AMENDMENT NUMBER 1 TO THE ENVIRONMENTAL IMPACT STATEMENT, FISHERY MANAGEMENT PLAN AND REGULATORY IMPACT REVIEW FOR THE SPINY LOBSTER FISHERY OF PUERTO RICO AND THE U. S. VIRGIN ISLANDS

NOVEMBER 1990

CARIBBEAN FISHERY MANAGEMENT COUNCIL

Introduction

The Environmental Impact Statement, Fishery Management Plan and Regulatory Impact Review for the Spiny Lobster Fishery of Puerto Rico and the U.S. Virgin Islands was implemented on January 1, 1985 (50 CFR Part 645).

This amendment adds a scientifically measurable definition of overfishing, an action plan to arrest overfishing, and should it occur, as required by the Magnuson Act National Standards (50 CFR Part 602).

Description of the Fishery

Data indicate an average annual increase in lobster landings of approximately 78,000 pounds during the period from 1975-1979. Spiny lobsters are an important resource and in 1979 composed about 8 percent (797,856 pounds) of the total estimated landings from the inshore fishery of the islands. There were 1,723 licensed fishermen in Puerto Rico and the Virgin Islands in 1979 and the ex-vessel value of their lobster catch was reported as $1,947,940. All of the lobsters are marketed locally; however, supply does not meet the demand and the market relies heavily upon imports.

The Overview of Puerto Rico's Small-Scale Fisheries Statistics 1988-1989, published by the Natural Resources Department reported a total landing of 186,423 pounds for 1989; 23 percent of total pounds landed in 1979. Total ex-vessel value was $803,483, a 59 percent reduction.

Statement of the Problem

NMFS in July 1989, published revised guidelines for fishery management plans that interpretatively address the Magnuson Act National Standards (50 CFR, Part 602). These guidelines require each plan to include a scientifically measurable definition of overfishing and an action plan to arrest overfishing should it occur. The FMP for spiny lobster is being revised by this Amendment to comply with the guidelines. In addition the Amendment includes a new habitat section to the FMP.

Proposed Action

The only action proposed in this amendment is the inclusion of a FMP section on overfishing and the enhancement of the habitat section as required by the Magnuson Fishery Conservation and Management Act as amended in 1988.

Action 1: Overfishing Definition

A spiny lobster stock or stock complex is overfished when it is below the level of 20 percent of the Spawning Potential Ratio.

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 percent Spawning Potential Ratio.

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 OY on a continuing basis.

Rationale and the Approach to Measuring Overfishing

When a stock is being fished, the potential that an individual will reproduce itself is indicated by the amount of reproductive products it can produce over its lifetime, discounted by the chance that it will die from natural causes (natural mortality rate) or from fishing (fishing mortality rate). The ratio of the level of reproduction at given rates of fishing compared to the level of reproduction when there is no fishing indicates the stress placed upon a population to maintain itself. This ratio is called the Spawning Potential Ratio (or spawning stock biomass per recruit), and can be used to measure the reproductive potential of a stock and the reduction of that potential in the face of fishing (Goodyear, 1989). The Spawning Potential Ratio for spiny lobster is expressed as an egg-per-recruit ratio, which is the average number of eggs per recruit at the present exploitation rate relative to the number of eggs per recruit in the absence of fishing (Gregory et al. 1982).

The definition of overfishing for this FMP establishes 20 percent Spawning Potential Ratio as the criterion. It is important to note that maintaining a 20 percent ratio does not guarantee that there will not be a subsequent decline in recruitment. Nor does a 30 percent or 40 percent level guarantee recruitment will always be successful or that a 19 percent level will trigger recruitment-collapse. Selection of a higher criterion will reduce the risk that recruitment-collapse might occur. The spawning potential should be big enough such that large, long-term reductions or fluctuations in recruitment and the resultant reduction in yields in the fishery are avoided.

After examining the available literature, the SSC found it has been documented that fisheries have a high probability of collapse when the spawning biomass was below the range of 20% to 40% (in some cases below 10%) of the virgin stock biomass. Not having enough information to precisely estimate the appropriate level for spiny lobster, the SSC chose the 20% SPR estimate as a level with an acceptable probability of protecting the stock biomass from long-

term reductions or fluctuations in recruitment and yields.

The Caribbean Fishery Management Council, on advice from the Scientific and Statistical Committee, thus adopted the 20% Spawning Potential Ratio as the definition of overfishing. For monitoring the Spawning Potential Ratio, the method described by Gregory et al. (1982) will be used to compare female fecundity by length class within fished areas to that in unfished areas.

