

PUERTO RICO AND THE VIRGIN ISLANDS COASTAL BARRIERS

SUMMARY REPORT

Prepared for:

United States Fish and Wildlife Service
Department of the Interior

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PREFACE

This draft report on coastal barriers in Puerto Rico and the Virgin Islands is intended to accompany and complement the comprehensive draft report on U.S. mainland barriers which was prepared in accordance with Section 10 of Public Law 97-348, the Coastal Barrier Resources Act of 1982, which states:

Sec. 10. Report to Congress.

(a) In General.---Before the close of the 3-year period beginning on the date of the enactment of this Act, the Secretary shall prepare and submit to the Committees a report regarding the System.

(b) Consultation in Preparing Report.--- The Secretary shall prepare the report required under subsection (a) in consultation with the Governors of the States in which System units are located and with the coastal zone management agencies of the States in which System units are located and after providing opportunity for, and considering, public comment.

(c) Report Content. --- The report required under subsection (a) shall contain---

- 1) recommendations for the conservation of fish, wildlife and other natural resources of the System based on an evaluation and comparison of all management alternatives, and combinations thereof, such as State and local actions (including management plans approved under the Coastal Zone Management Act of 1972 (16 U.S.C 1451 et seq.), Federal actions (including acquisition for administration as part of the National Wildlife Refuge System), and initiatives by private organizations and individuals;
- 2) recommendations for additions to, or deletions from, the Coastal Barrier Resources System, and for modifications to the boundaries of System units;
- 3) a summary of comments received from the Governors of the States, State coastal zone management agencies, other government officials, and the public regarding the System; and
- 4) an analysis of the effect, if any, that general revenue sharing grants made under section 102 of the State and Local Fiscal

Assistance Amendments of 1972 (31 U.S.C. 1221) have had on undeveloped coastal barriers.

Under the direction of the Assistant Secretary for Fish and Wildlife and Parks, the draft report has been prepared by the Coastal Barriers Study Group, a task force of professionals representing the National Park Service, Fish and Wildlife Service, U.S. Geological Survey, and other Department of Treasury and the Federal Emergency Management Agency.

This draft report is descriptive not prescriptive. No recommendations to the Congress have been developed at this time. Recommendations will be developed following the close of the public comment period.

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SUMMARY REPORT

Introduction

The Coastal Barrier Resources Act (16 U.S.C. 3509) (CBRA) enacted in 1982, established the Coastal Barrier Resources System (CBRS), a network of 186 units along the Atlantic and Gulf of Mexico coasts, within which most federal expenditures are no longer available to promote economic growth or development. The stated purposes of the Act are to minimize the loss of human life, reduce the wasteful expenditure of federal revenues, and reduce the damage to fish and wildlife and other natural resources that can occur when coastal barriers are developed. Section 10 of the Act directed the Secretary of the Interior to provide a report to Congress regarding the CBRS within three years of passage of CBRA. Specifically, Section 10 requires that this report shall contain:

- 1) recommendations for the conservation of fish and wildlife, and other natural resources of the System based on an evaluation and comparison of all management alternatives, and combinations thereof, such as State and local actions (including management plans approved under the Coastal Zone Management Act of 1972 (16 U.S.C. 1451 et seq.), Federal actions (including acquisition for administration as part of the National Wildlife Refuge System), and initiatives by private organizations and individuals;
- 2) recommendations for additions to, or deletions from,

the Coastal Barrier Resources System, and for modifications to the boundaries of System units;

- 3) a summary of comments received from the Governors of the States, State coastal zone management agencies, other government officials, and the public regarding the System; and
- 4) an analysis of the effect, if any, that general revenue sharing grants made under section 102 of the State and Local Fiscal Assistance Amendments of 1972 (31 U.S.C. 1221) have had on undeveloped coastal barriers.

In May of 1985, the Department of the Interior (Department) issued a document entitled "Coastal Barrier Resources System Draft Report to Congress." This report has been circulated for review and comment.

Additionally, the Department issued a set of draft maps that delineated recommended additions, to or deletions from, CBRS, and modifications to the boundaries of existing CBRS units. This new inventory was undertaken as one component of the Report to the Congress required of the Secretary by Section 10 of CBRA (Public Law 97-348). It includes barriers of the Great Lakes (Michigan, New York, Indiana, Ohio, Pennsylvania, and Wisconsin); Alaska; West Coast (California, Oregon and Washington); Hawaii and American Samoa and Puerto Rico and the Virgin Islands.

To complement the draft maps that have been prepared for the new areas, the Department has requested the U.S. Fish and Wildlife Service (FWS) to prepare summary reports on each of these areas

that briefly describe the physical characteristics of the area, provide an overview on the ecological value of barriers to fish and wildlife resources, and summarize state conservation and regulatory programs for protecting barriers.

A Physical Characterization of Coastal Barriers of the Islands

Section 3 of the Coastal Barrier Resources Act of 1982 defines a coastal barrier as a depositional geologic feature, such as a barrier, tombolo, barrier spit, or barrier island which:

- 1) consists of unconsolidated sedimentary materials;
- 2) is subject to wave, tidal and wind energies;
- 3) protects landward aquatic habitats including the adjacent wetlands, marshes, estuaries, inlets, and nearshore waters.

The accepted scientific classification follows:

Bay Barriers- coastal barriers that connect two headlands, and enclose a pond, marsh, or other aquatic habitat. The terms bay mouth bar or bay bar are considered to be synonymous.

Tombolos- sand or gravel beaches that connect one or more offshore islands to each other or to the mainland. Coastal barriers of this type occur principally in New York and New England. The terms connecting bar, tie bar, and tying bar are synonymous.

Barrier Spits - coastal barriers that extend into open water and are attached to the mainland at only one end. They can develop into bay barriers if they grow completely across a bay or other aquatic habitat. On the other hand, bay barriers can become spits if an inlet is created.

Barrier Islands - coastal barriers completely detached from the mainland. Barrier spits may become barrier islands if their connection to the mainland is severed by creation of a permanent inlet. The barrier island represents a broadened barrier beach,

commonly sufficiently above high tide to have dunes, vegetated zones, and wetland areas.

