

APPENDIX 3

DRAFT REGULATORY IMPACT REVIEW AND INITIAL REGULATORY FLEXIBILITY ANALYSIS FOR
THE DRAFT FISHERY MANAGEMENT PLAN FOR CORALS AND REEF ASSOCIATED PLANTS AND
INVERTEBRATES OF PUERTO RICO AND THE U. S. VIRGIN ISLANDS

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Caribbean Fishery Management Council

and

National Marine Fisheries Service

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I. INTRODUCTION

Executive Order (E.O.) 12866 "Regulatory Planning and Review" was signed on September 30, 1993 and established guidelines for promulgating new regulations and reviewing existing regulations. While the E.O. covers a variety of regulatory policy considerations, the costs and benefits of regulatory actions are a prominent concern. Section 1 of the E.O. is repeated in its entirety:

Section 1. *Statement of Regulatory Philosophy and Principles.*

(a) *The Regulatory Philosophy.* Federal agencies should promulgate only such regulations as are required by law, are necessary to interpret the law, or are made necessary by compelling public need, such as material failures of private markets to protect or improve the health and safety of the public, the environment, or the well-being of the American people. In deciding whether and how to regulate, agencies should assess all costs and benefits of available regulatory alternative, including the alternative of not regulating. Costs and benefits shall be understood to include both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to consider. Further, in choosing among alternative regulatory approaches, agencies should select those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts, and equity), unless a statute requires another regulatory approach.

(b) *The Principles of Regulation.* To ensure that the agencies' regulatory programs are consistent with the philosophy set forth above, agencies should adhere to the following principles, to the extent permitted by law and where applicable:

- (1) Each agency shall identify the problem that it intends to address (including, where applicable, the failures of private markets or public institutions that warrant new agency action) as well as assess the significance of that problem.
- (2) Each agency shall examine whether existing regulations (or other law) have created, or contributed to the problem that a new regulation is intended to correct and whether regulations (or other law) should be modified to achieve the intended goal of regulation more effectively.
- (3) Each agency shall identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public.
- (4) In setting regulatory priorities, each agency shall consider, to the extent reasonable, the degree and nature of the risks posed by various substances or activities within its jurisdiction.

- (5) When an agency determines that a regulation is the best available method of achieving the regulatory objective, it shall design its regulations in the most cost-effective manner to achieve the regulatory objective. In doing so, each agency shall consider incentives for innovation, consistency, predictability, the costs of enforcement and compliance (to the government, regulated entities, and the public), flexibility, distributive impacts, and equity.
- (6) Each agency shall assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs.
- (7) Each agency shall base its decisions on the best reasonably obtainable scientific, technical, economic, and other information concerning the need for and consequences of the intended regulation.
- (8) Each agency shall identify and assess alternative forms of regulation and shall, to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt.
- (9) Wherever feasible, agencies shall seek views of appropriate State, local, and tribal officials before imposing regulatory requirements that might significantly or uniquely affect those governmental entities. Each agency shall assess the effects of Federal regulations on State, local and tribal governments, including specifically the availability of resources to carry out those mandates, and seek to minimize those burdens that uniquely or significantly affect such governmental entities, consistent with achieving regulatory objective. In addition, as appropriate, agencies shall seek to harmonize Federal regulatory actions with related State, local and tribal regulatory and other governmental functions.
- (10) Each agency shall avoid regulations that are inconsistent, incompatible, or duplicative with its other regulations or those of other Federal agencies.
- (11) Each agency shall tailor its regulations to impose the least burden on society, including individuals, businesses of differing sizes, and other entities (including small communities and governmental entities), consistent with obtaining the regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations.
- (12) Each agency shall draft its regulations to be simple and easy to understand, with the goal of minimizing the potential for uncertainty and litigation arising from such uncertainty.

In compliance with E.O. 12866, the Department of Commerce (DOC) and the National Oceanic and Atmospheric Administration (NOAA) require the preparation of a Regulatory Impact Review (RIR) for all regulatory actions which either implement a new Fishery Management Plan (FMP) or significantly amend an existing plan, or may be significant in that they reflect important DOC/NOAA policy concerns and are of public interest.

The RIR is part of the process of preparing and reviewing fishery management plans and provides a comprehensive review of the changes in net economic benefits to society associated with proposed regulatory actions. The analysis also provides a review of the problems and policy objectives prompting the regulatory proposals and an evaluation of the major alternatives that could be used to solve problems. The purpose of the analysis is to ensure that the regulatory agency systematically and comprehensively considers all available alternatives so that the public welfare can be enhanced in the most efficient and cost effective way.

The Regulatory Flexibility Act (P.L. 96-353) has the purpose of relieving small businesses, small organizations, and small governmental entities from burdensome regulations and record keeping requirements. The Small Business Administration (SBA) defines a small business in the commercial fishing activity, classified and found in the Standard Industrial Classification Code, Major Group, Hunting, Fishing and Trapping (SIC 09), as a firm with receipts up to \$2.0 million annually. Additionally, the SBA defines a small business in the charter boat activity to be in the SIC 7999 code, Amusement and Recreational Services, not elsewhere classified, as a firm with receipts up to \$3.5 million per year.

To meet the basic objective of the Regulatory Flexibility Act, federal agencies are required to determine if proposed regulations will have a significant economic impact on a substantial number of small business entities. The process of making such determinations requires the preparation of an Initial Regulatory Flexibility Analysis (IRFA) and the RIR serves as the source of most of the information for the IRFA. However, certain information required for IRFA determinations is not necessarily available in the RIR. For example, if the RIR does not contain an estimate of the number of small businesses affected, a description of the small businesses affected or a discussion of the nature and size of impacts, then the IRFA would be expanded to include such information.

II. PREVIOUS MANAGEMENT REGIME

There are no federal regulations that currently govern the take of corals and reef-associated plants and invertebrates in the EEZ around Puerto Rico and the U.S. Virgin Islands.

Commercial harvest and export of reef-associated organisms is allowed under permit in the U.S. Virgin Islands. Of the 28 permits that have been issued on St. Thomas since 1990, 26 were for "private use" and 2 were considered commercial. The private use category included public aquariums and research facilities. St. Croix issued 25 permits, mostly for small numbers of

organisms, for both private and commercial use. Detailed information on the species composition of permitted collections is not available. In the U.S. Virgin Islands, collection and export of reef-associated plants and invertebrates for use in aquariums is regulated by permit.

In Puerto Rico, commercial harvest of black coral and octocorals is allowed under permit but export is prohibited. No information is available regarding the number of permits issued. Collection of reef-associated plants and invertebrates for use in aquariums is not regulated in Puerto Rico.

III. PROBLEMS IN THE FISHERY

1. Overfishing:

Some species in the fisheries management unit (stony corals, sea fans, gorgonians and live-rock) are overfished. This situation is by definition since optimum yield (OY) for these species is established as zero except for scientific collection, education and restoration programs and there is some documented take beyond the defined OY's. The historical and present take is more fully described by Sadovy (1991) and Goenaga and Boulon (1992); their descriptions are summarized later in the RIR.

The usual economic implication of an overfished resource is that total value from the resource will be increased if the overfishing problem is resolved. Even though the "overfishing" situation addressed by this FMP is quite different from the usual case of being unable to maintain a positive OY from fish or shellfish resources, the economics of the situation becomes analogous if the determination is made that OY is correctly established at zero. A great deal of the balance of the RIR will be involved with such a discussion.

2. Lack of Management:

Coral reefs, reef-associated invertebrates, live-rock and seagrass beds are not managed in federal waters (with the exception of spiny lobster). Some management is afforded corals and live rock in state waters of both the U.S. Virgin Islands and Puerto Rico. There is no management of reef-associated invertebrates or of seagrasses in either state or federal waters. Given the vulnerability of these species to land-based and sea-based activities, it is critical that these resources be managed consistently and comprehensively throughout the area. Furthermore, given the importance of the reef and seagrass habitats for other fisheries of commercial and recreational importance, their condition is clearly of significance for the management of other consumptive resources in waters under both state and federal authority. Lack of management of commercial and recreational fisheries can also impact the reef ecosystem if certain species are selectively removed. As a hypothetical example, suppose that management policy results in overfishing of reef-related carnivores. The absence of carnivores could in turn result in an excessive number of herbivores and lead to a situation of excessive grazing on sessile reef organisms. If the reef system depends on these organisms, then a situation could develop whereby the reef ecosystem and all or a major part of the value associated with the ecosystem is lost.