Alternative procedures for evaluating the status of the Spiny Lobster stocks relative to overfishing will be developed to address problems in data collection and analysis. Relative catch rates will be examined for the individual times and locations in which they have been collected and compared to present or recent locales. (Reductions in catch rates are indicative of reduction of the overall resource levels. If the catch rate of a species is less than 20 percent of what it was during some previous time period, then it is likely that the Spawning Potential Ratio could be less than 20 percent.) Data on the catches will be studied to indicate shifts in the species abundance and/or availability. The size/age data that is available will also be examined.

A scientific evaluation of the above data by a panel of expert biologists will determine the level at which the Spiny Lobster stocks is above or below the criterion.

This panel of experts will prepare the Stock Assessment and Fishery Evaluation (SAFE) Report which will serve as a source for the best scientific information available for this fishery.

Management Measures to Arrest Overfishing

Should overfishing occur, the Council might take one or more of the following actions by regulatory amendment :

- *implement a closed season*
- *increase minimum carapace length*
- *limit the use of shorts*
- *require escape gaps*
- *reduce number of traps*
- *create marine reserves*

If needed these measures will be taken to public hearings following the established procedures under the MFCMA.

Rejected Alternatives

No action.

Rationale: *Under the current management program established by the Council, recruitment overfishing is not currently occurring. However, based on the discussion of the proposed alternative rules to increase reproductive potential additional rules may eventually become necessary. The proposed alternative is superior to status*

quo by providing a method of monitoring the reproductive potential and condition of the stock and instituting the corrective actions necessary to prevent recruitment overfishing.

Relationships of the Recommended Measures to Existing Applicable Laws and Policies

Coastal Zone Management Act (Consistency Determination)

Section 307(c)(1) of the Federal Coastal Zone Management Act of 1972 requires that all federal activities which directly affect the coastal zone be consistent with approved State coastal zone management programs to the maximum extent practicable.

The amendment to the spiny lobster FMP does not require a separate consistency determination because it does not directly affect the coastal zone in a manner not fully considered in the FMP and the initial consistency determination.

Federalism Statement

No Federalism issues have been identified relative to the actions proposed in this amendment. The affected States have been closely involved in developing the proposed management measures and the principal State officials responsible for fisheries management in their respective States have not expressed federalism related opposition to adoption of this amendment.

Weather/Vessel Safety Act

Amendment by P.L. 99-659 to the Magnuson Act requires that a fishery management plan or amendment must consider, and may provide for, temporary adjustment (after consultation with the Coast Guard and persons utilizing the fishery) regarding access to the fishery for vessels otherwise prevented from harvesting because of weather or other ocean conditions affecting the safety of the vessels.

No vessel will be forced to participate in the fishery under adverse weather or ocean conditions as a result of this amendment. There are, no management adjustments contained in this amendment.

Endangered Species Act and Marine Mammal Protection Act

The proposed action will have no impact on threatened or endangered species or on marine mammals. A Section 7 consultation was conducted for the original FMP and it was determined that the FMP was not likely to jeopardize the continued existence of threatened or endangered animals or result in the destruction or adverse modification of habitat that may be critical to those species; this amendment proposes no changes to the FMP that would affect species included in the Endangered Species Act or the Marine Mammal

Protection Act. For a list of endangered or threatened species that are known to occur in the Caribbean EEZ refer to the spiny lobster FMP, page 28.

Paperwork Reduction Act

The purpose of the Paperwork Reduction Act is to control paperwork requirements imposed on the public by the federal government. The authority to manage information collection and record keeping requirements is vested with the Director of the Office of Management and Budget. This authority encompasses establishment of guidelines and policies, approval of information collection requests, and reduction of paperwork burdens and duplications.

There are no new information requirements under this amendment that are subject to the PRA. Socio-economic information will continue to be collected through existing state/federal cooperative programs. Statistical information that is required to maintain a current record of information on the spiny lobster fisheries is kept by the Territorial Government of the U.S. Virgin Islands and the Commonwealth of Puerto Rico through State-Federal agreements.

Environmental Consequences

The action proposed in this amendment will have no significant impact on the physical or human environment. The effect of these actions is to amend the FMP to include a measurable definition of overfishing that allows monitoring of the fishery and to outline the management measures that could be implemented to prevent or reverse overfishing should it occur. If management action is required to prevent overfishing, a regulatory amendment will be prepared accompanied by an environmental assessment of the proposed action.

Habitat Section for the Lobster FMP

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4.2 Description of habitat of the stock(s) comprising the management unit

This management plan covers inhabited and uninhabited islands in Puerto Rico and the U.S. Virgin Islands (USVI). The principal islands are: Puerto Rico, Culebra, Vieques, Mona, Monito, Desecheo and Culebrita. Puerto Rico has about 380 miles of coastline. The USVI include St. Thomas, St. John, St. Croix and several uninhabited smaller islands. These islands have a combined coastline of about 234 miles.