This classification is largely inappropriate for coastal areas in Puerto Rico and the U.S. Virgin Islands but the definition of a coastal barrier has been expanded to include the following, the first two of which are more applicable:

1. Areas containing carbonate-cemented deposits such as:
 - a. local deposits of beach rock - found in tropical and semi-tropical regions, consisting of carbonate-cemented gravel and/or beach sand underlain or overlain by unconsolidated sediment occurring on a coastal barrier.
 - b. cemented dunes - found as local features in Puerto Rico where a carbonate-cemented dune line is located immediately seaward of a more or less typical coastal barrier, consisting of a beach (which may extend seaward to the cemented dune), dune and mangrove.
2. Areas consisting primarily of silt and clay:
 - a. Fringing mangrove - that occur as nearshore deposits of silt and clay stabilized by mangroves as islands (a.k.a. overwash mangroves) and bands of mangrove along subtropical or tropical mainland shores in areas of low wave energy. Many of these areas are located behind coral reefs, which together with the mangroves themselves, afford significant protection for the mainland from storm impact.
3. Areas containing glacial and bedrock deposits:
 - a. Discontinuous outcrops of bedrock and coarse glacial

deposits - that comprise less than 25 percent of the coastalbarrier landform above mean high water.

Associated aquatic habitat includes wetlands (e.g., tidal flats, swamps, and marshes), lagoons, estuaries, coves, inlets, the nearshore waters seaward of the coastal barrier, including, in some tropical areas, fringing and barrier reefs. All such associated aquatic habitats are inseparable parts of the coastal barrier ecosystem. All aquatic habitat between a coastal barrier and the mainland is protected by the coastal barrier from direct wave attack. Protection of this habitat and the mainland itself from wave attack during major storms has long been recognized as a fundamental function of coastal barriers.

Fringing mangroves and associated coral reef systems are considered as coastal barriers in tropical and subtropical areas because the protection afforded the associated aquatic habitat and mainland are comparable to coastal barriers that contain linear or curvilinear beaches.

Puerto Rico is the easternmost island of the Greater Antilles. The U.S. Virgin Islands (U.S.V.I.), consisting of St. Croix, St. Thomas, St. John and about 90 smaller islands, lie 40-65 mi (65-100 km) east and southeast of Puerto Rico.

Bathymetry

Puerto Rico, St. Thomas and St. John are on the Puerto Rican plateau which is delineated by the 100 fathom depth contour. To the north is the Puerto Rican trench with depths to 27,500 ft (8,384 m). To the south, the Virgin Islands basin is 13,500 ft (4,116 m) deep. St. Croix is 35 mi (64 km) to the south on a separate submerged ridge. A flat terrace about 60 ft deep, probably a result of wave erosion when sea level was lower during the Pleistocene, surrounds St. Thomas and St. John. As a transition zone between oceanic and continental plates, the Caribbean island arc is an active earthquake zone. Puerto Rico and the U.S.V.I. do not experience as much volcanic activity as some of the other islands such as Guadeloupe and Martinique. Tsunamis have occurred in the area.

Puerto Rico formed on the emerged crest of an elongated ridge that trends through Hispaniola, Puerto Rico and the Virgin Islands. The island is primarily volcanic and bound by the seismically active Puerto Rican trench and the Anegada trough.

Winds

The Tradewinds (Easterlies) consistently approach the islands from the east. Changes in the position and intensity of the Bermuda High to the north and the Equatorial Trough to the south are responsible for major seasonal variations. The winds

blow counterclockwise around the Equatorial Trough, a low pressure zone.

The yearly wind regime can be divided roughly into four seasonal modes (Table 1). When the Bermuda High is intensified from December through February with only minimal pressure changes in the Equatorial Trough, the trade winds are at a maximum. During this period, the "Christmas winds", strong winds from the north, may appear as a result of weak cold fronts moving through the Caribbean. A decrease in pressure of the Equatorial Trough results in a reduction in wind velocities from March through May. From June through August, wind speeds approach those in December through February as the Bermuda High strengthens with a concomitant decrease in pressure in the Equatorial Trough.

The lowest wind velocities occur from September through November as the Bermuda High weakens with only a small decrease in pressure in the Equatorial Trough.

Although hurricanes have occurred in every month of the year, most storms pass through the Eastern Caribbean between August and October with peak activity in September. Twenty-four hurricanes have passed within 50 miles of the Virgin Islands since 1900 (U.S. Army, 1975). Major hurricanes occur about once every 33 years.

Table 1. Annual wind regime for the islands

<u>Time of Year</u>	<u>Wind Velocities</u>	<u>Primary Direction</u>
Dec-Feb	11 - 21 knots about 60% of the time	ENE
	>20 knots c.25% of the time	ENE
Mar-May	>20 knots c.13% of the time	E
June-Aug	>20 knots c.23% of the time	E,ESE
Sept-Nov	>20 knots c.7% of the time	E,SE

Waves and Currents

The mean tidal range in the islands is only 0.8-1.0 ft (0.24 - 0.30 m), and tidal currents are usually weak. Diurnal tides predominate around St. Croix and on the south coasts of St. John and St. Thomas. Semi-diurnal tides occur on the north coasts of Puerto Rico, St. Thomas and St. John because of exposure to open ocean water. Waves come primarily from the east in the winter and the southeast in the summer, in response to seasonal shifts in wind direction. Waves are 1-3 ft (0.3-0.9 m) about half of the time. Southeasterly swells are common in late summer and autumn, while northern swells, occasionally reaching 10-12 ft (3-3.7 m) nearshore, develop in winter. The northern swells create strong longshore currents. Wave energy is concentrated on projecting headlands, and shoreline configuration reflects variations in the resistance of specific rock types in these headlands to erosion.

Sediment Transport

Sediment transport involves a complex interaction of biological, physical, and gravitational factors. During storms, rates of sediment transport are an order of magnitude higher than during normal conditions. Distinct sand channels through coral reefs facilitate seaward sediment transport. Sources of sand include 1) areas of high carbonate productivity, and 2) existing accumulations of sand.