It has been documented that there is a growing market for reef organisms from the U.S. Caribbean. Because of dwindling world supplies and the imposition of management regimes in other nations, this recently observed growth is expected to continue and perhaps intensify and this situation also indicates the need for management throughout the range of state and federal waters occupied by these resources.

The obvious economic implication of this problem is that if management is indeed necessary, then the development of an appropriate management regime could lead to more valuable use of the resources and if the increased use value exceeds the costs associated with management then net national benefits can be increased.

3. Lack of Effective Environmental Policies/Enforcement:

There is serious concern over the lack of monitoring and enforcement of human activities that are actually or potentially detrimental to coral reefs and associated organisms, but do not involve direct harvest or other direct physical damage. For example, a major cause of mortality of corals and associated invertebrates worldwide is sedimentation and pollution related to land-based or nearshore activities such as agricultural, mining or forest operations and discharge of municipal or manufacturing wastes. The Council is aware of these problems and recommends that every effort be made for state and federal agencies to work together to resolve them. In particular, the reduction of sediment input from upland sources, the elimination of discharge of untreated/partially treated sewage and the release of petroleum products into coastal waters should be addressed. Additionally, current law does not adequately address the loss of Special Aquatic Sites (SAS) such as coral reefs and seagrass beds in the U.S. Caribbean (Clean Water Act, Section 404).

Enforcement of existing laws is likewise a concern to the Council. Some examples of recent or current illegal activities include the use of quinaldine for the collection of live organisms, nearshore ship tank cleaning and nighttime discharging of bilges.

Regardless of the importance of this problem, the solution is largely outside the authority of the Caribbean Fishery Management Council. Hence there are no management measures to analyze via this RIR.

4. Inappropriate Harvest Techniques and Holding Facilities:

Certain harvest techniques, such as the use of chemicals, powerheads to dislodge live-rock, the physical removal of live-rock and coral and the disturbance of substrate while collecting are considered damaging to the coral reef habitat. Some conditions encountered in the holding and shipping of live organisms are considered likely to result in unacceptably high rates of mortality. To the extent that current regulations are not sufficient, the assumption is that some resource value is lost. This FMP proposes regulations to address the harvest techniques, but not the holding facilities problem.

5. Inadequate Information Base:

There is insufficient scientific and fishery information on reefs, reef-associated invertebrates and plants regarding growth rates, life span, colonization patterns, distribution, abundance, landings, catch, effort and mortality. In particular, there is a lack of information on which to base appropriate levels of OY, MSY and allowable harvest for reef-associated invertebrates. Additionally, the interaction of reef community species and the roles of the various species are not well understood, although these associations are known to be of importance to the long-term health and productivity of the reef system. Information on water quality in the U.S. Virgin Islands, and on the impacts of onshore and nearshore human activities on offshore areas of both Puerto Rico and the U.S. Virgin Islands is needed.

6. Limited Public Information/Education:

There is a general lack of public understanding of the importance of reef ecosystems. While the FMP does not contain measures to address this problem, there are recommendations for public education.

7. Habitat Loss and Degradation:

Reef habitats around Puerto Rico and the U.S. Virgin Islands are considered to be limited areas of special importance and concern. Degradation that occurs through legal and illegal human activity, as well as uncontrollable natural phenomena, reduces the productivity and value of these ecosystems. Loss of coral reef and seagrass habitats directly affects a wide range of organisms that are heavily dependent on reef habitats for food and shelter. Some of these organisms are the basis for fisheries of considerable commercial and recreational significance in the region while the organisms collectively provide the basis for the recreational diving industry. Important sources of habitat degradation, other than land-based activities, are dredging and dumping, anchor damage, ship groundings, unmonitored or unsupervised tourist and diver activities and careless harvest by scientists or commercial collectors. While some of these effects can be mitigated by appropriate management action, the FMP does not attempt to regulate all activities that affect the coral habitat.

8. User Conflicts:

Given the importance of coral reef habitats for commercial and recreational fisheries, for tourism-related activities, and for other uses, it is clear that there is much potential for user conflicts. While the FMP discusses possible approaches to resolve conflicts, there are no measures proposed at this time.

IV. OBJECTIVES OF THE FMP

1. To optimize the benefits to the Nation generated from the resources of coral, live-rock, seagrasses and reef-associated plants and invertebrates, while ensuring their conservation and long-term preservation, through implementation of a management plan consistent with other management plans in the federal waters of the U.S. Caribbean.

2. To minimize adverse human impacts on coral, live-rock, seagrasses and reef-associated plants and invertebrate resources by reducing fishing pressure, wasteful harvest practices, and other anthropogenic stressors directly affecting them, and allowing for the restoration of naturally-balanced reef systems.
3. To establish resource data collection and permitting systems, and a research and monitoring program to collect fishery information and develop scientific data necessary to best utilize and preserve components of the management unit and to enable establishment of an OY for reef-associated invertebrates.
4. To provide, where appropriate, for special management of reef and seagrass habitats of particular concern or ecological importance through the establishment of reserves or other protected areas.
5. To increase public and government awareness of the importance and vulnerability of reef, seagrass and reef-associated resources. Informing and educating the general public of the importance of these resources will reduce adverse human impacts and foster support for management. Education of resource users, such as tourists and fishers, will provide more conscientious resource use.
6. To provide for and promote a consistent, coordinated and enforced management regime for the conservation and best utilization of reefs, seagrasses and reef-associated resources, in cooperation with state governments and other nations in the region.
7. To provide a flexible management system that minimizes regulatory delay while retaining substantial Council and public input into management decisions and which can rapidly adapt to changes in resource abundance, new scientific information, and changes in fishing patterns among user groups, or by area.
8. To reduce user conflicts in the fishery management unit through management and recommendations.
9. To eliminate or significantly reduce terrigenous sediment, anthropogenic input from upland sources into coastal waters, and the discharge of untreated sewage and petroleum products into coastal waters. This objective may be addressed through recommendations to local governments to encourage compliance with, and enforcement of, laws regulating activities that result in products that negatively affect the condition of reef and seagrass habitats and reef-associated organisms.

V. ANALYTICAL APPROACH

Most of the measures in the amendment are specifically designed to help meet the primary objective of the FMP regarding optimizing the benefits to the Nation from the management of the species contained in the fishery management unit. The main approach suggested by the FMP is to maintain the stocks at their present level and thus resolve the primary problem, which is overfishing

as defined by any take other than for scientific or restoration project purposes. In the case of the coral and associated stocks the overfishing is discussed largely in terms of a combination of legal and illegal commercial and recreational harvest as discussed in the FMP. However, the FMP also has extensive discussions about the effect of human activities not directly related to harvesting. For example, the FMP indicates that degradation by onshore activities such as agricultural production are important as are the effects of releasing untreated or partially treated sewage effluent, the effects of dredge and fill activities, damage caused by anchoring and other effects. With the exception of anchoring, for which limited management is proposed, the FMP cannot directly address these effects because the Council does not have the statutory ability to control them. Hence, the RIR analysis is largely limited to a determination of whether or not the measures designed to manage the direct harvest are expected to contribute to an increase in net benefits to society. It is obvious that changes in net economic benefits derived from the management of the fishery depend heavily on the effect that the implementation of a zero-take management strategy will have on the biological well being of the stocks and hence on values derived from non-consumptive use. The measures will be looked at separately to determine whether or not they contribute, in a positive manner, to the RIR condition of realizing a net positive economic benefit (benefits net of public and private costs).

Those proposed measures that restrict fishing practices will involve an analysis that provides a contrast of short term losses with long term gains, a procedure which is common with management schemes designed to rebuild overfished stocks.

The net economic benefits (which can be negative or positive) include the sum of (1) expected changes in producer surplus and consumer surplus for landings from the commercial fishery, (2) potential changes in consumer surplus derived from recreational and other non-use sources and (3) management costs (plan preparation and review, enforcement, additional data collection and public burden in terms of reporting costs).

The analysis used in this RIR will involve a combination of qualitative and quantitative approaches. In other words, the RIR analysis will attempt to discover how the proposed management measures affect net societal benefits but in some cases there will be no attempt to place estimated dollar values on the gains or losses discussed. There are some basic reasons for this. The first and major reason is that data on the biology and economics of the fisheries is insufficient even though the biological and economic decline of the fisheries is well established (see section 5.5 of this FMP). The second reason is that it may be more important at this stage to see if there are plausible benefits vs. trying to place exact dollar values on benefits. In this approach, some dependence will be placed on relating the results of quantitative studies on other reef systems to the situation in Puerto Rico and the U.S. Virgin Islands.

