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January 17, 1990

Dr. Caroline S. Rogers
Secretariat
Virgin Islands Resource
Management Corp.
P.O. Box 710, St. John
U.S. Virgin Islands 00830

Dear Dr. Rogers:

Greetings in the New Year. Enclosed please find a draft copy of the Habitat Section for the First Amendment to the Shallow-Water Reefish Fishery Management Plan. As agreed at the June 28, 1989 meeting, I am sending a copy for your review. Due to time constraints, if you have any comments or suggestions please send them on or before February 9, 1990 so that they may be incorporated in the draft.

If you have any questions please call 766-5926, 5927 or 5928.
Thank you for your time.

Cordially,

Sandra M. Laureano
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Special Assistant

HABITAT SECTION FOR THE
FIRST AMENDMENT TO THE SHALLOW WATER REEFFISH FISHERY
MANAGEMENT PLAN

4.2	Description of habitat of the stock(s) comprising the management unit.....	1
4.2.1	Habitat condition.....	5
4.2.1.1	Habitats of particular concern.....	7
4.2.1.2	Relationship of habitat quality to the ability to harvest and market the species..	7
4.2.2	Habitat threats.....	8
4.2.3	Habitat information needs.....	13
4.2.4	Habitat conservation programs.....	14
4.2.5	Habitat recommendations.....	16
4.2.6	Literature Cited.....	19

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

This management plan covers a total of six inhabited and four uninhabited islands in Puerto Rico and the U.S. Virgin Islands (USVI). Puerto Rico includes the main island and two smaller islands, Culebra and Vieques. There are also four major uninhabited islands (Mona, Monito, Desecheo and Culebrita) and several other smaller islands. Puerto Rico has about 380 miles of coastline. The USVI include St. Thomas, St. John, St. Croix (the larger of the three), and several uninhabited smaller islands. These islands have a combined coastline of about 234 miles.

About thirty different bottoms types are found around Puerto Rico and about 50 around the USVI (CFMC, 1984). The bottom types vary with depth as shown in Table 4.1 and consist of various combinations of gravel, rock, sand, mud, and clay. Many of the hard bottom areas consist of reefs both with and without coral assemblages. Nearshore, coral reefs are common and inshore of the reefs, seagrasses, and mangroves are the dominant saline wetland types (Table 4.2). These coastal areas interact in very complex ways and are linked to provide food, habitat, and water quality maintenance functions that support the many important fisheries around Puerto Rico and the USVI.

The wetlands (i.e., seagrasses and mangroves) also interact to protect each other. The reef structures are efficient dissipators of wave energy and provide the shelter required for the establishment of seagrass beds and mangroves. Mangrove fringes trap fine sediments that would otherwise be carried toward reef areas. Seagrasses bind and stabilize the sediments that could otherwise also impact the reefs. Seagrass beds and reefs are also important sources of sediments 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 detailed descriptions are provided:

Reefs

Coral reefs are one of the most productive and extensive tropical marine habitats on earth. In spite of their high productivity, they develop best in shallow, well lighted tropical waters which are usually poor in nutrients such as nitrates, ammonia and phosphates. Nevertheless, coral reef environments have among the highest rate of photosynthetic carbon fixation, nitrogen fixation, and limestone deposition of any ecosystem (Goureau et al., 1959).

Table 4.1
SUMMARY OF THE FREQUENCY DISTRIBUTION
OF TYPES OF OCEAN BOTTOMS IN THE P.R.
AND THE U.S.V.I. GEOLOGICAL PLATFORMS

Types of Bottoms	North					South					West					East*				
	<u>Fathoms</u>					<u>Fathoms</u>					<u>Fathoms</u>					<u>Fathoms</u>				
	10	10-19	20-99	100-299	300	10	10-19	20-99	100-299	300	10	10-19	20-99	100-299	300	10	10-19	20-99	100-299	300
Gravel	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hard	33	65	35	19	28	28	53	16	13	-	15	40	-	4	4	17	27	9	16	21
Rocky	17	9	12	1	-	26	22	32	3	12	43	16	3	-	4	15	10	2	-	-
Corals	8	7	9	5	-	2	-	11	8	-	3	12	56	37	34	19	15	12	9	-
Reefs	-	-	-	-	-	33	-	-	-	-	21	-	-	-	-	41	-	-	-	-
Sticky	-	2	-	-	-	5	5	-	-	-	10	20	-	-	-	2	-	-	-	-
Sand & Hard s.	-	9	4	-	-	-	8	5	-	-	-	-	-	-	-	-	12	7	-	-
Soft	-	2	-	-	-	-	8	-	-	-	-	4	-	-	-	-	-	-	-	-
Sand Corals	-	-	-	-	-	-	1	-	5	4	-	8	-	3	4	-	10	-	5	9
White Sand (Coral & Gravel)	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	13	-	10	17
Hard Corals	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23	-	-
Gray Sand	-	-	22	9	3	-	-	5	5	-	-	-	21	22	22	-	-	23	12	6
Sand Shell	-	-	3	-	-	-	-	10	-	-	-	-	1	-	-	-	-	3	-	-
Mud (various)	-	-	6	60	56	-	-	21	63	20	-	-	-	3	4	-	-	-	12	9
Yellow Clay	-	-	-	-	-	-	-	-	-	30	-	-	-	-	-	-	-	-	-	2