St. Croix's northern shelf has no major storage sites for sediment, and sediment is transported into the deep basin offshore. Off the south coast of the island are two large sand bodies, one along the southwest coast and the other extending from Grapetree Bay to Grassy Point. Substantial amounts of sediment move off the shelf near the southwest tip of the island, at Sandy Point. An extensive reef parallels most of the south shore. The U.S. Geological Survey identified three areas off St. Thomas with mineable sand deposits. Two are west of Saba Island and the other is west of Buck Island. There are also submerged sand resources on the insular shelf of Puerto Rico.

Sediments arise from the degradation of corals, coralline algae, and calcareous green algae. Biological organisms play a unique role in the production, break-down, and transport of carbonate sediments. The distribution of organisms can therefore significantly affect the distribution of sediments. Biological processes such as the reduction of water circulation in seagrass beds, reworking of sediments and building of mounds by calianassid shrimp, are more important in protected bays than in

open water where physical processes, particularly currents, dominate.

Beaches in Puerto Rico and the Virgin Islands have constantly changing profiles, varying with location and with the season. Steep slopes and narrow berms indicate high energy waves. In the summer months, berms tend to become wider. During the winter, high energy waves tend to transport sand offshore.

Many beaches inside deep bays show little change while more exposed beaches experience loss of sand because of longshore currents and "littoral drift". Reefs and seagrass beds buffer wave energies and promote beach stability.

PUERTO RICO UNITS

PR-01 Espiritu Santo (Rio Grande): The beach in this unit supports a coconut palm plantation lying just west of the mouth of the Rio Espiritu Santo. Mangroves grow along the river channel which is joined by a subsidiary channel from the west. Cienaga Swamp borders on the southwest corner. A fringing reef lies 0.5 miles offshore. Three species of sea turtles, green, hawksbill and leatherback, nest on the beach. An unpaved road runs parallel to the beach. Part of the unit is in the Rio Espiritu Santo Natural Reserve managed by the Department of Natural Resources.

PR-02 Ensenada Comezon (Rio Grande): The shoreline of this unit is largely fine-grained sand beaches with some mangroves, particularly along the back bay of Ensenada Comezon. Extensive mangroves grow along the southern border, including a channel and artificial ditch that drains La Picua swamp. Several intermittently opened inlets line the unit's shore. Unpaved roads lead to Puntas Miguillo and Picua. Fringing reefs lie off both these points. There is evidence of sand and gravel extraction at Punta Picua. Few structures have been built here.

PR-03 Rio Mameyes (Rio Grande): Several structures exist in the northwestern, south central, and southeastern portions of this unit. Mangroves line the Rio Mameyes and occupy the unit's southeastern third. The southwestern portion was filled for a golf course which extends right to the beach. Roads are unpaved.

PR-04 Punta La Bandera (Luquillo): Narrow sand and gravel beaches in the east are surrounded by development associated with the resort town of Luquillo in this undeveloped unit. Well-

developed reefs lie just offshore. Coconut plantations extend east from the popular Playa de Luquillo which is outside the unit.

PR-05 Luquillo Spit (Luquillo): This sand spit projects from a wide beach east of two condominiums on a rocky bluff at the junction of the Rio Sabana and the Rio Pitahaya. Sand and gravel bars occur at the river mouth and mangroves extend upstream in channels for about 0.4 miles. In the east, an unvegetated channel of the Rio Pitahaya cuts through the beach and empties into the bay. The beach berm is stabilized predominately by sea grapes and experiences significant off-road vehicle use. Hawksbill, green and leatherback sea turtles are reported to nest here. Pasture land borders and overlaps the unit on the south side.

PR-06 Juan Martin Spit (Luquillo): A long, mostly sand beach here is backed by freshwater and brackish marshes along the Rio Juan Martin. A coral reef occurs offshore, and mangroves occur in the western section. The unit is undeveloped except for a railroad track along the south and east borders, and unpaved roads along the beach. An overgrown coconut grove appears in the western section. The southwest side of the river is being cultivated.

PR-07 Laguna Aguas Prietas (Fajardo): Sand barriers have formed east and west of Laguna Aguas Prietas behind bedrock cliffs at Cabeza Chiquita. Some herbaceous marshes occur landward of the mangroves in the western portion. The lagoon is fringed by mangroves on all but the north side and drains through barrier

and fringing reefs leaving an outwash plume in the bay. Reef development is best just north of this outlet, behind Cabeza Chiquita. Immediately adjacent to the unit's eastern section is a recent major development. The lagoon provides habitat for populations of little blue herons and cattle egrets.

PR-08 Cabo San Juan (Fajardo): The gravel beach in the southwestern portion of this unit, surrounded by exposed rocky platforms, turns into a coarse grained sand beach extending to the headland at the northern end. Bay barriers protect Laguna Grande which has good mangrove development along its edge and herbaceous marshes to its southeast. Well-developed reefs occur in the west. There is one small structure west of the lagoon and a coconut plantation.

PR-09 Rio Fajardo (Fajardo): This unit runs north-south along the exposed eastern coast of Puerto Rico, from the Rio Fajardo in the north to the rocky shores of Punta Barrancas. The shoreline is a narrow beach with some mangroves. The unit extends about 0.5 miles inland to the west in extensive mangrove forest and is part of the Department of Natural Resources Ceiba State Forest.

PR-10 Punta Barrancas (Fajardo): This small bay barrier runs south from the point to Punta Mata Redonda. It is composed of mixed sand and gravel and fine-grained sand beaches, and includes a lagoon in the western part with good mangrove development. The unit is undeveloped although an unpaved road runs on the southern border and a landfill dump appears to be encroaching from the south.

PR-11 Punta Figueras (Fajardo): The northern shoreline of this

unit in Roosevelt Roads Naval Station is sand and gravel beach with the rest of the shoreline lined with mangroves. Lagoons at the neck of the point drain into Puerto Medio Mundo. Aerial photographs (1984) indicate about 10 small structures in the northwest corner and 15 more structures along the southwest shore of Bahia Demajagua, all accessed by unpaved road along the water's edge.