The analyses and discussions that follow contain two extremely important assumptions. First, it is assumed that all the measures that are implemented

as regulations will be fully adopted by the Governments of Puerto Rico and the United States Virgin Islands. Second, it is assumed that the level of compliance with any resulting regulations will be high enough so that the potential benefits (to the extent that they exist) can actually be achieved. **IF THESE ASSUMPTIONS ARE VIOLATED THEN EVERYTHING THAT FOLLOWS WILL BE IRRELEVANT. THE OUTCOME OF THE MANAGEMENT EFFORT WILL BE A NET ECONOMIC LOSS BECAUSE THERE WILL BE NO BENEFITS WHILE GOVERNMENT AND PRIVATE COSTS ARE INCURRED.**

VI. SYNOPSIS OF THE USE OF CORAL REEFS

Corals, coral reefs and associated species occur worldwide in the tropical-semitropical belt and have a number of competing uses in most places they are found. Spurgeon (1992), in his article "The Economic Valuation of Coral Reefs," provides a fairly exhaustive list of uses and functions of coral reefs (and associated organisms) deemed to have value. In order to provide a means of approaching the valuation question he describes three classifications, namely direct use, indirect use and non-use values.

Direct use includes fisheries production, aquarium trade, curio trade, pharmaceutical and other industrial uses, construction, tourism, research and education. Indirect uses are considered to be biological support of other ecosystems, coastal zone extensions (measuring exclusive economic zones using fringing coral reefs versus shorelines as the starting point), physical protection, global life support and social services (described as foregone cost of the provision of social welfare services that may be necessary if the reef did not exist). Finally, the non-use category encompasses existence (the value of "knowing that it is there"), option (the value to be able to use something at a future date) and what he terms intrinsic use. The latter is attributed to the proposition that all organisms have some right to exist (he agrees that this type of non-use is beyond valuation in any monetary sense).

In contrast to uses of value, there are some costs to society associated with coral reefs. Particularly because of their rock-like structure and because they tend to be subsurface, coral reefs pose hazards to navigation. While there is a tendency to think of ship groundings in terms of damages to the reef, the damage to human life and property can be significant in some instances. Beyond the direct costs associated with groundings, there are costs associated with the avoidance of reefs. In general these costs consist of the extra time, fuel and other costs incurred when ship traffic has to detour to ensure that a reef grounding is avoided. The costs can also include the provision of navigational aids designed to warn shipping traffic of the location of reefs and the costs of removing reef structure to provide shipping access to inside waters.

With the exception of intrinsic non-use value, all the other values and costs described by Spurgeon (1992) are capable of being valued if the data were made available. Unfortunately, most of the data are not available for the U.S. Caribbean or anywhere else in the world and it is indeed possible that the cost of collecting all the relevant data could easily exceed the total value of certain categories of use.

Spurgeon (1992) explicitly covered several classes of what might be termed "intended" uses of corals. There is another class of uses that will be labeled as "unintended use" for the purpose of this RIR. This class includes unintended damage or removal of coral by a variety of human activities, some related to the uses described by Spurgeon (1992) and some that are not. Most or all of these uses comprise section 5.7 in the FMP. While the RIR notes that the FMP does not provide for management of most of the unintended uses at this time, this class of uses will be referenced later because of their value relative to the value of other uses.

Most of the uses of coral resources as described by Spurgeon (1992) occur in the U.S. Caribbean and Section 3.0 of the FMP contains a useful synopsis of the known historical and current information on these uses. The following information is freely taken from that section with certain editorial changes to meet the needs of the RIR.

Historically, collection of coral was a common activity, particularly off eastern Puerto Rico (Goenaga and Boulon, 1992), with more limited harvest in southwestern Puerto Rico (Miguel Rolon, pers. obs). Mackenzie and Benton (1972) reported damage to coral reefs caused by coral harvest from Icacos Cay, off Fajardo, in the late 1960's and early 1970's. In 1979, Puerto Rico implemented a regulation that essentially prohibited the harvest of most coral species from state waters. In the U.S. Virgin Islands, the taking of coral is regulated by permit. In addition to commercial and recreational take, the harvest of coral and associated invertebrates has been important for scientific and educational purposes in both Puerto Rico and the U. S. Virgin Islands.

The taking of reef-associated organisms for the aquarium trade is a relatively new activity that began in about 1970 in Puerto Rico and since then has expanded from a handful of harvesters, dealers and exporters to an industry that employs about 100 people (Sadovy, 1991). This activity has remained relatively undeveloped in the U. S. Virgin Islands and has been regulated by permit since 1990. The expansion of the aquarium trade in Puerto Rico over the last two decades is attributable to three factors. The demand for live marine organisms has shifted with technology that enables more people to successfully maintain these species in home aquariums. Second, the excellent transport facilities from San Juan airport have made Puerto Rico a very attractive location for the harvest and export of Caribbean species. Finally, a reduction in supply from competing sources (restrictions on the collection of organisms in Florida waters, declines in abundance in the Philippines and a recent trade embargo against Haiti) has made Puerto Rico an increasingly important source of these organisms.

As previously stated, commercial harvest of reef-associated organisms is allowed in U.S. Virgin Islands state waters under permit and 53 collection/retention/transit permits have been issued since the implementation of permits in 1990. Information on the species composition of the harvest is not available although inspection of permit applications indicated that typical collections include low numbers of a variety of vertebrate and invertebrate species. Commercial harvest of black coral and octocorals is

allowed under permit in the state waters of Puerto Rico, but there is currently no known legal harvest of other corals in Puerto Rico. However, gorgonians and at least one stony coral species (Tubastrea aurea) are listed as available for the aquarium industry and shipments of corals to the U.S. mainland have been reported (Sadovy, 1991). It has also been alleged that boxes of coral and live-rock are shipped out of regional airports (e.g., Aguadilla and Ponce) where there is currently no inspection, and that occasional undetected shipments are made from the airport in San Juan. For example, a recent export shipment of 300 live corals was recently intercepted and this suggests that harvest and export occur, but with unknown frequency and volume.

In early 1993, approximately six companies were known to export live invertebrates from Puerto Rico for the aquarium trade and an additional seven businesses serve the domestic (Puerto Rico) market. While the majority of the marine aquarium trade is in fish species, in 1992 an estimated 25% of the trade involved invertebrates, live-rock and some corals.

Some reef-related species are collected and prepared for the curio trade. For example, gorgonian colonies (Gorgonia spp.) are marketed dried or as components of jewelry and other craftwork (Yvonne Sadovy, pers. obs.). It is not known to what extent this material originates from the collection of dead organisms at the shoreline, but the quality of some intact gorgonian colonies indicate that animals were harvested and preserved with marketing in mind (Yvonne Sadovy, pers. obs.). A wide variety of other species, some of which may eventually be regulated under this FMP, are a part of the curio trade. These include seashells, starfish, cured sea urchins and spines of the slate pencil urchin. However, the majority of organisms sold as curios and used in craftwork are imported. Trade figures from The Puerto Rico Planning Board indicate that there were no recent exports for the curio trade while imports of between 20,000 and 37,000 kg of these products were recorded and most of these probably came from Florida dealers. A random survey of 30 companies from a list of 200 marine life dealers in Florida indicated that 11 of them export marine products (mainly originating in the Philippines) to Puerto Rico.

The discussion above indicates that most of the existing commercial value of reef species is related to the harvest of live organisms for the aquarium trade, while the trade in coral species and live-rock is relatively minor. This conclusion is supported by the survey completed by Sadovy. On the basis of an analysis of 214 export shipping lists covering the period 1990-1992, she found that the combined exports of live-rock, gorgonians and corals constituted only 3.7% of all organisms recorded.