About thirty different bottom types are found around Puerto Rico and about fifty around the USVI (CFMC, 1984). The bottom types vary with depth as shown in Table 4.1 and consist of combinations of gravel, rock, sand, mud, and clay. Many of the hard bottom areas consist of coral and non-coral reefs. Nearshore, coral reefs are common. Inshore of the reefs the dominant tidal wetlands are seagrasses and mangroves (Table 4.2). Acting together these coastal areas provide food, habitat, and water quality maintenance functions that support the areas' important fisheries.

The wetland habitats (i.e., mangroves) interact to protect each other. The reefs are efficient wave energy dissipators and provide the shelter required for establishment of seagrass and mangrove habitats. Mangrove fringes trap fine sediments that would otherwise be carried into reef areas. Seagrasses bind and stabilize the sediments that could otherwise damage the reefs. Seagrass beds and reefs are also important sediment sources in these areas where external sediment inputs are very small (Cintron, 1987).

In view of the importance of reefs, seagrasses, and mangroves for fisheries production, the following habitat descriptions are provided:

Reefs

Coral reefs are among the most productive and diverse tropical marine habitats. Although highly productive, they develop best in shallow, well-lighted tropical waters which are usually poor in nutrients such as nitrates, ammonia and phosphates. Coral reef environments have among the highest rate of photosynthetic carbon fixation, nitrogen fixation, and limestone deposition of any ecosystem (Goureau et al., 1959).

Areal Extent (in hectares) of Marine Biotopes for Coastal Areas of Puerto Rico and the U.S. Virgin Islands[1]

	Vieques	Culebra	P.R.[2]	St. Thomas	St. John
Lagoons	1,295	68	2,069	---	---
Mangroves	395	345	3,580	---	---
Shallow sand	686	161	7,327	512	616
Deep sand	6,440	2,179	---	---	---
Shallow seagrasses	378	125	5,102	597	418
Shallow coral reefs	1,669	---	---	---	---
Deeper seagrasses and coral assemblages	21,838	---	---	---	669
Other coral reef areas	---	---	3,230	---	---
Reef-flat areas	---	377	---	---	---
Fringing reefs	---	---	409	---	---
Other reef areas	---	436	---	---	---
Inshore water	---	316	33,595	---	---
Turbid water	1,906	---	245	---	---
Shelf water	---	---	99,272	---	6,637
Cloud and cloud shadows	---	---	2,247	---	---

[1] This table is a summary of information presented in "Thematic Mapping of the Coastal Marine Environments of Puerto Rico and the U.S. Virgin Islands" by Roy A. Armstrong.

[2] These numbers correspond only to the main island of Puerto Rico.

The ecological importance of coral reefs is well documented (Goenaga and Cintron, 1979). Many fish species and crustaceans of commercial and recreational value depend on coral reefs during some or all their life stages. They provide a buffer against shoreline erosion and influence the deposition and maintenance of sand on the beaches which they protect. The sand in these beaches originates principally from the reefs.

Seagrasses

Important seagrasses of the Caribbean Region include turtlegrass (Thalassia testudinum), shoal grass (Halodule wrightii), manatee grass (Syringodium filiforme), Halophila baillonis, and Halophila engelmanni. Turtlegrass, however, is the most abundant in the coastal waters of the Gulf of Mexico and the Caribbean Sea (Buesa, 1974). These plants grow on sand or mud bottoms, from the shoreline to depths of 20 to 30 feet, depending on the species and sunlight penetration (Stephens, 1966). In the clear waters of the USVI, turtlegrass beds have been found at depths of 43 feet (Randall, 1965).

Seagrass leaves are the primary food source for a variety of organisms that include some fish, sirenians, turtles, sea urchins, gastropods, amphipods and other invertebrates. The great number of species that feed on seagrass leaves or their epiphytes, make them a unique and important resource (Ogden, 1976). Turtlegrass leaves provide a substrate for more than 100 species of algae. Other organisms (crustaceans, hydrozoans, snails) live on the blades. The beds themselves provide shelter and nursery grounds for larvae and juveniles of several fish and invertebrate species such as grunts, wrasses, parrotfish, snappers and conch (Stephens, 1966). More than one hundred species are known to rely on turtlegrass beds for protection and food (Croz et al., 1975).

Seagrass meadows are important in controlling and reducing erosion they trap and consolidate bottom sediments with their extensive root and rhizome network. They also accumulate organic matter that is, in turn, utilized by resident species.

Mangroves

Mangroves inhabit low energy intertidal areas in Puerto Rico and the USVI (Cintron, 1987). The four species found here are the red mangrove (Rhizophora mangle), black mangrove (Avicennia germinans), white mangrove (Laguncularia racemosa), and buttonwood (Conocarpus erecta). In general, mangroves form fairly uniform forests dominated by a single species. In some instances all four species may be present in a location and segregate among themselves and other wetland plants based on elevation, substrate suitability, salinity, availability of sediments and nutrients, and seed source availability. Mangrove forests are highly productive and support complex assemblages of marine plants and animals.