* Includes U.S. Virgin Islands

TABLE 4.2

**Areal Extent (in hectares) of Marine Biotopes for
Coastal Areas of Puerto Rico and the U.S. Virgin Islands¹**

	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 the 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 importance of coral reefs has been thoroughly documented by numerous authors (Goenaga and Cintron, 1979). Many species of fish 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 Mexican Gulf and the Caribbean Sea (Buesa, 1974). These plants can grow on sandy or muddy bottoms, from the shoreline to variable depths (20-30 feet), depending on the penetration of sunlight (Stephens, 1966). In the clear waters of the USVI, turtlegrass has been found to 43 feet deep (Randall, 1965).

Seagrass leaves are the primary source of food for a variety of organisms that include fishes, sirenians, turtles, sea urchins, and gastropods and other invertebrates. The great number of species that feed exclusively or nearly so on seagrass leaves or the epiphytes on their blades, make them a unique and important resource (Ogden, 1976). Turtlegrass leaves provide a substrate for more than 100 species of algae. Other organisms (crustaceans, naids) live encrusted on the blades. The beds themselves provide shelter and nursery grounds for larvae and juveniles of several fish and invertebrates species; such as grunts, parrotfish and snappers and conch respectively. Also, small fishes and invertebrates use the area as a refuge against larger species (Stephens, 1966). More than one hundred species of organisms are associated with turtlegrass beds for protection and food (Croz et al., 1975).

Besides providing food and habitat, seagrass meadows are important in controlling and reducing erosion by trapping and consolidating bottom sediments with their extensive root and rhizome network. They also promote the accumulation of organic matter for further utilization by the resident population. All these conditions support the great species diversity and productivity that is characteristic of turtlegrass beds (Ferguson, 1967).

Mangroves

Most of the low energy intertidal coastal areas in Puerto Rico and the USVI are colonized mainly by salt tolerant trees or bushes that collectively are called mangroves (Cintron, 1987). The four species encountered are red mangrove (Rhizophora mangle), black mangrove (Avicennia germinans), white mangrove (Laguncularia racemosa), and the buttonwood (Conocarpus erecta). In general, mangroves tend to form fairly uniform forests dominated by a single

species. In some instances all species may be present in a location and are segregated among themselves and other wetland plants by factors such as the elevation and suitability of the substrate, salinity, availability of sediments and nutrients, and availability of a seed source. Mangrove forests are very productive and support a very complex assemblage of marine plants and animals.

Some of the most important species which rely on mangroves are: invertebrates - sponges, crabs, tunicates, bivalves (oysters), and lobsters; fish - grunts, snappers, parrotfish, barracuda, eels, surgeonfish, doctorfish, tangs; algae - many species of red and green algae.

Mangroves are highly productive structures. A significant amount of the net production is incorporated into woody tissues and roots and a large proportion goes into the production of leaf tissues and fruits. Part of this productivity is exported and eventually routed into the marine food web. In this manner numerous fishery resources are directly supported. In mangrove areas where access to fish and invertebrates is available, considerable nursery and forage habitat is provided. Massive migrations of mullets and shrimps, among others, are well known. These migrations link mangroves directly to other coastal systems like coral reefs, and seagrass beds.

4.2.1. Habitat condition.

All of Puerto Rico's nearshore fringing reefs have been impacted to some degree by man-made actions such as sedimentation, raw sewage, marinas, sand extraction, sewage treatment plants, and thermal waters among others (Map 4.1).