The principal direct recreational importance of coral reefs is related to the tourism and diving industry. Recreational use includes viewing as well as harvest of reef species for use in home aquariums or as curios. The volume of this harvest is unknown but is probably rising over time. One indicator of an expanding personal use harvest is that diving and snorkeling has grown rapidly over the last decade. For example, the number of businesses that teach recreational diving in Puerto Rico has grown from about 3 or 4 in the 1970's to about 35-45 today. Most of these businesses are small family concerns and

the majority provide diving certification courses for island residents. A minority (about five) offer both diving courses and diving and snorkeling facilities for tourists. Another indicator of the growth of recreational diving and personal use harvest is that the Puerto Rico Board of Tourism is promoting eco-tourism and part of the promotion involves positioning Puerto Rico as a diving destination. Further, commercial fishers in a number of areas are increasingly providing services for recreational divers and fishers as income from traditional commercial fisheries enterprises continues to diminish (Ruperto Chaparro, pers. obs.).

The U.S. Virgin Islands currently rank ahead of Puerto Rico as a diving destination for tourists and the 25-30 dive businesses in the U.S. Virgin Islands predominantly cater to tourists (George Mitcheson, Ralf Boulon, pers. obs.). An indicator of the growing importance of diving-related activities in the U.S. Virgin Islands is that attendance at Trunck Bay beach, located in the national park on St. John, has increased from 20,000 people in 1966 to 170,000 people in 1986 (Rogers and Teytaud, 1988).

In addition to having well known commercial and recreational uses, certain gorgonian species are a source of chemical compounds of medical interest or use. As a result, gorgonians have been harvested in the La Parguera area of Puerto Rico and the southwest coast of St. Thomas, U.S. Virgin Islands for scientific research and testing for commercial feasibility as sources of these compounds. The impact of this activity on the gorgonian stocks is unknown and needs to be assessed (Goenaga and Boulon, 1992). Periodic harvest of other soft corals, sponges and macroalgae also has occurred for similar reasons and with unknown frequency and volume of harvest. It is not known to what extent harvesting activities on these species may change in the future or what additional compounds are yet to be discovered.

Education and research regarding the importance and significance of the reef environment is another use of the reef resource and some harvest of reef organisms for scientific and bona fide teaching purposes occurs in both Puerto Rico and the U. S. Virgin Islands.

VII. ANALYSIS OF MANAGEMENT MEASURES

MANAGEMENT MEASURE 1: Prohibit the harvest or possession of stony corals, wheter dead or alive, except for legally permitted research, education, and restoration programs.

In Puerto Rico and the U.S. Virgin Islands, stony corals have a number of the uses discussed above and the significance of the measure is to eliminate the uses and value associated with the harvest of stony corals (with the exceptions for research, education and restoration noted). Following Spurgeon (1992), this would involve eliminating the aquarium trade, the curio trade, other industrial uses, construction and that portion of tourism that involves harvesting (personal use would be assigned a value of the consumer surplus derived from the use of collected species). Of these, the information derived from the FMP contains no information indicating current use in the other industrial or construction categories. Hence, the significance of the measure

is to eliminate the commercial and recreational take for aquarium and curio purposes. Uses not eliminated by the measure therefore include fisheries production, tourism, research, education, biological support, coastal zone extensions, physical protection, global life support, social services, existence, option and intrinsic.

Because stony corals grow at a slow rate, the FMP has concluded that stony corals cannot be viewed as renewable resources. If this is true (the operating assumption is that the FMP is correct), then coral resources must be treated like mineral resources or petroleum when considering the value of the consumptive uses. In economic terms, the annual value of the consumptive uses is the one-time sum of producer and consumer surplus in any given year and the total present value is the sum of discounted annual values.

Not only do the stony corals represent a unique fishery in that they are considered as non-renewable from a biological and hence economic perspective, their role in creating the value of the non-harvest uses once again makes them somewhat unique among fishery or marine resources. Specifically, as they are harvested over time, the value derived from the other uses diminishes in some (unfortunately unknown) proportion to the remaining stock of coral. Taken to the extreme, if all the stony corals were to be harvested at some annual rate, it is clear that the value from all other uses of stony corals would decline over time and would reach zero at some point. Although that scenario is not very realistic because management would surely change before that point was reached, the general notion is correct. The general notion is that while the harvest-related uses have a one-time value that is realized at the point of harvest, the other uses have a value that is not generally eroded over time if the coral resource remains intact but approaches zero as the remaining stock of coral approaches zero.

The significance of the point made in the previous paragraph can be illustrated by a hypothetical example. Using fishery management jargon, assume that there is an annual fixed quota for stony corals and that the quota is equal to five percent of the beginning stock of coral. By simple math, the life of the "fishery" is fixed at 20 years (all the coral will have been harvested) and regardless of the beginning annual value of the fishery, it is zero for year 21 and thereafter. Now consider the value of all the other uses combined and assume that the value of the other uses is proportional to the amount of coral in the water. On a ceteris paribus basis the first year value is the maximum annual value (even before discounting the values accruing in later years) and values after the first year will steadily decrease over time and will be zero in the 21st year and thereafter. The opposite conclusion is that if there is no harvest then, on the same ceteris paribus basis, the non-use value can be considered as an annuity, i.e., the value does not decline over time (except for the discounting to calculate the present value). In the case of the hypothetical example, the value of the other uses under the no harvest scenario extends beyond the 20th year and into perpetuity.

Regardless of the economic uniqueness of coral resources, the task of the RIR is to determine the economic effect of the management measure on net benefits to society and this determination involves calculating the net present value

of the stony corals in their harvest uses versus the decline in value from the other uses. Note that the last sentence indicates another unique aspect of the coral fishery. In the usual fishery case, the notion of competing uses almost always refers to the distribution (allocation) of Total Allowable Catch (TAC) from the fishery and the question concerns the way to distribute the harvest rights in a fashion that will tend to maximize the economic benefit derived from the quotas assigned to the competing groups. The operating principle in this usual case is to allocate the TAC among competing user groups so that the marginal benefit is equal for all users. If marginal benefits are not equal then total benefits can be increased by increasing the quota assigned to those users having the higher marginal benefit. However, in the case of stony corals, the entire harvest quota would be allocated to the users that have to harvest coral to create benefits. The other users (competing non-harvest users) get their benefits from the coral which is not harvested and the "competition" occurs because their future benefits decline if the total stock of coral declines. Further, the non-harvest users are not concerned so much with the harvest (quota) for any given year but are instead concerned with the cumulative effect of a continuing annual harvest.

In the case of the harvest uses, the FMP provides information that indicates the current commercial harvest may be small. However, there are a number of world-wide supply and demand factors that point to making the commercial uses increasingly valuable over time with the obvious outcome of an increasing harvest over time. Summarized, the supply factors largely involve the fact that some Indo-Pacific and other resources may have been harvested to a degree that the cost of harvest from those areas has risen significantly and in other areas management regimes to limit or eliminate the harvest are in effect. On the demand side, the increasing use of home aquariums as well as an increasing interest in these types of natural products as curios probably provides the major demand shift.

The FMP provides the only known information on commercial harvest in the U.S. Caribbean. Sadovy's survey of exports during 1992 indicated that less than one percent of all marine organisms were classified as corals of all types and would number less than 1,000 valued at about \$4,000. This admittedly very rough estimate of minimum export value is not economic value defined as the sum of producer and consumer surplus and that true value would be some relatively small fraction of the export value. While the estimates provided by Sadovy are very conservative for a number of reasons, the data nonetheless indicate that exports of stony corals are small. More recently, Sadovy (pers. comm.) reported that there appears to be little or no current harvest of stony corals for the curio trade or jewelry manufacturing and that Puerto Rico imports corals, principally from Florida. In spite of the small reported commercial harvest there appears to be an unknown level of illegal harvest that enters commercial channels. In addition to the small commercial take for export, there is an unknown amount of harvest for domestic markets and this amount is likewise small. Additionally, there is undoubtedly some recreational take for personal use but once again there is no information on the volume. Despite the lack of information on direct harvest the supposition based on available information is that the current harvest is relatively small but increasing. The consequence in terms of the RIR is that the stony coral

harvest and value are small at present and that the value of all the other uses of stony corals combined is declining (or more accurately rising at some reduced rate since the demand for the other uses is rising) due to the small directed commercial harvest.

The observation that current harvest is probably relatively small can be interpreted in two ways. One line of thought is that there is no need for a harvest restriction because the harvest is small and the other is that eliminating a small harvest has only a minor negative economic impact. While the latter appears to be correct, it should be recalled that the effect of direct harvest on the value of the other uses is not reflected by the annual take, but that value derived from the other uses declines as a result of the cumulative harvest over a number of years. In addition, it has been noted previously that a decline in the world supply of stony corals and a demand that appears to be increasing over time indicates that the harvest of stony corals in the U.S. Caribbean will undoubtedly increase in the absence of management controls. This indicates that the decline in the value from other uses in future years will proceed at a faster rate than the present rate.