Important inhabitants of mangrove wetlands are: invertebrates such as, sponges, crabs, tunicates, bivalves (oysters), and lobsters; fish such as, grunts, snappers, parrotfish, barracuda, eels, surgeonfish, doctorfish, tangs; and many species of red and green algae.

A significant amount of the plants' net production is incorporated into woody tissues, roots, leaf tissues and fruit. Part of this productivity is exported as detrital material and eventually enters the marine food web. In mangrove areas where access to fish and invertebrates is available, considerable nursery and forage habitat is provided. Massive juvenile mullet and shrimp migrations into and out of mangroves are well known. These migrations link mangroves directly to other coastal systems such as coral reefs, and seagrass beds.

4.2.1. Habitat condition.

All of Puerto Rico's nearshore fringing reefs have been impacted adversely to some degree by man's actions, increased sedimentation, raw sewage discharges, marina construction, sand extraction, and thermal water discharges are characteristic of the activities known to damage reefs.

Overall the nearshore area is in good condition, but local problem areas exist. For example, water quality may be reduced in areas affected by the river plumes. Local disturbances occur in association with coastal development and dredged material disposal.

The U.S. Virgin Islands' nearshore reefs have been degraded during recent decades due to sedimentation, boat groundings, storm damage and overfishing. The seagrass beds have been reduced in size due to anchor damage from ever increasing boat activity.

The estuarine nursery areas appear to be the most impacted of the habitats used by fishery resources. Natural and man-induced alterations of this fragile environment have altered freshwater inflow and removed much of the area that would be considered suitable habitat. The amount of remaining wetlands suitable for fishery production has not been quantified; however, Alexander et al. (1986) estimate that for the last 25 years, coastal wetlands in the coterminous United States have been depleted at an average rate of 20,000 acres per year.

Estuaries have been among the areas most impacted by water quality degradation. Although numerous reports and publications exist (e.g., NOAA, 1987), a complete list of chemical contaminants, their concentrations, or effects is not available. A comprehensive inventory assessing the seriousness of pollution of Puerto Rico and the USVI's estuaries is needed. In St. Thomas, Mangrove Lagoon receives approximately 170,000 gpd of "treated sewage" which has diminished its capacity of acting as a nursery ground for different

species. Similar problems exist in other areas such as Red Hook.

4.2.1.1 - Habitats of particular concern (HPC) are those which are essential to the life cycle of important species. Since Puerto Rico and the USVI estuaries are important to many fishery species, particularly as nursery grounds, we are generically identifying them as HPCs. Nearshore reefs and other hard bottom areas also are considered HPCs because of their fishery value. A great deal of life history work needs to be done in order to adequately identify HPCs.

4.2.1.2 - Conditions that restrict commercial and recreational fish harvest presently do not exist. Stout (1980), has found low levels of DDT, PCB, endrin, and dieldrin organochlorines in fish such as red and black grouper, gag, and red snapper. Should high levels of contaminants be found in fishery resources around the Islands, the edibility as well as marketability of fishery resources could be affected adversely.

Traditionally the northern part of the Caribbean has had a serious problem with ciguatera poisoning.[3] Caused by a tiny benthic dinoflagellate, ciguatera is widespread in a tropical belt extending worldwide between latitudes 35 degrees North and 35 degrees South. Curiously, occurrence of poisonings is highly variable. Fish on one side of an island have been found to be toxic, while those caught on the other side of the same island are often harmless. Scientists believe that the poison-producing organisms routinely exist in the world's coral reefs but multiply when the environment is disturbed.

In the U.S. Virgin Islands and Puerto Rico, some species of fish are more likely to be ciguatoxic than others. As a family, the carangids or jacks contain the most species prone to ciguatera, they are followed by the snappers and groupers.

4.2.2 Habitat threats.

A direct quantitative relationship between fishery production and habitat has not been developed for the habitats addressed in this document. Accordingly, the degree that habitat alterations have affected fishery production is unknown. Turner and Boesch (1987) assembled and examined the relationship between wetland abundance and the yield of fishery species dependent on coastal bays and estuaries.

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[3] A survey of the emergency room records of 10 hospitals in five areas of Puerto Rico from 1980-1982 disclosed 122 apparent ciguatera cases involving 212 individuals. Assuming that these records represented 10-15 percent of the total number of cases during this period, an estimate of 8-11 cases per 10,000 residents per year was calculated (Escalona de Motta, et al., 1986).

Natural Factors

Factors affecting habitat quantity and quality in the Islands are discussed below.