PR-12 Playa Flamenco (Culebra): A long and wide beach bay barrier protects Laguna del Flamenco, the largest lagoon on Culebra, from wave action in Bahia Flamenco. Coral formation is moderate in the northwest just offshore. Unpaved roads lead to about 8 structures at the eastern end. The lagoon's south shore provides winter and spring habitat for waterfowl, particularly the northern pintail, a migratory bird of special concern. Hawksbill sea turtles nest here.

PR-13 Playa Brava (Culebra): This undeveloped unit in the central northern coast of Culebra is defined by Punta Resaca to the west and a small promontory to the east. The beach of coarse-grained sand is very wide, low, and flat, and acts as a bay barrier to protect mixed vegetation and small ponds to the south, winter and spring habitat for the northern pintail. Raptors, sea birds, and gulls are found associated with this and other units on the island. Leatherback, hawksbill and green sea turtles nest here.

PR-14 Playa Large (Culebra): This undeveloped unit is a bay barrier beach which shelters a mangrove swamp and a small pond, Laguna Zoni, to the south. The lagoon is northern pintail habitat. The beach is reported to be nesting habitat for the

hawksbill sea turtle.

PR-15 Laguna de Molino (Culebra): This undeveloped barrier protects Laguna de Molino. The western portion of the beach is fine-grained sand, while the eastern portion and the south shore beach of Cayo Botella, 0.5 miles offshore, are mixed sand and gravel. The north and east shores of the cay are rocky. Some reef development occurs to the northwest. Hawksbill sea turtles are reported to nest on the western end of the beach.

PR-16 Culebra Tombolo (Culebra): This low tombolo connects Culebrita Island with Cabo del Pasaje to the north and features wide, fine-grained beaches. Coral growth is evident to the west of the tombolo but absent in the eastern bay. Hawksbill sea turtles are reported to nest on the tombolo.

PR-17 Puerto del Manglar (Culebra): This undeveloped unit is a deeply incut southeast-facing bay with mangroves through most of the area. Sand and gravel beaches occur at the extreme eastern end.

PR-18 Punta Arenas (Vieques): This unit is U.S. Navy land at the WNW corner of Vieques Island. This complex landform has several spits and barriers protecting four ponds. A paved road runs east-west, and an unpaved road follows the 3 mile long beach. The wetlands support numerous waterfowl. Various species of diving birds, wading birds, shorebirds, and waterfowl, as well as raptors, and manatees and three species of sea turtles are found along the coast of Vieques in this and the following units.

PR-19 Playa Grande (Vieques): This coarse-grained sand beach protects Laguna Algodones and limited wetlands to the south, and

is located on the northeastern coast of Vieques. It is bordered on the east by rocky cliffs. An unpaved road runs parallel to the beach and around the lagoon. The beach is reported to be nesting habitat for hawksbill, leatherback and green sea turtles.

PR-20 Puerto Negro (Vieques): This unit features a narrow barrier of coarse sand that protects Laguna Monte Largo with sparse wetlands. An unpaved road runs just above the high-tide mark. Reefs occur in the northern portions of the unit. Hawksbill, leatherback and green sea turtles are reported to nest here.

PR-21 Bahia Playa Blanca (Vieques): This bay barrier on the northeast coast of Punta Este protects a small lagoon and associated wetlands. Although the unit is undeveloped, the area to the west appears to be a bombing range. The coarse grained sand beach serves as nesting habitat for the leatherback, hawksbill and green sea turtles.

PR-22 Laguna Anones (Vieques): This very large lagoon formed by a barrier beach extends northeast from Bahia Salina del Sur almost across the narrow neck at the east end of the island. The beach is rimmed by cliffs on either side. The area may be a bombing range. An unpaved road runs along the west side of the lagoon.

PR-23 Ensenada Honda (Vieques): Extensive mangroves fringe the north shore of this major bay on the south coast. The unit is protected by a rocky headland on the southeast.

PR-24 Laguna Yanuel (Vieques): This small bay on the west side of Ensenada Honda is protected on the east by the rocky headland of Punta Carenero attached to the mainland by a narrow mangrove

spit. Mangroves line the shore of the unit with the exception of a small beach where the lagoon empties into the bay. Leatherback, hawksbill and green sea turtles are reported to nest on this small coarse grained beach. No structures exist.

PR-25 Bahia de la Chiva (Vieques): A wide, fine-grained beach along the shore of this small bay west of Ensenada Honda protects a lagoon in the northwest. Green, leatherback and hawksbill sea turtles use this beach as nesting habitat. The north half of Isla Chiva is covered with coarse sand and gravel, and there is a rocky outcrop to the southeast. (No structures).

PR-26 Bahia Tapon (Vieques): Mangroves line the shores of this phosphorescent bay, protecting inland wetlands. A small pond is at the eastern end of the unit. (No structures).

PR-27 Puerto Ferro (Vieques): Mangroves line the northern shore of Bahia Ferro while the southwest shore is rocky and sheltered. A few very small ponds are protected by the mangroves on the north and extreme southwestern sides of the bay. The bay opening is very narrow. An unpaved road skirts the west side of the unit and a faint track extends to a spit at the extreme southeast corner.

PR-28 Ensenada Sombe (Vieques): The unit forms the eastern half of the long beach of Ensenada Sombe, well-protected on the east by Punta Negra but open to direct wave attack from the south. The beach barrier protects a mangrove forest. Hawksbill, leatherback and green sea turtles are reported to nest on the beach. An unpaved road provides access to the beach and vacation center operated by the Puerto Rican Recreation Development

Company, a public corporation. The U.S. Navy owns the unit with the PRRDC. Minimal facilities are present.

PR-29 Cayo de Tierra (Vieques): This unit includes one of the largest islands south of Vieques. A small cape in the north extends toward the main island just south of the town of Esperanza. The south half of the island has bedrock cliffs lined by gravel beaches which extend around the island to the north. (No structures).

PR-30 Laguna Playa Grande (Vieques): The beach here protects a very large lagoon from wave attack from the south and east. The beach is fine-grained sand, except for a short gravelly portion where the lagoon empties into the bay. Green, hawksbill and leatherback sea turtles are reported to nest here. Mangroves fringe the lagoon. An unpaved road runs along the barrier.

