club in Red Hook, St. Thomas, and April 8 at the University of the Virgin Islands Research Extension room on St. Croix.

Both meetings will run from 7 to 9 p.m.

Sjoken said that the division solicited input from various user-groups when developing the plan.

"The reason we wrote the plan is to be eligible for future funding," he said of the federal money that flows into Fish and Wildlife.

During his presentation, he said that the federal government funds nearly 100 percent of Fish and Wildlife's budget.

Sjoken said before the meeting that the Caribbean Fishery Management Council, not Fish and Wildlife, oversees fishing area closures. The council is an arm of the National Oceanic and Atmospheric Administration.

The council plans to meet May 3 and 4 at the Holiday Inn Windward Passage Hotel on St. Thomas to discuss closing some fishing areas.

The closures are a hot topic, and Sen. Louis P. Hill weighed in on the matter Monday. He sponsored a resolution asking for intervention before more fishing grounds are closed. The resolution, signed by Gov. Charles Turnbull, went to President Bush, Interior Secretary Gale Norton, Commerce Secretary Carlos Gutierrez, and Delegate Donna M. Christensen.

Hill said in a news release that for any fisheries management plan to be effective there must be full coordination between fishermen and marine scientists because fishermen see first hand the fluctuations in fish populations and spawning aggregations.

He said that scientists know the critical role healthy fish populations play, especially to the reefs, and have a responsibility to protect them.

Hill also said that runoff from poorly planned development is severely impacting the reefs and that little is being done to enforce existing laws.

Sjoken said that the council used a lot of data from Puerto Rico in determining what fishing areas to close. He said that Fish and Wildlife is trying to analyze its 20 years worth of data to see if closing fishing areas is the right move.

In discussing enforcement issues during his presentation, Sjoken said that Planning's enforcement officers should attend the police academy to improve their skills. He did not elaborate further, but did say, "There may be federal government support for this."

He said that when a NOAA fisheries officer based in the Virgin Islands retired, he was not replaced. That is a further problem with federal enforcement, he said.

The plan is available for viewing at www.vifishandwildlife.com.

St. Croix Avis—March 30, 2005

Wed, March 30 2005
St. Croix Avis

DPNR to hold public meetings on fisheries management plan

USVI — The Division of Fish and Wildlife will hold public meetings on the draft conservation management plan for the fisheries and marine resources in the territory.

A brief overview of the draft will be provided and the public will have the opportunity to provide input into the draft.

The U.S. Fish and Wildlife Service's State Wildlife Grant (SWG) Program stipulates that "no state, territory or other jurisdiction shall receive a grant unless it has developed or committed to develop by Oct. 1, 2005, a comprehensive wildlife conservation management plan," according to the press release.

In response to this, DPNR/Division of Fish and Wildlife has drafted a conservation management plan for the fisheries and marine resources in the territory.

Public meetings are scheduled for St. Thomas at the VI Game Fishing Club in Red Hook, April 7 from 7 to 9 p.m.; and for St. Croix at the Research Extension room on the UVI St. Croix campus, April 8, from 7 to 9 p.m.

The public is encouraged to attend. A copy of the draft plan is available at www.fishandwildlife.com and limited numbers of copies are also available at the Division of Fish and Wildlife offices in Red Hook (775-6762) and Frederiksted (773-1092).

The Daily News—April 6, 2005

The Daily News 4/6/05

DPNR to gather public input on fisheries plan this week

By TANYA MANNES
Daily News Staff

The V.I. Department of Planning and Natural Resources' Fish and Wildlife Division will hold public meetings beginning Thursday on a draft conservation management plan for the fisheries and marine resources of the Virgin Islands.

The Virgin Islands' territorial waters extend three miles out from the islands' shores. The plan does not address management of federal waters.

The plan's goal is to manage fisheries and marine resources in a sustainable manner for the continued benefit Virgin Islanders.

Beginning this year, the federal government is requiring comprehensive plans from all states and territories that receive federal funding.

At the public meetings, a brief overview of the plan will be presented and the public will have the opportunity to provide input on the draft. After public comments are incorporated into the plan, it will be forwarded to DPNR Commissioner Dean Plaskett for his approval, then to the federal government.