Flooding

Although the southern part of the island of Puerto Rico receives less rainfall than northern or eastern areas, the coral reefs located in the south are affected to a larger extent by flooding and runoff. Heavy rainfall coupled with inadequate preparation of construction sites (poor soil conservation practices) are the reasons why large amounts of silt and fine particles are transported towards the coast where the accumulation on reefs, mangroves and seagrasses may cause severe damage to the ecosystem.

Erosion

Erosion is the transport of sediment from one place to another. Although a certain degree of erosion is natural, severe erosion may result from large-scale disturbances of the earth's top layers. Island erosion is exacerbated by the short distances between interior and coastal areas.

Tropical Disturbances

The passage of storms and hurricanes through mangroves, coral reefs and seagrasses can cause uprooting, defoliation, and deposition of sediment and other materials. This stress can eliminate vegetation from some areas. For mangroves, rapid re-establishment by seedlings occurs on suitable habitats. Seagrasses may recover quickly if damage is slight and the substrate has not been severely altered. Some storms may benefit mangroves by removing accumulations of materials that choke drainage ways and by reopening salt ponds. They also are important in the redistribution of accumulated materials. The impact on coral reefs depends on the intensity of the storm and on the distance from its center.

Hypersalinity

Hypersalinity affects mainly mangroves. The accumulation of high salt concentrations through evaporation is a chronic natural stressor in dry areas. When evaporation exceeds rainfall throughout the year, tidal action and evaporation accumulate salt in certain areas of the forest. Eventually the soil salinity increases beyond the tolerance of the mangroves and a barren zone develops. Mangrove coverage in these areas is unstable, with coverage fluctuating between expansion following storms or a succession of very wet years, and contraction triggered by drought or silting of drainage ways. During different periods, an area may

undergo several changes and subsequently provide food and other benefits to resident and migratory species.

Reef Diseases

Reef corals in the Islands are affected by diseases such as black, and white band diseases and bleaching. White band disease is serious in areas such as Buck Island in St. Croix where it is widespread and significant. Black band disease is more limited in its occurrence and has little overall effect. The bleaching occurrences are intermittent and of minor consequence in the U.S. Virgin Islands.

Human-related Factors

The amount and rate of human-induced wetland losses have not been quantified. These losses are controlled by state and/or federal regulatory agencies. The Environmental Protection Agency (EPA) for example, has the responsibility to regulate wastewater discharges and the Corps of Engineers (COE) manages a program that regulates physical wetland alterations (dredging, filling, impounding, etc.). The amount of fishery habitat affected by EPA's program is unknown, but data on the effect of the COE's regulatory program in the Southeast are available. The National Marine Fisheries Service (NMFS) tracked habitat alterations involved in 7,408 water development projects proposed between 1981-1987. Almost 300,000 acres of wetland losses were proposed in the southeast, including the Islands (Mager and Ruebsamen, 1988). This provides an indication of the significance of the COE's program and the potential cumulative nature of wetland losses.

Water quality degradation also is a threat to fishery habitat. This results from the discharge of petrochemicals, sewage, heavy metals, and other chemicals in industrial and chemical wastes and from non-point-source discharges such as from septic tanks and parking lots. Urban and agricultural runoff can be laden with toxic substances such as petrochemicals, pesticides, heavy metals, and herbicides. The aerial spraying of large areas for mosquito control results in the addition of pesticides to estuarine waters. These pesticides are extremely toxic to larval aquatic organisms. Thermal effluent from steam and nuclear generating facilities using "once-through" cooling can raise the temperature of estuarine waters making them less suitable or uninhabitable, especially during summer (López, 1979). The discharge of sewage also can create problems for the organisms that reside in the estuaries where the discharge occurs.

Offshore species, may be affected adversely due to the discharge of petroleum products. Malins (1982) reviewed laboratory experiments describing the deleterious effects of petroleum fractions on fish. Grizzle (1981) and Pierce et al. (1980) have documented that wild fish have been injured by petroleum pollutants. Grizzle (1983)

suggested that larger liver weights in fish collected in the vicinity of oil and gas production platforms versus control reefs could have been caused by increased toxicant levels near the platforms. He also suspected that severe gill lamella epithelium hyperplasia and edema in red snapper, vermilion snapper, wenchman, sash flounder, and creole fish were caused by toxicants near the platforms. These types of lesions are consistent with toxicosis and their prevalence and severity increased near drilling platforms.

The destruction of reefs (natural and man-made) or other hard bottom areas result deleterious to the species that use these habitats. Human impacts on reef habitat result from activities such as pollution, dredging and treasure salvage, boat anchor damage, fishing and diving related perturbations, and petroleum hydrocarbon discharges (Jaap, 1984).