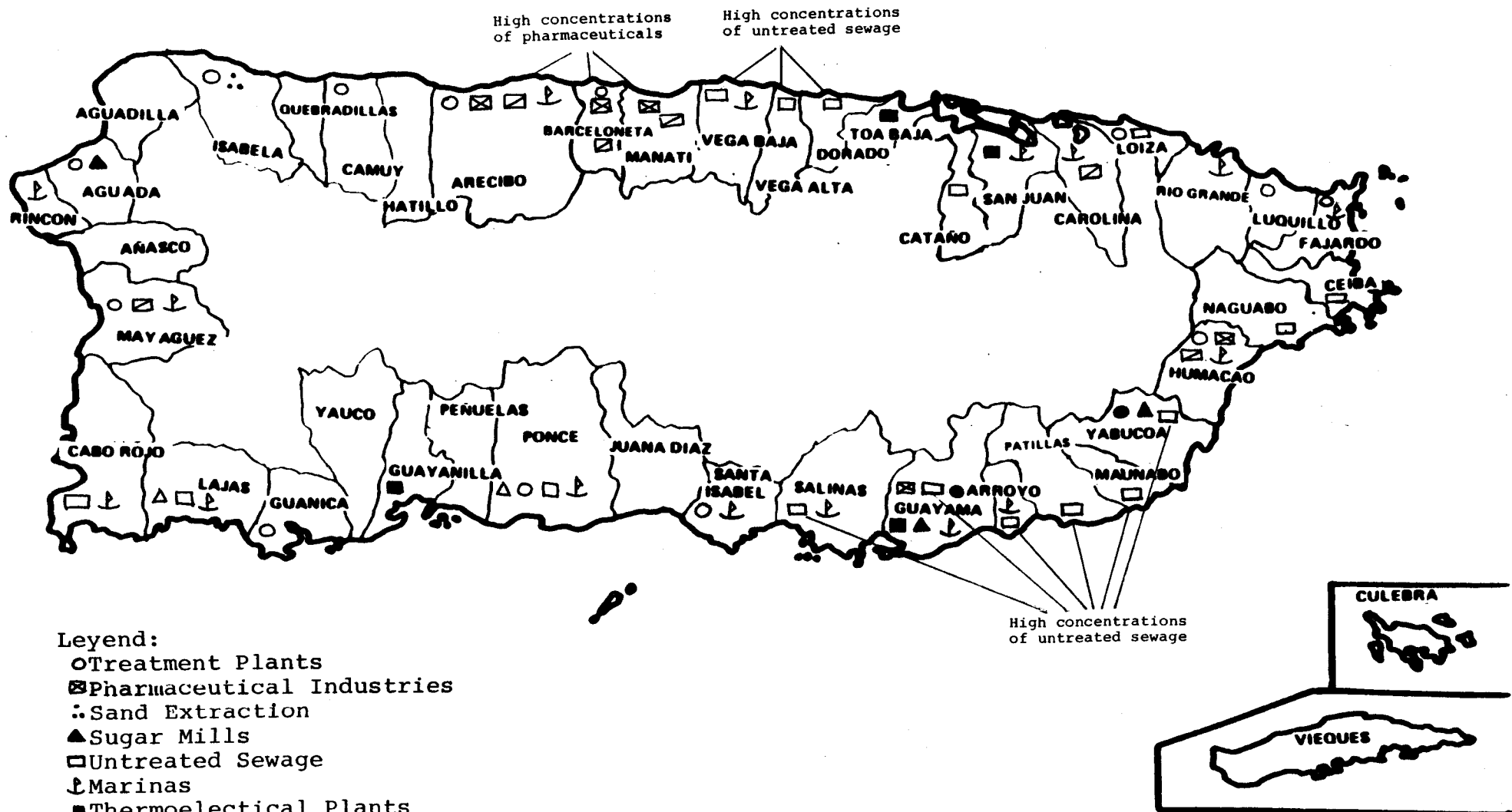
Nearshore areas as a whole appear to be in good condition, but local problem areas exist. For example, water quality may be reduced in areas affected by the plumes of the various rivers. Local disturbances occur during construction related coastal development, dredged material disposal, and dredging. Some areas also are affected by thermal effluent and sewage outfalls.

The U.S. Virgin Islands nearshore reefs have been gradually degraded during the last decades due to sedimentation, boat groundings, storm damage and overfishing. The seagrass beds have been reduced in number 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 the 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

Map 4.1

CONTAMINATION SOURCES OF COASTAL WATERS



Legend:

- Treatment Plants
- ⊠ Pharmaceutical Industries
- ⋯ Sand Extraction
- ▲ Sugar Mills
- Untreated Sewage
- ↓ Marinas
- Thermoelectrical Plants
- △ Sedimentation
- Refineries
- ⊞ Industrial Complexes

Source: Neftalí García Martínez, Ph.D.

et al. (1986) estimated 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.