The V.I. plan includes:

- Information on the distribution and abundance of a long list of key species, including reef fish such as grouper and Caribbean spiny lobster.
- Description of locations and relative condition of key habitats: coral reefs, seagrass beds, algal plains, mangroves and salt ponds.
- Description of problems: pollution, lack of enforcement, gillnets, overfishing, traps, longlines, habitat degradation and lack of moorings.
- Description of conservation actions that are necessary and priorities for implementing them. These include improving enforcement by hiring more personnel, providing more education, controlling pollution, deploying more fish aggregation devices, developing more artificial reefs and improving boat and public access to marine resources.

The first meeting will be 7 to 9 p.m. Thursday at the V.I. Game Fishing Club in Red Hook, St. Thomas. The second meeting will be 7 to 9 p.m. Friday at the University of the Virgin Islands Research Extension room on the St. Croix campus.

A copy of the draft plan is available online at www.vifishandwildlife.com.

Comments can be e-mailed to ronsjoken@hotmail.com or mailed to Ron Sjoken, Division of Fish and Wildlife, 6291 Estate Nazareth, St. Thomas, VI 00802.

— Contact Tanya Mannes at 774-8772 ext. 317 or e-mail tmannes@dailynews.vi.

The Daily News 4/8/05

STT fishermen walk out of DFW meeting

ERIK SANZENBACH

ST. THOMAS — The St. Thomas Fisherman's Association is not happy with the Division of Fish and Wildlife.

At a Thursday night meeting held by the DFW in Red Hook to explain the proposed Marine Resources and Fisheries Strategic and Comprehensive Conservation Plan, commercial fisherman walked out of the meeting in protest.

"This is an illegal meeting," said Jimmy Magner, the association's president to Barbara Kogis, DFW director..

There were only three commercial fishermen at the meeting, and Magner said that was because the members of his association were only given two days notice. He said that since the DFW's plan was a "federal document," and covered by the National Environmental Policy Act, the DFW was mandated to give the association two weeks notice of the meeting. He said that one local newspaper published notice of the meeting two days before.

Kogis told Magner that the plan was a territorial document, and that she had sent out a press release about the meeting on March 17.

The Avis published the press release two weeks ago.

Magner then read a letter that he had sent to Dean Plaskett, Department of Planning and Natural Resources commissioner and several members of the VI Legislature. In essence the letter said that despite input from the STTFA and several requests for meetings with the DPNR on the proposed plan, the association has been ignored by the government.

The proposed plan contains strategies and solutions to conserving and increasing the marine life in territorial waters. In order for the DPNR to get federal funds to implement the plan, the Department of the Interior mandated the plan be submitted by October 2005. The Thursday night meeting at the VI Game Fishing Club was meant to elicit public response to the plan before its submission to the federal government.

However, Magner said the plan is a threat to the local commercial fishermen.

The STTF claims the plan is not realistic about the territory's marine resources, and fishermen are scared that it will limit their fishing grounds, and even close some areas. The STTF wants the VI Legislature to review and approve the plan before it is submitted to the Department of the Interior.

Sen. Louis Hill, who has been championing the commercial fishermen's cause says that fishermen and the general population are confused by the two plans, and that more education is needed, before any decision is made.

"People want to know if there will be any more closures," said Hill. "It is very confusing right now."

Magner said his organization is not opposed to further meetings with the DFW, and just asks that the fishermen be given ample notice for the next meeting. He also asks that the meeting not be held in Red Hook, but at the Cyril E. King Airport in the DPNR office.

"When they want to deal with us directly, we will meet with them," said Magner.

Hill said he hoped the DPNR would honor the request of the fishermen.

The DFW will present their plan to the fishermen of St. Croix tonight at 7 p.m. at the Extension Center on the University of the Virgin Islands campus.

The Daily News—April 8, 2005

Friday, April 8, 2005, The Daily News

Second meeting set to let fishermen comment on draft conservation plan

By TANYA MANNES
Daily News Staff

ST. THOMAS — The V.I. Department of Planning and Natural Resources' Fish and Wildlife Division plans to hold a second public meeting on St. Thomas to allow more fishermen to comment on a draft conservation management plan for the fisheries and marine resources of the Virgin Islands.

At a meeting Thursday evening, fishermen complained that they did not receive adequate notice of the meeting on the 400-page document, which will be submitted to the federal government as a condition of receiving grants.

About a dozen fishermen showed up at the meeting at the V.I. Game Fishing Club in Red Hook, but most left in protest before listening to the presentation. A representative of the St. Thomas Fishing Association read aloud from a letter signed by association president Jimmy Magner. The letter, addressed to DPNR Commissioner Dean Plaskett, stated that no one contacted the fishermen about the meeting and that public notice was not adequate.