According to Lindall et al. (1979) the major man-induced activities that impact environmental gradients in the estuarine zone are:

1. *construction and maintenance of navigation channels;*
2. *discharges from wastewater plants and industries;*
3. *dredge and fill for land use development;*
4. *agricultural runoff;*
5. *ditching, draining, or impounding wetlands;*
6. *oil spills;*
7. *thermal discharges;*
8. *mining, particularly for phosphate, and petroleum;*
9. *entrainment and impingement from electric power plants;*
10. *dams;*
11. *marinas;*
12. *alteration of freshwater inflows to estuaries;*
13. *saltwater intrusion; and*
14. *non-point-source discharges of contaminants.*

Marinas bring recreational boat traffic, hence the shallow water of estuaries, the extremely soft sediments, and the turbulence caused by outboard motors (especially when operated at high speeds) results in highly turbid waters which transport sediment to reef areas.

All of the Island's estuaries have been impacted to some degree by one or more of the above activities. The more significant man-induced impacts to the coastal areas around the islands are described below.

Sedimentation

Sediment resulting from erosion and runoff inevitably causes damage to coastal waters. Erosion from agricultural and development practices in coastal areas is a principal factor. Sedimentation is increased by unsuitable agricultural practices,

overgrazing of rangeland, and indiscriminate deforestation, all of which help remove the leafy humus base that protects the soil. Rapid urban development in many parts of the islands has also caused major erosion and sedimentation; improper cutting and grading practices at construction sites accelerate erosion, as do poor sloping and lack of revegetation on cuts, fills, and ditches.

Sedimentation affects coral abundance, growth and distribution. Whether natural or man-induced, it is detrimental to corals (Dodge and Vaisnys, 1977). Although most corals have effective means of shedding sediments which have fallen on their tissues, sedimentation and turbidity will decrease available light which is needed for photosynthetic fixation of calcium carbonate (Lasker, 1980).

In addition to turbidity increases, sedimentation may adversely affect reef corals by smothering, increasing energy expenditure in particle rejection, and increasing potential for bacterial infection. Abrasion, creation of conditions unsuitable for larval settlement, alteration of feeding habits, alteration of food supplies such as plankton, and alteration of species composition on reefs may also occur.

With increased sedimentation and turbidity, mangroves are degraded through the loss of floral and faunal communities found on the prop roots, this in turn, reduces habitat quality for juvenile fish.

Seagrasses are similarly affected by reduced light transmission that is needed for photosynthesis and increased epiphytic colonization. Because they are an important food source for conch, turtles and other species, loss of seagrasses will severely impact the life cycles of these species.

Sewage Disposal

Nutrient enrichment (eutrophication) seriously stresses wetlands and associated fauna. Pollution by fecal bacteria and viral agents also pose serious health hazards. Commercially valuable species may become vectors of serious water borne diseases and toxic substances which can be incorporated into the food web. Nutrient enrichment of coastal waters, mainly by the dumping of poorly treated water or raw sewage directly into the ocean or into rivers and creeks, stresses mangroves and seagrass and/or their associated biota. Coral reefs, however, can be the most seriously impacted. High nutrient concentrations stimulate high phytoplankton production as well as high benthic algae production (Birkeland, 1977). This will favor the establishment of organisms that compete with or damage corals (such as burrowing bivalves and boring algae and sponges). High recruitment by benthic algae would reduce the substrate available for coral larvae settlement and may result in the young corals being overgrown (Birkeland, 1977). Heavy metal accumulations in sediment and reef biota near population centers

also have been noted (Manker, 1975). Disposal of wastes may further create local problems.

Oil Pollution

The most common sources of oil contamination of coastal waters are marinas, refineries, bilge pumping, deballasting of tankers, ship accidents, and vessel operations. During 1975, some 150 oil spills occurred in Puerto Rican waters. Major spills occurred in 1969, when the tanker Ocean Eagle broke up in San Juan Bay, and in 1974 when the Zocolocotronis ran aground off the south coast.

Damage caused by oil spills depends on the quantity and type of oil, the degree to which it has been refined, wind and wave conditions, and the location of the spill. The most serious damage normally occurs in near-shore waters and enclosed bays and estuaries.

Mangroves are extremely sensitive to oil pollution. Oil fouls the intertidal root region where gas exchange takes place. A heavy coating of oil always leads to death (Cintron, 1987). In addition to the mechanical damage caused by coating, oil may be toxic and poisonous to the trees. Since the toxic fractions come in contact with the roots, where vital functions take place, toxic products cause rapid mortality. Residual amounts of the spilled product may remain trapped in the sediment for long periods. As a result, natural restoration may be very slow, if at all. There are no effective ways to clean oiled mangroves because efforts are labor intensive, costly, and inefficient. Only protection by booming can reduce damages. Effects of oil on reefs and seagrasses develop as soluble components of oil become "balled" with sand and sink.