The FMP contains some information that indicates the value of the other stony coral uses combined may be quite large. However, that information tends to concentrate on the expenditures associated with recreational diving experiences and expenditures are not the correct measure of the contribution of stony corals to the value of the other uses. Measurement of the correct values emanating from the existence of stony corals have been attempted in a few cases. For example, Hudloe (1990) used contingent valuation methodology to determine that Australian citizens valued the existence and option use of the Great Barrier Reef at over \$29 million or about \$36 per resident adult. That value would not include the consumer surplus derived from resident and tourist recreation diving, fishing and viewing on the Reef. In another study, Hudloe (1990) estimated that the resident population that actually used the Reef gained a total consumer surplus of about \$4 million annually or about \$5 per adult user (tourist consumer surplus would have to be added to this amount). The results of these studies provide an indicator of the recreational use value of the coral reefs of the U.S. Caribbean. With an adult population of about 2.1 million, the existence and option value of the reefs would be about \$76 million if the reef system has a value similar to that of the Great Barrier Reef. The extent to which lower per capita values in the U.S. Caribbean (due to relative per capita incomes and perhaps an overall lower reef quality) are offset by the larger population in the U.S. Caribbean versus Australia makes it difficult to estimate the true value. Nonetheless, the existence and option value to adult residents is substantial and does not include the actual resident or tourist direct use value. As a caution against misinterpreting this large value, note that it represents the total value lost for all time if the entire reef system were to disappear and readers should avoid comparing this value with annual values related to other uses.

Fish production is another value of coral reefs and Munro and Williams (1985) estimated that coral reefs produce an average maximum sustainable yield of 15 metric tons per square kilometer and Munro (1984) estimated that the

productivity of coral reefs is responsible for about one-eighth of the world's fish harvest. Most of the fisheries production of the U.S. Caribbean depends on the existence of the coral reefs and in 1991, Puerto Rico recorded landings of 2.5 million pounds valued at \$4.3 million (Fisheries Research Laboratory, PRDNR, 1992) while the U.S. Virgin Islands reported projected landings of 1.9 million pounds valued at \$4.8 million (Department of Planning and Natural Resources U. S. V. I., 1992). While landed value overstates the true economic value of the fisheries and hence the contribution of coral reefs, a crude estimate that the true value amounts from 10% to 40% of landed value (author's estimate), results in a rough estimate of the annual economic value of fisheries production of about \$0.9 to \$3.6 million.

There is no information available to infer the value of the other uses which include research, education, biological support of other ecosystems, coastal zone extensions, physical protection, global life support (Note: The RIR guidelines preclude counting values that accrue to non-U.S. citizens) and social services. Although no information is available, these uses do have value and should be considered when attempting to determine any loss in value that is related to loss of reefs.

Another entirely different approach to the valuation of coral reefs is to refer to court settlements involving governments and parties responsible for ship groundings on coral reefs. Some examples include a settlement of \$600,000 involving the destruction of 340 square meters of coral in the Strait of Tiran (Spurgeon, 1992), \$1.5 million for a grounding involving 1,610 square meters in the Florida Keys and \$2.8 million involving 3,073 square meters of coral also in the Florida Keys (Finch, Julious and Lopez, 1992). Averaging these examples, the value of coral reefs is determined to be \$975 per square meter. Once again, this value is for all time and hence should be viewed with caution. Nonetheless, this independent valuation method points to a considerable value that the courts place on coral reefs.

Finally, there are the costs associated with reefs (ship groundings, coral reef avoidance costs and avoidance systems such as navigational aids). Although some information is undoubtedly available for the U.S. Caribbean, the RIR has made no attempt to research these costs.

Recall (perhaps redundantly, but for emphasis) that the issue is weighing the annual direct harvest value against the increasing loss in value for all other uses in all future years. It should be evident that the small annual harvest values previously reported will be exceeded by the lost value that would be associated with the cumulative loss of coral reef material over time.

The entire discussion above depends heavily on the notion that enforcement and compliance will be good enough to ensure that the current and future direct harvests are kept at a reasonably small level. Although it is not possible to estimate that threshold level, it exists and if it is exceeded, then the losses in future value would make management moot. Related to the need for an effective compliance rate is the need to have consistent regulations throughout the range of the corals. The RIR recognizes the implication that current U.S. Caribbean regulations and permitting systems will have to be

altered and operated at some cost and these costs are discussed further in the "Management Cost" section of the RIR.

Another potentially important part of this option is the allowance of some harvest for research, education, and restoration purposes. For the research and education exemption, it may be necessary to create some incentives or procedures to ensure that the harvest for these purposes is kept to a minimum. Information in the FMP indicates that the removal of corals for research and education purposes can be particularly destructive and there may be a plausible explanation rooted in economics. Quite a lot of research, education, and testing of various types involves what is termed "destructive sampling" and a well-known example is the crash-testing of cars. In the usual case, such as in the example, the researchers have to incur the cost of the destruction as a part of their research budget and therefore have an incentive to minimize their costs. However, in the case of research involving corals, the researchers presumably do not pay for the lost use value associated with their destruction of coral for research and education purposes. In economic terms, this situation could lead to the creation of marginal costs to society that exceed the marginal value associated with the research and education requiring the destruction of coral. The way to correct the situation is to ensure, through some effective process, that the research and education community consider the societal costs and use only the very minimum amount of material possible. Further, there should be some mechanism available to ensure that the destruction of the first piece of coral is justified by the value of research results before permits are issued. The exemption for transplanting or laboratory production of corals is less of an issue, but it is clear that some reasonable probability of success of such experiments should be determined before permits are issued.

The RIR concludes that the measure has a (perhaps large) net benefit to society.

Option 1A: Permit the regulated harvest of stony corals.

It is recognized that the supposition that all stony corals are non-renewable is countered by information in the FMP that some species grow fast enough that a sustainable harvest may be possible. However, the FMP also suggests that there is not enough information available to support a reasonable management measure and states that when such information becomes available, then the Council intent is to amend the plan accordingly.

If this option was exercised, it would be expected that the current small level of harvest would increase by a small but unknown amount because this option is less restrictive than current state law. Accordingly, current direct use values from commercial and recreational harvest would increase slightly. With some level of harvest, the non-use values would tend to decline over time. A regulated harvest would also imply some level of public and private costs associated with permits or similar documents. Assuming that most of the stony corals can be considered as non-renewable resources, the RIR conclusion is that this option would have a small negative impact on net national benefits.

Option 1B: Prohibit all harvest of stony corals.

Referring to the discussion and analysis for the preferred option, this option would prohibit commercial and recreational take and would also disallow take for scientific and restoration purposes. The RIR conclusion is that this option would have a positive net benefit to society but would be inferior to the preferred option if reasonable controls on scientific and restoration take are implemented for the preferred option. Given the historical take for such purposes, the outcome of the option is less clear if appropriate controls are not instituted. Refer to the previous discussion on the exemptions provided by the preferred option.

Option 1C: No Action.

Refer to the discussion and analysis for the preferred option. While the status quo generally has no impact (nothing changes), the unique status of the coral fishery implies that the status quo would have a negative economic effect on societal benefits in the long run. This conclusion is predicated on the cumulative loss in other coral uses with a given annual harvest for direct use.

MANAGEMENT MEASURE 2: Prohibit the harvest or possession of sea fans and gorgonians (octocorals), live or dead, and any species in the fishery management unit if attached or existing upon live-rock, except for legally permitted research, education and restoration programs.

Following the categories of use described by Spurgeon (1992), octocorals have most of the same uses as stony corals with the addition of uses as pharmaceutical compounds, but do not have use in terms of other industrial, construction and physical protection. Their main uses and value probably derive from fisheries production and from uses related to recreational diving. They have some use as commercial and personal use in home aquariums and as curios and it is this use that would be eliminated by the measure.