The estuaries also have been the most impacted by water quality degradation. Numerous pollution-related reports and publications exist (e.g., NOAA, 1987), but there still is no complete list of chemical contaminants, their concentrations, or effects. A comprehensive inventory to assess how seriously Puerto Rico and the USVI's estuaries are polluted also 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 like Red Hook.

4.2.1.1 - Habitats of particular concern (HPC) are those which play an essential role in the life cycle of the species. This information is largely unavailable. However, since Puerto Rico and 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 they support many fisheries.

4.2.1.2 - We are unaware of any current habitat condition that affects the ability to harvest fishery resources commercially. The same applies to recreationally caught fish. Stout (1980), however, 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 adversely affected.

Traditionally the northern part of the Caribbean has had a serious problem with ciguatera. Caused by a tiny dinoflagellate organism, 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 are normally found 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 followed by snappers and groupers. (For further information see Section 6.4 in the Fishery Management Plan for the Shallow-Water Reef Fishery of Puerto Rico and the U.S. Virgin Islands)

4.2.2 Habitat threats.

The quantitative relationship between fishery production and habitat has not been determined. Accordingly, the degree that habitat alterations have affected fishery production is unknown. Turner and Boesch (1987) assembled and examined the accumulating evidence of the relationship between the extent of wetland habitats and the yield of fishery species dependent on coastal bays and estuaries. They discussed evidence of stock losses following wetland losses and stock gains following wetland gains. While most of the studies related to shrimp production, other fisheries likely follow similar trends. Accordingly, a significant threat facing fishery production is the loss of habitat by natural and human-related causes.

Natural Factors

Some of the more important natural factors that affect quantity and quality of habitat around the Islands are discussed below:

Flooding

Although the southern part of the island of Puerto Rico receives less rainfall than northern or eastern municipalities, the coral reefs located in the south are affected to a large extent by flooding. Heavy rainfall will cause flooding because of poor construction site location. Inadequate protection of removed sediments in addition to heavy rainfall will carry large amounts of silt and fine particles towards the coastline. It is the accumulation of these particles on reefs, mangroves and seagrasses which cause sedimentation.

Erosion

Erosion is the transport of sediment from one place to another. Although a certain degree of erosion is a natural phenomenon, severe movement of sediment is mostly due to inadequate removal of the earths' top layers, mostly for construction activity. This movement increases with large amounts of rainfall which together with the short distances between the interior and the coastal areas, which prevail in Puerto Rico and the U.S. Virgin Islands, accounts for the sedimentation problems which are discussed later.

Tropical Disturbances

The passage of storms and hurricanes through mangroves and seagrasses can cause uprooting, mechanical defoliation, and deposition of sediment and other materials. This stress can eliminate vegetation from some areas. For mangroves, following the acute stress there is rapid re-establishment of new seedlings on suitable habitats, and the system restores itself. Seagrasses also may recover quickly if damage is slight and the substrate has

not been too altered. Some storms may have beneficial effects on mangroves such as removing accumulations of materials choking drainage ways and reopening salt ponds to the sea. They are important agents that redistribute materials within the coast.

Hypersalinity

This affects mainly mangroves. The accumulation of high levels of salts through evaporation is a chronic natural stressor in dry areas. When evaporation exceeds rainfall throughout the year, tidal action and evaporation accumulate salt in the back areas of the swamp. Eventually the soil salinity increases beyond the tolerance of mangroves and a barren zone develops. Mangrove coverage in these areas is unstable, with coverage fluctuating between periods of expansions 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 these changes and subsequently provide a great number of animals with food and other benefits.

Reef Diseases

Reef corals in the Islands are affected by various diseases such as the black, and white band diseases and bleaching. The white band disease is serious in some areas like Buck Island in St. Croix where it is quite widespread and is thought to be significant. The black band disease is of limited occurrence and has little overall effect. The bleaching occurrences are intermittent and of minor effects in the U.S. Virgin Islands.

Human-related Factors

The amount and rate of human-induced wetland losses have not been quantified, but can be 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 is 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. The discharge of sewage also can create problems for the organisms that reside in the estuaries where the discharge occurs.

Offshore species, may be adversely affected 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 kinds of effects listed above could result from major spills.

The destruction of suitable reefs (natural and man-made) or other types of hard bottom areas also may prove 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 hydrocarbons (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.