After the letter was read, the fishermen left.

V.I. Fish and Wildlife Director Barbara Kojis said later that another meeting will be scheduled on St. Thomas.

Kojis said that announcements were submitted to print, radio and online media, but she said she understood the association's concerns. "We should have contacted them directly," she said.

The plan's goal is to provide a road map for managing local fisheries and marine resources in a sustainable manner for the continued benefit of Virgin Islanders. Fisheries Chief Roger Uwate said the plan is not necessarily binding. "Consider this plan guidance but not a fixed path to take," he said.

The Virgin Islands' territorial waters extend three miles out from the islands' shores. The plan does not address management of federal waters. After public comments are incorporated into the plan, it will be forwarded to DPNR Commissioner Dean Plaskett for his approval, then to the federal government.

The V.I. plan includes information on a long list of key species, key habitats and problems such as pollution, lack of enforcement, gill nets, overfishing, traps, longlines, habitat degradation and lack of moorings. The plan also provides an overview of conservation actions that are necessary and priorities for implementing them.

A meeting will be held on St. Croix from 7 to 9 p.m. today at the University of the Virgin Islands Research Extension room.

A copy of the draft plan is available online at www.vifishandwildlife.com.

Comments can be e-mailed to ronsjoken@hotmail.com or mailed to Ron Sjoken, Division of Fish and Wildlife, 6291 Estate Nazareth, St. Thomas, VI 00802.

— Contact Tanya Mannes at 774-8772 ext. 317 or e-mail tmannes@dailynews.vi.

The Daily News—April 22, 2005

The Daily News Friday 4/22/05

DPNR sets 2nd public meeting on fisheries plan

Daily News Staff

ST. THOMAS — The V.I. Department of Planning and Natural Resources has announced that a second public meeting will be held on a draft fisheries conservation management plan. The meeting will be held from 7 to 9 p.m. May 9 at Frenchtown Community Center on St. Thomas.

The first public meeting early this month was sparsely attended, and fishermen complained that they received inadequate public notice.

The plan is required as a condition of eligibility for federal grants. The U.S. Fish and Wildlife Service's State Wildlife Grant program states: "No state, territory or other jurisdiction shall receive a grant unless it has developed or committed to develop by Oct. 1, 2005, a comprehensive wildlife conservation management plan."

Responding to this requirement, DPNR's Fish and Wildlife Division drafted a comprehensive plan for the fisheries and marine resources of the Virgin Islands.

A brief overview of the plan will be presented, and the public will be able to provide input into the draft.

A copy of the draft plan can be viewed at www.vifishandwildlife.com. Public comments can be sent to the Fish and Wildlife Division by e-mail through the Web site.

St. John Public Meeting - The St. John public meeting for an overview of DFW's draft fisheries and marine resources conservation management plan held on the 21st of March 2005, had only one person in attendance, a reporter covering the meeting for the *St. Thomas Source* (see article on page 546).

The memo documenting this public meeting is as follows:

GOVERNMENT OF THE VIRGIN ISLANDS OF THE UNITED STATES

========

DEPARTMENT OF PLANNING AND NATURAL RESOURCES

DIVISION OF FISH AND WILDLIFE

6291 Estate Nazareth #101
St. Thomas, VI 00802-1118
Phone: (340) 775-6762, Fax: (340) 775-3972

MEMORANDUM

TO: Dr. Roger Uwate, Chief of Fisheries

FROM: Ron Sjoken, Fisheries Biologist II

DATE: April 5, 2005

RE: Public meeting on St. John to present overview of DFW's draft fisheries and marine resources conservation management plan.

On Monday, 21 March 2005, a DFW-organized public meeting was held in the Legislative conference room in the Cruz Bay Legislative Building on St. John. The purpose of the meeting was to present an overview of DFW's draft fisheries and marine resources conservation management plan. The meeting, scheduled for 7-9 pm, consisted of an hour-long PowerPoint presentation given by Ron Sjoken. Only one person, a reporter from *The Source*, was in attendance. Public meetings are to follow on St. Thomas (4/7/05) and St. Croix (4/8/05).

St. Thomas Public Meeting - Attendance for the first St. Thomas public meeting on April 7, 2005 was documented in the attendance sheet below.