PR-31 Medio Mundo (Ceiba): Extensive mangroves along bay barriers and spits comprise this unit within the Roosevelt Roads Naval Station. Mangroves are bisected by unpaved roads. Four major channels support well-developed mangroves throughout the southern two-thirds of the unit. Punta Medio Mundo and Isla Pineros protect the mangroves to the north and east, respectively, from storm surges. Northern pintails are found in the interior mangroves. Coral reef development off the point and north of Isla Pineros is good.

PR-32 Isla Pineros (Ceiba): Mangrove development is good in the sheltered southwestern corner of the island, and fine-grained sand beaches adjoin the mangroves to the north and south. Hawksbill sea turtles are reported to nest on the southeastern beach. This undeveloped unit is owned by the U.S. Navy.

PR-33 Roosevelt Roads (Ceiba): The unit lines Ensenada Honda from the town of Del Pueblo to the north to an exposed mangrove point that protects a sheltered mangrove channel running to the southwest in Guayacan Barrio. An exposed rocky headland in the center of the unit has extensive mangrove development behind it. Access roads and small docks appear at the north and south edges of the unit which is U.S. Navy property.

PR-34 Punta Cascajo (Ceiba) Fringing mangroves at the southwest corner of Ensenada Honda line the small protected bay. The southwest point of the bay, Punta Cascajo, is connected to the Puerto Rican mainland by a tombolo, which protects mangroves on its western side. The entire point is excluded from the unit; a paved road that crosses the tombolo leads to an extensive housing development. The unit is within Roosevelt Roads Naval Station.

PR-35 Rio Dagua0 (Ceiba, Naguabo): An extensive mangrove forest protects two lagoons just inland at the mouth of the Rio Dagua0 along which mangroves extend to the north. All of the unit is within Roosevelt Roads Naval Station except for the southwest corner which is in Naguabo Municipio and which has an unpaved road.

PR-36 Bosque Estatal de Ceiba (Naguabo): This unit is bisected by the mouth of the Quebrada Palma as it empties into the Bahia Algodones, and its eastern boundaries coincide with those of the state forest managed by DNR. Mangroves exposed to wave attack in the Pasaje de Vieques line the long spit out to Cayo Algodones in the southeastern corner. A pocket of exposed mangroves lines the shore east of the outflow of the Quebrada; otherwise the

shore is fine-grained sand. There is no development. This unit has recently been named a Natural Reserve by DNR.

PR-37 Punta Santiago (Naguabo, Humacao): With a shoreline length of 6.42 miles, this unit encompasses large coconut plantations along the northeast and southwest shore. The southwest area of the unit contains large ponds and freshwater wetlands that support a population of Bahama ducks and West Indian whistling ducks. The northeast boundary follows a manmade channel for 0.25 miles. Both DNR and USFW have recommended exclusion of the point in this unit because of major development including two subdivisions. Part of the unit belongs to DNR and part is operated by the PRRDC as a public beach.

PR-38 Punta Candelero (Humacao): This fine-grained sand bay barrier protects a small lagoon in the northeast near the sea and wetlands to the west and southwest. Some artificial ditching is apparent. The unit is privately owned and operated by Palmas del Mar resort hotel, with part of the grounds set aside for conservation.

PR-39 Puerto Yabucoa (Yabucoa): The unit surrounds the mouth of the Cano Santiago and features a spit. River channel migration is evident from aerial photos. The unit has mixed wetlands. DNR has recommended that the unit be eliminated because of extensive dredging to create an industrial port for the Sun Oil Co.

PR-40 Punta Tuna (Maunabo): The unit consists of a short coarse sand beach protecting a small mixed mangrove stand landward. It is undeveloped.

PR-41 Rio Maunabo(Maunabo): Spits occur northeast and southwest of the mouth of the Rio Maunabo, joined at the mouth by the

Quebrada Arenas from the north. A lagoon or channel connects from the west. Seasonal diversion of small streams by the spits creates only narrow aquatic habitat landward. Small coconut plantations are present.

PR-42 Punta Viento (Patillas): This prominent point south of the village of Lamboglia is bordered on the north by a small channel. Mangroves are well-developed in the northern two-thirds of the unit, giving way to coconut plantations along the shore to the south. Unpaved roads follow the narrow beach just inland. Reef development to the southwest is good. (No structures)

PR-43 Las Mareas (Guayama): This long and wide spit protects a large aquatic habitat, heavily modified outside of the unit especially to the west surrounding the oil facility in the bay protected by Punta Ola Grande. The Las Mareas area immediately north of the eastern portion of the unit is actively developed. A channel has been dredged into the bay for oil tanker traffic. Two settling ponds have been built in wetlands outside the unit north of the bay. Coconut groves occur in the southwest, with unpaved access roads. Fringing reefs are moderately developed to the south and east, especially at the southwest tip of the point. Hawksbill sea turtles are reported to nest on the south shore of the unit.

PR-44 Bahia de Jobos (Guayama): This unit is almost entirely within the Aguirre State Forest and/or Jobos Bay National Estuarine Sanctuary. Punta Pozuelo is a huge spit protecting Jobos Bay. The spit is excluded from the unit because of development. Extensive mangroves occur in the east, and

fringing mangroves line the north and east shores of the bay. Salt production ponds exist in the southern portion of Punta Pozuelo. Mangroves fringe the shorelines of the Cayos Caribes, islands which run southwest of the point. A Leucaena plantation, mixed with coconut palms, occurs in the unit's southeast corner. Puerto de Jobos has high-density residential structures and 3 docks and seems to be excluded, along with the city of Central Aguire.

PR-45 Mar Negro (Salinas): Most of the unit is within the Jobos Bay National Estuarine Sanctuary and/or the Aguirre State Forest. Mangroves grow in a set of channels in the eastern half. Mar Negro is a series of lagoons linked by channels and lined by mangroves. The Cayos de Barca, islands to the south, have extensive mangroves and small offshore reefs. Abandoned salt production ponds occur southwest of Las Mareas. About 30 structures along the beach near an unpaved road running southeast from Las Mareas should probably be excluded. Punta Arenas has several small structures and a coconut plantation accessed by an unpaved road. Mangroves appear to have been cut back extensively from this road. A fringing reef occurs around the south shore of Cayos de Ratones. The northwest corner of the unit has dense residential development all around the bay protected by Punta Salinas.