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

Sedimentation

Sediment resulting from erosion and runoff inevitably causes some damage to coastal waters. Erosion results from current agricultural and development practices in coastal areas. 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 in coastal areas. 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, so do poor sloping and lack of revegetation on cuts, fills, and ditches, especially in major highway developments.

Sedimentation is an important factor determining the abundance, growth and distribution of corals. Either 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 the amount of light available to the corals for the photosynthetic fixation of calcium carbonate, thereby reducing calcification rates (Lasker, 1980).

Other than increasing turbidity, sedimentation may limit reef corals by smothering, increasing energy expenditure in particle rejection, 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.

With the increase in sedimentation and turbidity mangroves are degraded with the loss of floral and faunal communities on the prop roots which in turn reduce habitat quality for juvenile fish. There occurs a loss of food resources and overall habitat complexity is reduced.

Seagrasses are affected by reduction of light transmission for photosynthesis, increased epiphytic colonization, therefore, diminished general health. They are an important food source for conch, turtles and other species and loss of seagrasses will severely impact the life cycles of these species.

Sewage Disposal

Extreme enrichment (eutrophication) seriously stresses wetlands and associated fauna. Pollution by fecal bacteria and viral agents pose some very 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 the 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. Coral reefs, however, can be the most seriously impacted. High nutrient concentrations stimulate high phytoplankton productivity as well as high productivity by benthic algae (Birkeland, 1977) which will favor the establishment of organisms that compete 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 a very long time. As a result, natural restoration may be very slow, if at all. There are no effective ways to clean up 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. No recovery is possible and massive die-offs may occur unless the fresh water source is restored. Both white and black mangrove

species are very susceptible because of their high dependence on upland water flow.

Impoundment

Impoundments can occur when roads are built through wetlands and no provision is made to preserve water flows. In the Islands this practice affects mangrove wetlands the most. Impounding may cause water levels to rise, suffocating the trees. The results of impoundment is rapid because tidal range is small and evaporation is high. In some cases when dikes are abandoned, partial recovery may occur, 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 disposal of waste materials due to consumption practices and limited land sites for disposal lead individuals as well as governmental agencies to loose practices. Not only are coastal areas used for the dumping of wastes (domestic and industrial) but like it has been stated before, the size of our islands creates a direct relation on how solid wastes are disposed of inland and the effect on the coasts.

4.2.3 Habitat information needs.

The vast majority of our highly-valued living marine resources are critically dependent upon 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.

Our chief concern related to living marine resources is how human activities impact fishery productivity. Research is needed to provide knowledge of the factors that affect energy flow. This understanding of ecological processes must then be combined with information on the health, distribution, and abundance of ecologically important organisms. By understanding the ecological linkages and information on the status of fishery stocks, managers of fisheries and habitat will be better able to manage estuarine dependent living marine resources.

For us to understand the causes of fishery declines and better predict the effects of human activities on fishery populations, the following research needs are provided so that state, federal, and private research efforts can focus on those areas that would allow the development of measures to better manage fishery resources and

their habitat:

1. Identify optimum coastal pelagic habitat and environmental and habitat conditions that limit production (e.g., focus more on life history studies that will define the critical fisheries habitats for food, cover, spawning, nursery areas, and migration routes);

2. 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?);

3. 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

4. Determine habitat 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 area "... 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 with the NMFS. The also FWS manages national refuges for wildlife.

Geological Survey (USGS). The USGS has conducted considerable research in nearshore areas and assisted or cooperated 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. Further, the USGS must ensure 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 a 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. This is similar to the function of the GMFMC's Habitat Committee. 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 (Map 4.2). 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 commercial fishing opportunities. The fisheries are dependent upon the survival of these resources, which can only be assured by the wise management of all aspects of the fishery, including habitat. Accordingly, activities that adversely affect habitat also will require action 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,

Map 4.2

PROPOSED U.S.V.I. TERRITORIAL MARINE RESERVE SYSTEM



- ⊗ Seagrass Beds
 - ⊖ Coral Reefs
 - ⊗ Suggested Anchorages
- > No anchoring - No spearfishing

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 three objectives which are to:

1. 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. Restore and rehabilitate the productive capacity of habitats which have already been degraded; and

3. 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 bring to the Councils' attention activities that may affect the habitat of the fisheries under their management. The Councils, 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 species being managed.

Public hearings and the building of administrative records also 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 kept to the minimum and that efforts for appropriate mitigation strategies and applicable research are supported.

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