Attendance Sheet 4/7/05
St. Thomas Public Meeting for DFW draft plan

SANDRA ROMANO UVI
Erik [illegible]
JIMMY MAGNER STFA PRES.
Julian Magras STFA Vice Pres.
[illegible] Olsen STFA Staff Secty
Annette Olsen
LINDA EVANS
Elizabeth Ban VIMAS/STFA
Catherine Bryan representing Senator Lorraine Berry
Colette Monroe on behalf of Senator Louis Patrick Hill
BOB [illegible] FAC RECREATIONAL
Harry Clinton FAC
Barbara Kojis
Bryson Bryan
CHRIS TRONQUET
CAPT [illegible]
ROGER [illegible]
Ron Sioken

A memo documenting the first St. Thomas public meeting was made. It is presented below.

GOVERNMENT OF THE VIRGIN ISLANDS OF THE UNITED STATES
========
DEPARTMENT OF PLANNING AND NATURAL RESOURCES
DIVISION OF FISH AND WILDLIFE
6291 Estate Nazareth #101
St. Thomas, VI 00802-1118
Phone: (340) 775-6762, Fax: (340) 775-3972

MEMORANDUM

TO: Dr. Roger Uwate, Chief of Fisheries

FROM: Ron Sjoken, Fisheries Biologist II

DATE: April 22, 2005

RE: Public meeting on St. Thomas to present overview of DFW's draft fisheries and marine resources conservation management plan.

On Thursday, 7 April, 2005, a DFW-organized public meeting was held at the V.I. Game Fishing Club in Red Hook. The purpose of the meeting was to present an overview of DFW's draft fisheries and marine resources conservation management plan. The overview was presented by Ron Sjoken, Fisheries Biologist II, with DFW. Dr. Barbara Kojis, DFW Director, Dr. Roger Uwate, Chief of Fisheries, representatives for Senators Lorraine Berry and Louis Patrick Hill, and about a dozen members of the general public were also in attendance.

At the meeting, Julian Magras read a statement prepared by Jimmy Magner, president of the St. Thomas Fishermen's Association (STFA), declaring the meeting illegal due to the short notification given to commercial fishermen for this meeting. Mr. Magras and about a half-dozen people then walked out of the meeting. Other comments concerning the draft plan that were brought up at the meeting include:

1. A call for a second public meeting to allow more commercial fishermen to comment on the draft plan. A second public meeting has subsequently been scheduled for Monday, 9 May, 2005, from 7-9 pm, to be held at the Frenchtown Community Center.

2. A distinction needs to be made between the territorial plan by the USVI DFW and the federal plan by the CFMC. Confusion between the two plans and concerns over proposed fishing area closures by the federal government were given as reasons for this.

3. The need for inclusion of commercial fishermen in the decision-making process.
4. The reference to billfish "landings" in local tournaments should be changed to indicate that all billfish tournaments are now "catch and release" only.
5. Whether the issue of longlining is a legitimate concern in the USVI.
6. The need for better enforcement concerning fisheries and marine resource issues.

<u>Second St. Thomas Public Meeting</u> – Attendance for the <u>second</u> St. Thomas public meeting on May 9, 2005 was as follows.

Roger Olivarez	DFW
Ron Sjoken	DFW
Julian Magras	STFA
[illegible]	
Norman Smith	
Elizabeth Barr	STFA/VIMAS
David Olsen	STFA
Jimmy Magner	STFA
R Platenberg	DFW/CBW.
Linda Evans	STFA
Annette Olsen	

A memo documenting public comments at the second St. Thomas public meeting was made. It is presented below.

GOVERNMENT OF THE VIRGIN ISLANDS OF THE UNITED STATES
========
DEPARTMENT OF PLANNING AND NATURAL RESOURCES
DIVISION OF FISH AND WILDLIFE
6291 Estate Nazareth #101
St. Thomas, VI 00802-1118
Phone: (340) 775-6762, Fax: (340) 775-3972

MEMORANDUM

TO: Dr. Roger Uwate, Chief of Fisheries

FROM: Ron Sjoken, Fisheries Biologist II

DATE: May 10, 2005

RE: Second St. Thomas public meeting for overview of DFW's draft conservation management plan

On Monday, 9 May, 2005, from 7-9 pm, a second DFW-organized public meeting was held on St. Thomas at the Frenchtown Community Center. The purpose of the meeting was to present an overview of DFW's draft fisheries and marine resources conservation management plan, and was held at the request of the St. Thomas Fishermen's Association. The overview was presented by Dr. Barbara Kojis, DFW Director. Dr. Roger Uwate, Chief of Fisheries, Dr. Renata Platenberg, Wildlife Biologist III, and Ron Sjoken, Fisheries Biologist II, were also in attendance. About nine members of the public, consisting of commercial fishermen and/or members of the St. Thomas Fishermen's Association (STFA), were present as well. Numerous comments and suggestions were brought up during the meeting which are outlined below.