PR-46 Arenal (Salinas): The mouth of the Rio Nigua is characterized by dynamic spits and barriers of mixed sand and gravel, with some mangroves in the west. Sand migration WNW along the coast has created a sand barrier that has almost closed the mouth of the river. Three small structures occur along the

road at the unit's northwest corner.

PR-47 Punta Petrona (Santa Isabel): Poorly developed mangroves fringe the shores of Bahia de Rincon, Bahia de Juaca, and an unnamed bay. Small reefs occur offshore. A coconut plantation occurs on the far eastern border. Weak mangrove development on the east side and point of Bahia de Rincon, and a dense development of small structures along the bay's north shore are evident. Several unpaved roads run along the west shore near sandy areas or borrow pits. Punta Petrona has fringing mangroves and salt ponds. On the west side are mangrove barrier islands and reefs which protect a lagoon. The unit's northwest corner has several structures just behind the mangroves.

PR-48 Rincon Keys (Santa Isabel): The unit is a collection of small islands associated with well-developed reefs running roughly E-W. Cayos Cabezazos and Cayos de Caracoles are about 2.0 miles offshore with exposed mangroves and gravel beaches. The mangroves of Cayos de Caracoles support populations of great Blue Herons. Other islands are reef limestone. The two easternmost islands have breaking reefs. The unit is located within the proposed Punta Petrona Natural Reserve to be administered by DNR. (No structures)

PR-49 Cayo Berberia (Santa Isabel): This island 2.5 miles offshore of Playa Cortada features exposed mangroves along most of its shore, except for small coarse-sand beaches at the north and southwest tips. Reef development is good in the protected waters southwest of the island. The unit is included in the DNR-administered Caja de Muertos Natural Reserve. Small-scale coral

reef fisheries for snapper, grouper, grunt, lobsters, and conchs are present.

PR-50 Chardon (Santa Isabel): This unit is mixed sand and gravel barrier beach with a small patch of fringing mangroves flanked by small channels on either side. Hawksbill sea turtles are reported to nest in this area. (No structures)

PR-51 Rio Descalabrado (Juana Diaz): This unit includes a prominent spit on the south side of the mouth of the Rio Descalabrado, with several smaller spits and associated mangroves. One new structure on about 2 acres of land is located on the unit's north central boundary. An unpaved road accesses the spit in the southwest portion.

PR-52 Punta Pastillo (Juanica Diaz): This bay barrier has substantially disturbed sand and gravel beaches. A small river channel lined with mangroves and a sand spit form the unit's western boundary. An unpaved road runs south from the paved road on the northern boundary. The unit's southern point has a sparse shrub and herbaceous cover on sand flats. A fringing coral reef occurs in the southeast corner of the barrier.

PR-53 Bajo de Marea (Juana Diaz): This small unit includes a channel and spit on its western border. A small sand and gravel beach protects the mangroves. (No structures)

PR-54 Rio Jacaguas (Ponce): This unit consists of reasonably well-developed mangroves and a mixed sand and gravel beach. A channel on the west side forms a sand spit that encloses a small lagoon. (No structures)

PR-55 Cayos Frios (Ponce): This unit includes an exposed mangrove island (Isla del Frio) about 0.5 miles offshore with a

small fine-grained sand beach on its northeastern shore. The island has poorly developed reef to the south and a small gravel beach on its southeast shore. Cattle egrets nest on the island and hawksbill turtles nest on the shore. The unit also includes a mixed sand and gravel beach spit formed where the Rio Inabon drains near the western boundary.

PR-56 Punta Cabullones (Ponce): This barrier spit directly abuts PR-55 on the east side and includes the following ecosystems: 1) mixed sand and gravel, and coarse-grained sand beaches, with low sand ridges on either side of the point, 2) exposed and sheltered mangroves, especially well-developed along the artificially dredged canals in the western corner, 3) a flooded zone on the landward boundary with wetlands, 4) reefs running offshore of the exposed mangroves in the west, and 5) numerous limestone and mangrove cays which are inhabited by brown pelicans, white-tailed tropic birds and cattle egrets. All of the unit, except the point mangroves and cays, is completely modified by extensive ditching, drainage canals, unpaved roads, and sand mining. The five structure settlement of Quinta Esperanza is within the unit.

PR-57 Punta Cucharas (Ponce): This bay barrier includes a coarse-grained public beach operated by the Recreation Development Company in its western portion, complete with large bathhouse, pool, parking lots, and coconut grove. The south shore is characterized by fringing exposed mangroves and fringing coral reef. A network of unpaved roads winds along the southern mangrove border and throughout the eastern half of the unit. The

extreme northeast section has been mined for sand, and the former extensive mangroves in the northeast have been drained. The east shore exhibits good beach development. One third of the unit is a large lagoon opening to the southeast through a break in the beach among the mangroves.

PR-58 Tallaboa Keys (Penuelas): The six major keys and several minor ones here are characterized by exposed mangroves and offshore reefs south of the beaches of Bahia de Tallaboa. There are also small segments of rocky shore, riprap, and a seawall and breakwater. The Rio Tallaboa drains just west of the seawall. Four breaking reefs are found east and west of the cays, while reefs are best developed on the south and southeast sides. Small scale reef fisheries exist for snapper, grouper, grunt, spiny lobster, and conch. Extensive oil refinery development has occurred along the shore. The extreme eastern shore has an unpaved road following the mangroves and about 15 units (which should be excluded) have replaced the mangroves within a mile of the coastline.

PR-59 Punta Ballena (Yauco, Guanica): This spit and mangrove island complex forms the west border of Bahia de la Ballena. Extensive coconut plantations occur along the east half of Punta Ballena. Sheltered mangrove development behind the point to the west and ringing the bay is extensive. A large reef fringes the cays to the south. Small scale reef fisheries exist for snapper, grunt, grouper, spiny lobster and conch. The unit includes Guanica State Forest. Salt production ponds north of Punta Jacinto have been abandoned. The mangrove cays (Cayes de Cana Gorda) are used extensively for recreation. About 15 structures

and several cleared lots at the south tip of Punta Jacinto should be excluded. The Balneario de Cana Gorda, administered by the Dept. of Parks and Recreation, has extensive structural development (about 7 structures).