Information in the FMP indicates that the soft corals (octocorals) differ from the stony corals in their rate of growth to the extent that many of the species can be considered as renewable resources from both a biological and economic perspective. If this is true, and if it is feasible to enforce harvest regulations at a reasonable level of compliance, then a measure that totally eliminates all harvest for commercial and recreational use should result in a negative change in net societal benefits. The reasoning is straightforward and essentially indicates that soft corals can be considered in the same manner as other renewable fishery resources, i.e., some level of harvest is allowable and the objective is to set the harvest at the level corresponding to maximum economic yield (MEY). Even though the stocks can be considered to be renewable, the level of MEY for soft corals would be below that level which maximizes the direct harvest value over time. This is the case because the harvest of soft corals will decrease the values in other uses, although not to the degree shown previously for stony corals. Unfortunately, the available biological information has not been assembled and analyzed in terms of determining the acceptable level of harvest of the

various species of soft corals. The RIR notes that the Council is on record as agreeing that at least some soft coral species may be treated as renewable resources and has indicated an intent to consider an amendment to the FMP when more information becomes available.

Information in the FMP indicates that the current harvest level is minor as judged from the Sadovy report on the export of marine aquarium species that indicated less than 4% of all exports involved corals and live rock and most of the volume was in live rock. Since the current harvest appears small, the RIR concludes that the portion of the measure that refers to soft corals will have a small net negative impact on benefits to society.

The measure also addresses any species in the FMU if attached or existing upon live-rock and for the purposes of the RIR, live-rock is deemed to have the growth characteristic of stony corals, i.e., live-rock is judged to be a non-renewable resource. For essentially the same reasons as making the determination that prohibiting the harvest of stony corals will have a net positive benefit to society, the same conclusion is reached for live-rock.

In summary the RIR concludes that it is economically sound to prohibit all commercial and recreational harvest of live-rock, but not necessarily economically sound to prohibit all commercial and recreational harvest of soft corals.

Option 2A: Prohibit the harvest or possession of octocorals and any species in the fishery management unit if attached or existing upon live-rock, except for legally permitted research, education and restoration programs, or in the course of bona fide aquaculture operations.

For clarification, the reference to aquaculture operations is specifically meant to refer to live-rock.

Recalling the discussion on the outcome for the preferred measure, the portion of the option which refers to traditional commercial and recreational harvest is expected to have a small negative impact on net benefits to society.

In the case of live-rock aquaculture, the measure has no impact since there is no live-rock aquaculture in the EEZ of the U.S. Caribbean at this time. It is noted in the FMP that the Council may reconsider this part of the management of live-rock if aquaculture systems are successfully developed (presumably in jurisdictions outside the U.S. Caribbean).

Option 2B: Permit the regulated harvest of octocorals and any species in the fishery management unit if attached or existing upon live-rock.

As mentioned above, octocorals rejuvenate removed portions and grow faster than stony corals. Thus, limited harvest of certain octocoral species probably would generate net benefits to society. Since the measure does not specify the level of harvest, e.g., allow harvest at present levels, it is not possible to be more explicit. The FMP indicates that some level of managed

harvest may be possible in the future based on appropriate scientific findings that could help establish sustainable harvest levels.

A sustained regulated harvest of live-rock is expected to reduce economic benefits because of the expected decline in non-use value over time. See the discussion of the preferred option.

Overall, the option is expected to have a negative impact on benefits in the case of the octocorals, but a positive impact for live-rock. It is not possible to predict the overall outcome of the two effects combined.

Option 2C: Prohibit all take of octocorals and any species if attached or existing upon live-rock.

This option imply that take of octocorals for scientific, education and restoration programs would not be allowed. Assuming adequate controls on scientific, education and restoration permits under the preferred option, this option would have a small negative impact resulting from presumed lost research values. Referring to the discussion on the outcome of prohibiting commercial and recreational harvest of octocorals under the preferred measure, this part of the option is also expected to have a small negative impact on net benefits to society.

Option 2D: No Action.

The status quo option does not alter current net societal benefits.

MANAGEMENT MEASURE 3: Prohibit the sale or possession of any species whose harvest is prohibited unless the specimen entered the management area in interstate commerce and is fully documented as to point of origin.

No sale provisions which accompany no harvest provisions have been deemed to have a positive effect on benefits in a number of other FMP's because such actions help ensure compliance with regulations. It is assumed that the record-keeping requirements are already met since invoices accompany shipments at present. The only potential additional cost would be to maintain such invoices and that cost would be very small or zero (most businesses probably maintain such records for normal business purposes).

Option 3A: No action.

The status quo option does not alter current net societal benefits.

MANAGEMENT MEASURE 4: Prohibit the use of chemicals, plants or plant derived toxins, and explosives to harvest organisms in the coral fishery management unit, except for legally permitted research, education and restoration programs.

Synthetic chemicals, natural products derived from plant species, and explosives, including powerheads on spear guns, would be prohibited. Chemicals currently being used to harvest reef-associated organisms include

quinaldine, gasoline, and bleach. These substances are known to be detrimental to both fish and invertebrate species, including the target species. In the case of the target species the use of chemicals in harvesting is known to result in relatively high mortality during holding and shipping (Sadovy, pers. comm.).

Since other harvest methods are available to successfully harvest these organisms, the proposed prohibition on the use of chemicals would not preclude harvest of the majority of commercial organisms. However, the measure would presumably increase the harvest cost to an unknown degree because the harvester would have to revert to use of the next most efficient and legal harvest method. On the other hand, benefits should accrue to the first and subsequent buyers via reduced mortalities of the organisms being purchased. Additional benefits would accrue through reduced mortality of non-target species. In the absence of definitive information, the measure is expected to have a net positive impact on benefits to society.

Option 4A: Permit the regulated use of chemicals, plants or plant derived toxins, and explosives to harvest organisms in the coral fishery management unit.

Referring to the discussion on the outcome for the preferred measure, this option is expected to have a small negative impact on net benefits to society.

Option 4B: No action.

The status quo option does not alter current net societal benefits.

MANAGEMENT MEASURE 5: Limit harvest methods of fishery management unit organisms to hand-held dip nets, slurp guns, by hand and other non-habitat destructive gear, except for legally permitted research, education and restoration programs.

Gear methods commonly used to harvest marine aquarium invertebrates include hand-held dip nets, by hand, chemicals such as quinaldine, and slurp guns. A crow bar or similar instrument is sometimes used to remove live-rock or to overturn corals and coral heads to allow access to organisms being harvested. Some of these methods can damage the reef habitat and are a source of incidental mortality for other reef-associated organisms. Of the traditional gear employed in the harvest of marine aquarium organisms, only hand-held dip nets and slurp guns represent no threat to coral reefs and associated organisms and are effective for the majority of commercial organisms. While most invertebrates may be collected with dip nets and slurp guns, certain collections for scientific or restorative purposes may require the use of chemicals (such as anesthetics) or nets such as cast nets. Accordingly, an exemption for certain permitted activities is proposed. The measure apparently has almost no current economic impact in the case of the use of chemicals since chemicals will be prohibited if Measure 4 is adopted. However, the measure will outlaw the use of crowbars and similar instruments. As was the case with the discussion on the use of chemicals, the scant evidence available results in the RIR finding of a small net positive benefit to society.

Option 5A: Limit harvest of organisms in the fishery management unit to hand-held dip nets and slurp guns and to current levels of harvest.

There is insufficient information to allow evaluation of OY for reef-associated invertebrates managed by the FMP. Although an estimate of current harvest levels could be based on reported exports, this may be an underestimate due to the substantial but unquantified domestic market. Given the available information, the Council does not believe that any of these species are in current danger of being overfished, with the possible exception of Condylactis sp. which constitutes over 50 percent of the export trade, by number. When additional information becomes available the Council will re-evaluate this option.

The present level of information is insufficient to make a solid determination on the change in net benefits to society if invertebrate harvest were limited to current levels. If the majority of the resources are not overfished and if there are no overcapitalization problems in the fishery, then a restriction of harvest at present levels would result in a small net loss in benefits to society. This result would occur because there would be losses in consumer and consumer surplus and additional management costs associated with monitoring the necessary quotas.

Option 5B: Prohibit harvest of organisms in the fishery management unit.

Maximum protection of invertebrate species would be afforded by a total prohibition of harvest. However, because the majority of reef-associated invertebrates are thought to be currently harvested in low numbers and may be able to sustain limited harvest at least at current levels, a total prohibition is not justified at this time. If harvest levels increase or certain species are considered to be particularly vulnerable to harvest, the Council intends to reconsider this option.

The RIR determination is that the measure would have negative impacts on benefits to society because of an expected loss of all current producer and consumer surplus associated with current harvests of what appear to be underfished resources (see the RIR discussion and conclusion regarding the preferred option).