Channelization

Diversion of fresh water flows causes nutrient deprivation and development of stressed, nutrient limited wetland vegetation. Recovery is not possible and massive die-offs may occur unless the fresh water source is restored. Both white and black mangrove species are susceptible because of their high dependence on fresh water flow.

Impoundment

Impoundments may occur when roads are built through wetlands and provisions are not made to preserve water flows. In the Islands, this practice commonly affects mangrove wetlands. Impounding may cause water levels to rise, suffocating the trees. The result of impoundment is rapid because the tidal range is small and evaporation is high. In some cases when dikes are abandoned, partial recovery may occur. The Salt River in St. Croix is an example. On the other hand, Martin Marrietta in St. Croix was impounded and turned into a sedimentation basin; recolonization or

restoration of this area is not likely (Cintron, 1987).

Solid Waste Disposal

Solid waste disposal is a major problem both in the Virgin Islands and in Puerto Rico. Excessive waste disposal due to consumption practices and limited land disposal sites have led to lax practices. Not only are coastal areas used for the dumping of wastes (domestic and industrial) but, as previously stated, the limited size of the islands creates an inherent problem regarding solid waste disposal.

4.2.3 Habitat information needs.

The vast majority of our highly-valued living marine resources require healthy environments. Declines in commercially and recreationally important fisheries may be attributed to over-fishing, loss of habitat, pollution, disease, environmental alteration, and natural variability of the stocks. Effective fisheries management requires an improved understanding of these factors.

A chief concern regarding living marine resources is the effect of human activities on fishery productivity. Research is needed about the elements that are affecting energy flow within ecosystems. This understanding of ecological processes can then be combined with information on the health, distribution, and abundance of ecologically important organisms. By understanding the ecology and status of fishery stocks, resource managers will be better able to manage estuarine dependent living marine resources.

The following research needs must be addressed in order for state, federal, and private research efforts to develop measures needed to better manage fishery resources and their habitat:

1. *Identify optimum coastal habitat;*

2. *Identify environmental and habitat conditions that limit production;*

3. *Focus more on life history studies that will define the critical fisheries habitats for food, cover, spawning, nursery areas, and migration routes;*

4. *Quantify the relationships between fishery production and habitat (e.g., what are the key trophic pathways in the ecosystem, and how does the flux of essential nutrients, carbon compounds, and energy through these systems influence fisheries productivity?);*

5. *Determine the relative effects of fishing, pollution, and natural mortality on fishery population dynamics. Also determine*

the effects of cumulative habitat loss on fisheries productivity and economic value; and

6. Determine habitats of particular concern and means for enhancing and/or maintaining critical habitats.

4.2.4 Habitat conservation programs.

Involvement by federal and state agencies in habitat conservation programs are noted as follows.

Office of Coastal Zone Management (OCZM), Marine Sanctuaries Program (MSP), NOAA. *This program manages and funds the marine sanctuaries program (MSP). On-site management and enforcement are generally delegated to the states through special agreements. Funding for research and management is arranged through grants. This program was authorized under Title III of the Marine Protection Research and Sanctuaries Act (MPRSA) of 1972. Its purpose is to preserve or restore the conservation, recreational, ecological, or aesthetic values of localized areas "... as far seaward as the outer edge of the continental shelf, ...(and in) other coastal waters whether the tide ebbs and flows ..." (MPRSA, Section 302a). In effect, the MSP is a coastal water counterpart to the more familiar national park, forest, wildlife refuge, and wilderness systems. Site management and administrative responsibility for a sanctuary may either be retained by OCZM or delegated with necessary funding support to other appropriate management units.*

National Marine Fisheries Service. *The enactment of the Magnuson Act provides for exclusive management of fisheries seaward of state jurisdiction. This includes both specific fishery stocks and their habitat. The process for developing FMPs is highly complex. It includes plan development by various procedures through fisheries management councils. NMFS implements approved plans. The Coast Guard (CG), NMFS, and some states under agreements, enforce regulations implemented by FMPs. FMPs for shallow water reef fish and Caribbean spiny lobster are in effect.*

National Park Service (NPS). *National parks and monuments are under the jurisdiction of NPS. Management, enforcement, and research are accomplished in house. The system of national parks and monuments operated by the NPS, in the broadest terms, preserve for all times scenic beauty, wilderness, native wildlife, indigenous plant life and areas of scientific significance and antiquity {16 U.S.C. (1)}.*

The U.S. Virgin Islands presently have two national parks; St. John and Buck Island.

Minerals Management Service (MMS). This agency has jurisdiction over mineral and petroleum resources on the continental shelf. The MMS along with the U.S. Geological Survey is charged with administering mineral exploration and development on the Outer Continental Shelf (OCS), pursuant to the OCS Lands Act (OCSLA), as amended in 1978 [43 U.S.C. (1331 et seq.)]. The MMS serves as the administrative agency for leasing submerged federal lands.