PR-60 Punta Meseta (Guanica): Most of this unit is within Guanica State Forest although a portion has been developed as a public bathing beach by the Recreation Development Company. The shore includes exposed fringing mangroves protected by small fringing reefs, as well as short stretches of gravel and fine-grained sand beaches. Several ponds exist, and Route 333 runs directly above the unit's northern boundary. (No structures)

PR-61 Ensenada Las Pargas (Guanica): The shore consists of fringing mangroves interspersed with segments of exposed rocks and a small coarse-grained sand beach. Reefs protect the landward mangroves and are also associated with about 15 small mangrove islands. The hawksbill turtle nests on the western end of the shore. (No structures)

PR-62 Punta Jorobado (Guanica): Exposed mangroves, heavily damaged in recent storms, and a coarse-grained sand beach characterize this unit within Guanica State Forest. The hawksbill turtle is reported to nest on this beach. A small fringing reef runs along a segment of shoreline, and an unpaved road follows the northern shore. (No structures)

PR-63 Cayo don Luis (Guanica): This unit includes exposed fringing mangroves in small patches and a mangrove cay located about 0.3 miles southwest of its shoreline. Developed reef lies south of the cay and between the cay and vegetated shore. An

unpaved road winds along the shore. (No structures)

PR-64 Bahia Montalva (Guanica): This unit has a long shoreline of fringing mangroves and about 15 offshore mangrove cays with excellent reefs as well as wetlands bordering Bahia Fosforescente. This small bay has a narrow opening with promontories at the mouth and well-protected, extensive mangroves inside. Extensive salt production ponds occur just north of the mangroves fringing Montalva Bay. An unpaved road runs along the east shore of the bay in the far east of the unit, and there is a cluster of 8 structures on the beach and 2 in the mangroves which should be excluded. DNR and other agencies are acting to halt illegal construction of houses here. Part of the unit is in the La Parguera Natural Reserve and part has been acquired by the Puerto Rican Conservation Trust.

PR-65 Margarita (Cabo Rojo): Over 90% of this large unit is within the Boqueron State Forest; all of the fringing mangroves as far west as Punta Pitahaya are within this forest and also fall within DNR's La Parguera Nature Reserve. The landward boundary follows the forest boundary for administrative convenience. Portions of the coastline include a tombolo, sheltered mangroves, coarse and mixed sand and gravel beaches, and exposed and sheltered rocky shores. The unit includes a National Institute of Health research facility on Isla Cueva, within the state forest, as well as the University of Puerto Rico's Institute of Marine Biology on Isla Magueyes at Parguera. The entire east section of shoreline is lined with numerous structures in the mangroves (some illegal), extending west of Parguera into Boqueron State Forest and east to Punta Papayo.

Magnificent frigate birds nest on the mangrove island of Cayo Vieques.

PR-66 Cabo Rojo (Cabo Rojo): This complex barrier cape and tombolo, part of the Boqueron State Forest, includes fringing mangroves along Bahia Sucia. Mangroves grow along both sides of the spit out to the cape, and two small mangrove islands sit west of the tombolo. Other shoreline components include fine and coarse-grained sand beaches, sheltered mangroves, rocky shores, and commercial salt flats behind Punta Aquila and Bahia Salinas. A good beach occurs northeast of the cape. Other wide beaches border the cape's northwest side and the northwest corner of the unit where coconut and other shore species thrive. A network of unpaved roads runs throughout. Three of the fine-grained sand beaches host nesting sea turtles (hawksbill, green, and leatherback), while the white-tailed tropic bird breeds on the cape's point.

PR-67 Bahia de Boqueron (Cabo Rojo): This unit consists of a spit in the southwest and a major barrier in the center protecting very extensive mangroves from the Bahia de Boqueron. Shoreline components include coarse-grained sand beaches where the hawksbill turtle nests, minimal sheltered rocky shore, and both exposed and sheltered mangroves. The spit has commercial salt ponds. At the bay head is Boqueron Balneario, a public beach and vacation center with cottages, bathing facilities, public parking, and utilities operated by PRRDC. East of the beach lies a substantial tract of mangroves managed by DNR as a Wildlife (Bird) Refuge; it is also a Natural Reserve. The north

side of the bay is dominated by fringing mangroves, most within the Boqueron State Forest. The extreme northern bay barrier is characterized by a coconut plantation protecting a lagoon.

PR-68 Boca Prieta (Cabo Rojo): The coarse-grained beach here supports a coconut grove and a limited mangrove forest. Hawksbill sea turtles nest on the beach. Spits have formed at the mouth of the Quebrada Zumbon. There is an unpaved road, and two structures exist at the stream mouth. Ownership is private and public.

PR-69 Punta Carenero (Cabo Rojo): The southern cape here features a coconut grove and exposed mangroves behind the spit of Punta la Mela. The area directly south of this point along the shore should be eliminated because of private resort development with permanent structures in the coconut grove. The head of Puerto Real consists of fringing mangroves. Sheltered mangroves line the northwest portion of Puerto Real, the town proper, which is eliminated. Extensive mangroves protect a well-developed beach on the prominent Punta Carenero spit. In the extreme north, Punta Ostiones forms a cape protecting mangroves behind. Unpaved access roads are laced throughout the north and south segments of the unit. Several exposed mangrove cays run north from Punta Carenero.

PR-70 Belvedere (Cabo Rojo): This small unit consists of fringing mangroves as well as mangroves behind the fastland. The extreme tip of the unit should be excluded because the area has been developed as a yacht club and marina.

PR-71 Garita (Cabo Rojo): Fringing exposed mangroves in the south and a spit with scattered structures and mangroves in the

north comprise this unit. The shore has alternating mangroves, gravel and coarse sand. However, both DNR and Fish and Wildlife have recommended rejection of the entire unit because it is densely developed.