Option 5C: No action.

The status quo option does not alter current net societal benefits.

MANAGEMENT MEASURE 6: Require a permit (up to a year) to harvest or possess organisms in the fishery management unit in the EEZ.

MANAGEMENT MEASURE 7: Require harvesters, dealers, and exporters of species managed under the Plan to acquire a permit (up to a year), to submit records on a regular basis and to report harvest, shipments, and unit costs.

These two preferred measures are discussed jointly because of their relationship and because both need to be implemented for each to be effective.

A permit would be required to harvest, maintain, and/or sell reef-associated invertebrates and the permit system would be operated by local governments, with the assistance of the National Marine Fisheries Service (NMFS). The measures also implies that permit applicants would have to supply information regarding species, quantities, unit value, harvest areas, and gear used. A permit would be denied anyone with an outstanding violation in any state or federally regulated fishery. Potential permit holders would have to agree to follow minimum standards of maintenance, handling, and transport of live marine organisms. An appropriate fee would be charged to recover costs of administering the permit system.

The stated reason for a permit system is to collect data on effort in the fishery and to identify the participants. A permit system would also facilitate introduction of a limited entry system in the event such a system is warranted and could be an aid in ensuring adequate compliance with regulations. Special permits also would be available for research, education and restoration purposes for other components of the FMU (stony corals, octocorals, and live-rock). Research, education and restoration permits would be awarded on a case-by-case basis following submission of a research plan, including species and quantities to be harvested, and area of collection.

The appropriate RIR analysis involves the determination as to whether or not the benefits of data collection and other implied uses of the permits system exceed the combined public and private costs of implementing and maintaining the system. Information in the FMP suggests that about 100 permits may be issued and the administrative costs are estimated at \$35 per permit or a total of \$3,500 (refer to "Management Costs" section of the RIR). These costs would accrue to the state governments or to the permit holders, but the details are not yet available. Costs of associated data collection have not been estimated in the FMP because the details of a proposed regular reporting system have not been fully addressed. However, the FMP indicates that the burden hours would "not be onerous." If the notion of regular dealer reporting via a mail-in system (to include appropriate harvest data) is followed, then the costs would be minimized. The proposed option is similar to logbook reporting systems used on the U.S. mainland except that the state governments would administer the program. For these similar programs, the reporting burden is estimated to be 15 minutes for each monthly report. In the case at hand, the annual burden would be 3 hours per permit holder or 300 total hours. If time is valued at \$10/hour then the total private cost is estimated to be \$3,000. The sum of administrative and reporting costs becomes \$6,500.

It is not possible to determine the dollar value of the benefits associated with the permits system. In the case of a number of existing FMP's it has been determined that the provisions of the FMP cannot be implemented without a permits or similar system. In such cases, it can generally be demonstrated that the benefits exceed costs if the costs are reasonably small. However, in the case of this FMP, the other management measures can be implemented in the absence of the permits system and this situation makes the net benefit determination more difficult. A number of the options in the FMP are stated as being subject to change if better data becomes available and that scenario

provides the basis for the value (in the future) of the permits system. In particular, the FMP indicates that the complete prohibition on harvest of all corals and live-rock may be relaxed if information regarding potential harvests (along with an analysis of existing biological data) indicates the possibility of a managed sustained harvest of certain species. In such a case the value of the permits system would probably exceed the cost. To the extent that permits aid compliance, there is some benefit but it cannot be quantified without further information.

Given the information available, the qualitative determination is that a case exists for the net benefits from a permit system and associated data collection system to be positive.

Option 6A: No action.

Option 7A: No action.

The status quo options do not alter current net societal benefits.

MANAGEMENT MEASURE 8: (Establish a Marine Conservation District (MCD) in the EEZ due South of St. John, U.S.V.I.). RESERVED. This measure will be reserved until more information is available and further consultation with the user groups is carried out.

VIII. MANAGEMENT COSTS

Major categories of management costs typically include administrative costs incurred by the Council and NMFS, enforcement costs borne by the states, NMFS and Coast Guard, public burden costs associated with data collection and costs of developing and maintaining permits and data collection systems.

The Caribbean Fishery Management Council has provided detailed information on their administrative costs broken down into the categories shown below. In December 1989, at its 68th regular meeting, the Caribbean Fishery Management Council received information on the trends in the use and exploitation of live-rock. Input on the live-rock issue was furnished by the Southeast Regional Office of NMFS, the NMFS General Counsel, interested organizations, Council Members, the scientific community and the general public. At the 69th regular meeting held April 1990 in St. Thomas, U.S.V.I., more and broader information was presented on live-rock. The Scientific and Statistical Committee (SSC) and the Advisory Panel (AP) considered the live-rock issue and the possibility of the development of a Fishery Management Plan for Corals at their meeting on July 17, 1990. Recommendations for the management of live-rock were presented to the Council by the SSC and the AP at its 70th regular meeting in July 1990. At that meeting, a motion was presented by Mr. D. Moore (Council member representing the Government of the U.S.V.I.) and seconded by Ms. Ana Olivencia (Council member representing the Government of Puerto Rico) requesting the Council to initiate the process for the development of this FMP that includes aquarium trade fish, live-rock, corals and soft corals.

The Council contracted with the late Dr. Carlos Goenaga to assess the state of corals around Puerto Rico and with Mr. Ralf Boulon to do the same in the U.S. Virgin Islands. At a later date Dr. Yvonne Sadovy was contracted to assess the state of the aquarium trade fishery in Puerto Rico. The reports from these contractors served as source documents in the process of developing the FMP.

Scoping meetings on the Plan were held by the Council during 1992. Proposed management measures were considered by the SSC, AP, and HAP and recommendations were presented to the Council by the end of 1993. After Council recommendations, a draft FMP was prepared and presented at public hearings during the first quarter of 1994. It is expected that the FMP will be completed during 1994.

STATEMENT OF ESTIMATED COUNCIL COSTS - AS OF JUNE 30, 1994

I. Consideration at the Council Meetings

Estimated Cost of Council Members Compensation for One Council Meeting	\$4,519
Estimated Travel Expenses for Council Members to One Council Meeting	<u>\$3,430</u>
Total Cost of Compensation and Travel Expenses for One Council Meeting	\$7,949

Using the estimated total cost of a Council meeting shown above, the costs of meetings related to the FMP are as follows. The Council meetings are estimated to last 16 hours, of which at least an average of 2.5 hours were devoted to the FMP for Corals and associated organisms during the 70th to the 78th meetings (9 meetings).

Estimated Cost from 70th to 78th Meetings	
2.5 hours divided by 16 hours = 15.6%	
\$7,949 x 15.6% x 9 meetings =	\$11,160

The Council considered the draft of the FMP at its 79th, 80th, and 81st Regular Meetings. These meetings were dedicated almost entirely (90%) to the development of the FMP. The estimate is as follows:

Estimated cost of Council Members for One Council Meeting	\$4,519
Estimated cost of Compensation at the 79th, 80th, 81st Meetings \$4,519 x 90% x 3 =	\$12,201
Estimated Travel Expenses for Council Members for Three Meetings	<u>\$10,020</u>
Estimated Compensation and Travel Expenses for these Regular Meetings	\$22,221

II. Time Devoted by the Staff

It is estimated that the Fishery Biologist has devoted 90% of the time to the development of the FMP since October 1992.

Salary for the Period October-December 1992	\$14,095
Salary for the Period January-March 1993	<u>14,571</u>
Total	\$28,666
Estimated Cost of Staff - \$28,666 x 90%	\$25,799

It is estimated that the Special Assistant for FMP Development devoted 80% of the time to the development of the FMP during the period July-September 1993 and October 1993 - June 1994.

Salary for period July-September 1993	\$12,858
Salary for the period October 1993-June 1994	40,409
Estimated Cost of Staff - \$53,267 x 80% =	\$42,614

III. Scoping Meetings

Scoping meetings were held in Salinas, San Juan, Fajardo, Lajas, Naguabo and Aguadilla in Puerto Rico and in St. Thomas and St. Croix in the U.S.V.I.