Fish and Wildlife Service (FWS). FWS assists with environmental impact review, develops biological resource evaluations, and administers the endangered species program jointly with the NMFS. The FWS also manages national refuges for wildlife.

Geological Survey (USGS). The USGS conducts considerable research in nearshore areas and assists or cooperates with other institutions and agencies to facilitate logistics and support of research. The USGS also is charged with supervising mineral development operations on the OCS. The USGS ensures oil company compliance with regulations and lease stipulations once a lease is sold. This represents a key management authority for ensuring protection of nearshore communities. Although these authorities are not comprehensive, they are significant because of the widespread interest in current OCS oil and gas development and its potential impacts.

Coast Guard. The 1978 Waterways Safety Act charges the CG with marine environmental protection. The CG is the general enforcement agency for all marine activity in the federal zone. Among the duties are enforcement of sanctuary and fishery management regulations, managing vessel salvage, and coordinating oil spill cleanup operations at sea.

U.S. Army Corps of Engineers. The COE contracts and regulates coastal engineering projects, particularly harbor dredging and beach renourishment projects. The COE also reviews and is the permitting agency for coastal development projects, artificial reefs, and offshore structures.

Environmental Protection Agency. This agency has general responsibility for controlling air and water pollution. Disposal of hazardous wastes and point-source discharge permitting are EPA functions. Certain mineral and petroleum exploration and production activities are managed by EPA. Environmental research germane to waste disposal and pollution also are funded.

Federal environmental agencies such as the NMFS, MMS, FWS, and the EPA also analyze projects proposing inshore and offshore alterations for potential impacts on resources under their purview. Recommendations resulting from these analyses are provided to the permitting agencies (the COE for physical alterations in inshore waters and territorial sea, the MMS for physical alterations in the OCS or the offshore Exclusive Economic Zone (EEZ) and EPA for

chemical alterations). Even though the COE issues permits for oil and gas structures in the EEZ, they only consider navigation and national defense impacts, thus leaving the rest to the Department of Interior, in a nationwide general permit.

EPA is the permitting agency for chemical discharges under the National Pollution Discharge Elimination System program of the Clean Water Act for chemicals used or produced in the Islands (i.e., drilling mud, produced water or biocides) and then released, or under the Ocean Dumping Regulations of the Marine Protection, Research and Sanctuaries Act if the chemicals are transported into the Islands for the purpose of dumping. When discharge or dumping permits are proposed, federal and state fish and wildlife agencies may comment and advise under the Fish and Wildlife Coordination Act and the National Environmental Policy Act (NEPA). The CFMC may do likewise under the Magnuson Act and NEPA.

The proposed U.S.V.I. Territorial Marine Reserve System will protect a number of inshore grassbeds and coral reef areas which will hopefully serve as refuges for species which utilize them. In addition, the government runs several terrestrial wildlife sanctuaries in offshore cays.

4.2.5 Habitat recommendations.

The fisheries of the Islands contribute to the food supply, economy, and health of the Nation, and provides recreational and economic opportunities. Continued existence of the fisheries is dependent upon the prudent management of all aspects of the fishery, including habitat. Accordingly, activities that adversely affect habitat will need to be addressed by the Councils. Increased productivity of stocks may not be possible without habitat maintenance and regulatory restrictions.

Recognizing that all species are dependent on the quantity and quality of their essential habitats, it is the policy of the Caribbean Fishery Management Council (CFMC) to protect, restore, and improve habitats upon which commercial and recreational marine fisheries depend, to increase their extent, and to improve their productive capacity for the benefit of the present and future generations. This policy shall be supported by the following three objectives:

1. To maintain the current quantity and productive capacity of habitats supporting important commercial and recreational fisheries, including their food base (This objective may be accomplished through the recommendation of no net loss and minimization of environmental degradation of existing habitat);

2. To restore and rehabilitate the productive capacity of habitats which have already been degraded; and

3. To create and develop productive habitats where increased fishery productivity will benefit society.

The CFMC has formed Habitat Committees and Advisory Panels for the Islands to address activities that may affect the habitat of fisheries under the Council's management. The Council, pursuant to the Magnuson Act, will use existing authorities to support state and federal environmental agencies in their habitat conservation efforts and will directly engage the regulatory agencies on significant actions that may affect habitat. This may include commenting on specific actions, policies, or regulations that affect the habitat of managed species.

Public hearings and the building of administrative records may be conducted to assure an adequate disclosure of facts and public participation in actions that adversely affect habitat. The goal is to insure that habitat losses are avoided or minimized and that appropriate mitigation strategies and applicable research are supported.

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