Fisher's comments, suggestions, and issues of concern:

1. Enforcement, or lack of, seemed to be a recurrent point of issue, and many management measures, either proposed or already in effect, need to be adequately enforced. This includes permit compliance inspections, enforcement of sediment control measures, etc.

2. Sediment runoff, sewage runoff, industrial pollution, etc., need to be controlled.

3. Nursery areas such as mangroves need to be preserved and protected. Fishers would also like to see both berms opened up for water exchange to Mangrove Lagoon (two openings were made by DFW a few years ago).

4. A comprehensive water-use plan is needed.

5. Moorings are needed for Water Island in order to reduce seagrass damage from anchor chains (i.e. “blowouts”).

6. Places are needed to sell and market fish. The basement of the new Humane Society building was suggested as a possible location.

7. One of the speakers stated that he did a survey of Northside fishers and the Northside fishers said they would give up fishing 1/4 mile out from Hans Lollik, except for baitfish, in exchange for a moratorium on construction on that island. They feel DPNR and TNC are promoting the development of Hans Lollik.

8. Fishermen feel that CZM isn’t doing their job, that permits are granted by default, and developers should be held more accountable for problems they create.

9. Fishers didn’t understand why marbled groupers were on the species of concern list [Note: marbled groupers were on Fishbase’s list of threatened species in the U.S. Virgin Islands.]

10. The STFA would like to meet with the Commissioner of DPNR to discuss grievances.

11. Comments about the draft plan itself include:
    - The plan favors recreational fishers, not commercial fishers.
    - More emphasis needs to be placed on studying fish, not catch reports.
    - The plan is filled with anti-fishing language. The STFA would like final editorial control over wording in the plan.
    - The plan fails to address DPNR’s failure to carry out its duties.

12. The STFA presented an open letter at the meeting, addressed to the Commissioner of DPNR, spelling out many of the grievances listed above. This letter will be added to the appendix (see Appendix 4) containing other fisher comments in the draft plan and is also attached to this memo.

St. Croix public meeting- Attendance for the St. Croix public meeting on April 8, 2005 was as follows.

Attendance Sheet 4/8/05
St. Croix Public Meeting for DFW draft plan

- ROGER UWARE
- DOMINIQUE TESSIER
- WAYNE GEORGE
- Hiram Maldonado III
- Mavel Maldonado.

Doule —

A memo documenting public comments at the St. Croix public meeting was made. It is presented below.

GOVERNMENT OF THE VIRGIN ISLANDS OF THE UNITED STATES
========
DEPARTMENT OF PLANNING AND NATURAL RESOURCES
DIVISION OF FISH AND WILDLIFE
6291 Estate Nazareth #101
St. Thomas, VI 00802-1118
Phone: (340) 775-6762, Fax: (340) 775-3972

MEMORANDUM

TO: Dr. Barbara Kojis, Director DFW

FROM: Dr. Roger Uwate, Chief of Fisheries
Ron Sjoken, Fisheries Biologist II

DATE: April 11, 2005

RE: St. Croix public meeting for DFW's draft fisheries and marine resources conservation management plan held on April 8, 2005.

On Friday, 8 April 2005, Dr. Roger Uwate and Ron Sjoken went to St. Croix to hold a public meeting outlining DFW's draft fisheries and marine resources conservation management plan. Similar meetings were previously held on St. John (3/21/05) and St. Thomas (4/7/05). The public meeting on St. Croix was held at the Research Extension Center on UVI's St. Croix campus. The meeting took place from 7-9 pm and was attended by four members of the public. Doug McNair, Wildlife Biologist III, with the St. Croix Bureau of Wildlife, also attended. A PowerPoint presentation outlining an overview of the draft plan was given by Dr. Roger Uwate. Topics discussed after the presentation mainly concerned the effects of proposed management measures on the charter boat industry and on commercial fishing. Suggestions included the deployment of more FADs and their potential benefits.