Estimated Council Members Compensation	
1 member x 1 day x 7 scoping meetings	\$2,072
Estimated Travel Expenses - Members (1)	800
Estimated Travel Expenses - Staff (2)	<u>1,600</u>
Estimated Cost of Scoping Meetings	\$4,472

Estimated Cost of Other Related Meetings	
Coral Reef Symposium	\$2,604
Meeting at the SERO/NMFS	<u>1,188</u>
Estimated Cost of Other Related Meetings	\$3,792

IV. Public Hearings

The Council held public hearings on the FMP during the month of February 1994, in St. Thomas, St. John, St. Croix, U.S.V.I.; Cabo Rojo and Fajardo, Puerto Rico.

Estimated Cost of Council Members Compensation	
1 member x 2 days x 5 public hearings	\$3,060
Estimated Cost of Travel Expenses - Members (1)	1,250
Estimated Cost of Travel Expenses - Staff (3)	750
Estimated Cost of Conference Rooms	<u>500</u>
Estimated Cost of Public Hearings on the FMP	\$5,560

V. Contractors

Contract to Dr. Carlos Goenaga for the Assessment of the State of Corals Around Puerto Rico	\$1,000
Contract to Mr. Ralf Boulon for the Assessment of the State of Corals in U.S.V.I.	950
Contract to Dr. Yvonne Sadovy for the Assessment of the State of the Aquarium Trade Fish in Puerto Rico	<u>1,000</u>
Estimated Cost of Contractors	\$2,950

VI. Summary of Council Estimated Costs

Consideration at Council Meetings	\$33,381
Time Devoted by Staff	68,413
Scoping Meetings	4,472
Other Related Meetings	3,792
Public Hearings	5,560
Contractors	<u>2,950</u>
Total Estimated Cost of Development of the FMP as of June 30, 1994	\$118,568

The NMFS incurred administrative costs during the development of the FMP and these costs are as follows.

NMFS Administrative Costs

Fisheries Management Division	\$ 9,000
Economics and Trade Analysis Division	10,500
Travel to meetings	<u>4,000</u>
Total NMFS Administrative Cost	\$23,500

Enforcement Costs

National Marine Fisheries Service	\$13,750
U.S. Coast Guard	31,096
Commonwealth of Puerto Rico	18,700
U.S. Virgin Islands	<u>10,522</u>
Total Enforcement Cost	\$74,068

Cost of Public Burden for Reporting **\$3,000**

Cost of Permits **\$3,500**

SUMMARY OF COSTS OF FMP

Caribbean Council (Through June 30, 1994) 118,568

NMFS Administrative (One-time)	23,500
Enforcement (Annual)	74,068
Permits and Data Reporting (Annual)	<u>6,500</u>
TOTAL FIRST YEAR COST	\$222,636

IX. SUMMARY OF IMPACTS OF MANAGEMENT MEASURES

Table 1 gives the summary of expected changes to net economic benefits if the preferred or alternative options were implemented. The "no action" options do not appear in the table because in most cases no action implies no impact.

The one-time costs of developing the FMP as well as continuing costs for permits, data reporting and law enforcement activities are shown in the preceding section. The one-time costs total \$142,068 and the continuing costs have been estimated at \$80,568 on an annual basis.

Table 1. Summary of Economic Outcome of Proposed and Rejected Management Measures for Major Use and Non-Use Values of U.S. Caribbean Coral Resources

<u>Measure</u>	<u>Commercial Harvest</u>	<u>Recreational Harvest</u>	<u>Fisheries Production</u>	<u>Viewing, Existence and Options Value</u>	<u>Private Cost</u>	<u>Overall Change in Net Benefits</u>
1. Prohibit stony coral harvest except for research, education and restoration purposes.	Small Negative	Small Negative	Positive	Positive	None	Positive (Perhaps Large)
1.A Permit regulated harvest of stony corals.	Small Positive	Small Positive	Negative	Negative	Small (Permits)	Negative
1.B Prohibit all harvest of stony corals.	Small Negative	Small Negative	Positive	Positive	None	Positive
2. Prohibit harvest of soft corals and live-rock except for research, education and restoration purposes.	Negative	Negative	Small Positive	Small Positive	None	Small Negative (Octocorals) Positive (Live-Rock)
2.A Prohibit the harvest of octocorals and live-rock, except for research, education and restoration purposes or for aquaculture of live-rock.	Negative	Negative	Small Positive	Small Positive	Small (Aquaculture Permits)	Small Negative
2.B Permit regulated harvests of octocorals and live-rock.	Positive	Positive	Small Negative	Small Negative	Small (Permits)	Positive (Octocoral) Negative (Live Rock)
2.C Prohibit all take of octocorals and live-rock.	Negative	Negative	Small Positive	Small Positive	None	Small Negative
3. Prohibit sale of prohibited species.	Positive	Positive	Positive	Positive	None	Positive (Where Applicable).
4. Prohibit use of chemicals and explosives.	Increase in Harvest Costs	None	Positive	Positive	None	Positive

Table 1.(cont.) Summary of Economic Outcome of Proposed and Rejected Management Measures¹ for Major Use and Non-Use Values of U.S. Caribbean Coral Resources

<u>Measure</u>	<u>Commercial Harvest</u>	<u>Recreational Harvest</u>	<u>Fisheries Production</u>	<u>Viewing, Existence and Options Value</u>	<u>Private Cost</u>	<u>Overall Change in Net Benefits</u>
4.A Permit regulated use of chemicals and explosives.	None	None	Negative	Negative	Small (Permits)	Small Negative
5. Limit harvest of FMU organisms to hand-held dip nets and slurp guns, except for research, education and restoration purposes.	Increase in Harvest Costs	None	Positive	Positive	None	Positive
5.A Limit harvest of FMU organisms to hand-held dip nets and slurp guns and limit harvest to current levels.	Negative and Increase in Harvest Costs	None	Small Positive	Small Positive	Small (Permits)	Negative
5.B Prohibit harvest of FMU organisms.	Negative	Negative	Small Positive	Small Positive	None	Negative
6. Require permits to harvest or possess legal species. Require harvesters, dealers and exporters to be permitted and to report harvests, shipments and unit costs.	None	None	Small Positive	Small Positive	\$3,000 or \$6,500	Positive

1 "No Action" alternatives are not present in the summary"

X. ANALYSIS FOR THE NEED FOR AN INITIAL REGULATORY FLEXIBILITY ANALYSIS

The Regulatory Flexibility Act requires a determination as to whether or not a proposed rule has a significant impact on a substantial number of small entities. If the rule does have this impact then an Initial Regulatory Flexibility Analysis (IRFA) has to be completed for public comment. The IRFA becomes final after the public comments have been addressed. If the proposed rule does not meet the criteria for "substantial number" and "significant impact," then a certification to this effect must be prepared. The determinations for this amendment are based largely on the RIR and partially on information in the FMP, both of which can be referenced for additional information.

The substantial number criterion is that 20% of the businesses engaged in the fishery must be affected by the action. There are about 16 small business in the U.S. Caribbean which are potentially involved in the collection, sale and export of coral reef organisms managed by this FMP. These firms employ a total of less than 100 workers in all phases of the businesses (mostly harvesters, biologists, packers and shippers). In addition to firms involved in the commercial aspects of harvest, there are an estimated 65 businesses which provide recreation diving services. Since the FMP will eliminate collecting for personal use, there is the chance that their businesses could be marginally affected by the actions contemplated by the FMP. However, of the total of about 81 businesses identified, less than 20% are expected to be affected by the actions because the volume of harvest is quite low.

The outcome of "significant impact" can be triggered if any of the following conditions are met:

- The regulations are likely to result in a reduction in annual gross revenues by more than 5 percent.
- Annual compliance costs (annualized capital, operating, reporting, etc.) increase total costs of production for small entities by more than 5 percent.
- Compliance costs as a percent of sales for small entities are at least 10 percent higher than compliance costs as a percent of sales for large entities.
- Capital costs of compliance represent a significant portion of capital available to small entities, considering internal cash flow and external financing capabilities.
- The requirements of the regulation are likely to result in a number of the small entities affected being forced to cease business operations. This number is not precisely defined by SBA but a "rule of thumb" to trigger this criterion would be two percent of the small entities affected.

For the commercial businesses, the FMP and RIR show that about 3 percent of their business involves the coral and associated species to be managed by the FMP and although the businesses would lose some sales and value via the

action, the loss is expected to be less than 5% of sales. These small businesses will not have any compliance costs associated with the action and none of the businesses are expected to cease operations as a result of the rule.

Since neither the substantial number nor significant impact criteria are expected to be met, the determination is made that an IRFA is not required.

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