PR-72 Punta Guanajibo (Mayaguez): The Rio Guanajibo forms the southern boundary of the coarse-grained sand beach here and creates a southwest-pointing spit with interspersed mangroves. To the northeast is the town of San Jose and a paved road is included in the unit. The cattle egret uses the beach for breeding.

PR-73 Cano Corozones (Mayaguez): Significant erosion has occurred here. The coarse sand beach immediately north of San Jose and protecting the entrance to the canal is included. The paved road is now almost in the water northeast of the canal due to wave attack from the southwest. Former structures along the road are no longer readily visible. Coconut palms fringe the fastland and cattleegrets breed here.

PR-74 Cano Boquilla (Playa Grande)(Mayaguez): This highly developed unit has been recommended for elimination by DNR. Fine-grained sand beaches and extensive coconut groves protect the mangroves along the Cano Boquillo river. Mangroves are densest in the southeast corner of the unit and continue behind the unit's eastern boundary. The West Indian whistling duck breeds here year-round. Hawksbill sea turtles are reported to nest on the fine grained sand beaches. Recent aerial photographs indicate that about 32 structures and a paved road exist within the unit.

PR-75 Espinar (Aguadilla): This bay barrier features fine and coarse-grained sand and gravel beaches protecting a small pond in the south. Hawksbill sea turtles nest on these beaches. Humpback whales are seen off shore in the winter and spring. Mangroves run parallel to shore from west to east along the channel. The barrier in the southwest features coconut groves. A paved road leads to the Aguadilla Municipal Park in the northeast.

PR-76 Punta Agujereada (Aguadilla): This bay barrier has coarse-grained sand beaches with two exposed rocky platforms. The eastern section has been recently cleared and contains numerous unpaved roads, but no substantial development. Landward of the barrier and its coconut grove there is mixed wetland vegetation.

PR-77 Bajuras (Isabela): This small bay barrier unit includes rocky shore and coarse-grained sand beaches. Cemented dunes protect fringing mangroves to the landward side that cuts east of the unit. An unpaved road and one structure are present. The unit is within the Bajura Isabela Special Planning Area designed and managed by the PR Planning Board.

PR-78 Guayabos (Isabela): This barrier contains landward aquatic habitat protected by cemented dune deposits. The hawksbill sea turtle nests on the sand beach here. The eastern end has an unpaved road. (No structures)

PR-79 Penon Brusi (Camuy): Coarse-grained sand dunes here appear to have been mined. A small mangrove forest runs parallel to the coast behind the dunes. A beachrock formation along the coast line allows extensive sand deposition landward. Unpaved roads access the area.

PR-80 Punta Maracayo (Camuy): The center of this bay barrier has

been cleared, filled and developed thereby creating two segmented barriers. Thinly vegetated beach dunes protect the west segment while recent development is evident along the eastern border. Beach rock protects the wide coarse-grained sand beach. In the eastern segment trees grow in concentric circles around a herbaceous wetland. An unpaved road allows access in the east.

PR-81 Puerto Arecibo (Arecibo): This half-mile fine-grained sand spit supports some coconut trees and low herbaceous growth. The unit forms the south shore of Puerto de Arecibo bay on the east shore of the outlet of the Rio Grande de Arecibo. A paved road provides access from the west. (No structures)

PR-82 Punta Manati (Manati): This small barrier includes coarse-grained sand beach and cemented dunes, which front the unit on the ocean side. The hawksbill turtle nests on this beach. Seagrape trees at the beach edge protect black mangroves and related species. (No structures)

PR-83 Tortuguero (Manati): A freshwater lake and valuable wetlands designated as DNR's Tortuguero Laguna Natural Reserve are located behind this barrier. The shoreline consists of coarse-grained sands interspersed with beachrock. The hawksbill turtle nests on the beach. Both paved and unpaved roads, plus scattered structures, are present. Mixed freshwater wetlands surround the lagoon.

PR-84 Rio Cibuco (Vega Baja): Fine-grained sand beach and some rocky shore protects extensive mangroves where the Rio Cibuco empties into Boca del Cibuco. Sand spits are well-developed at the northeastern point. At the northwest corner of the unit,

sand bar development parallel to shore may be intermittently attached as a spit at the western end. Paved and unpaved roads provide access. Coconut groves thrive at the extreme northeast corner. (No structures)

PR-85 Rio Cocal (Toa Baja): Most of the eastern portion of this spit is administered by the U.S. Navy (U.S. Naval Radio Station, Sabana Seca). The dune line is well-developed. Extensive mangroves and freshwater wetlands occur in the west. The major river, Rio Cocal, and tributaries run throughout. Some development in the Lagos de Plata was begun in the wetlands west of Levittown Lakes until a cease and desist order was given by the Army Corps of Engineers in 1981. The remaining land in that project must by agreement be kept undeveloped as conservation land. Mangroves have been reseeded. Paved and unpaved roads, as well as scattered structures, are present.

PR-86 Punta Salinas (Toa Baja): A tombolo with fine-grained sand and gravel beaches and a coconut grove links Punta Salinas with the mainland. The area has been developed as a public beach. The rocky point and its 5-6 large structures, plus the rocky isle with 3 structures connected to the tombolo by an artificial causeway, are excluded from the unit. No wetlands are present. A trail network has been established in the southeast corner, and a paved road runs through the center of the tombolo to the point. An unpaved road runs around a lake in the southwest corner. The unit's southern border consists of the Levittown development with high density residential structures. Accordingly, recreational demands are high. The unit is protected by public ownership of the bathing beach.

PR-87 Bosque Estatal de Pinones (Carolina): This sand spit consists of DNR's Pinones State Forest and Natural Reserve in the west, and some private land in the east. The tract includes Puerto Rico's largest exposed and sheltered mangrove forest. Private developments have been excluded from the unit at La Torre, Punta Maldonado, Pinones, and Arenas. A sewage treatment plant has also been excluded. Paved and unpaved roads, and utilities are present.

PR-88 Punta Boca Juana (Dorado): Coarse grained sand beaches lie at the mouth of the Dorado River and protect inland wetlands. Unpaved roads lead out to the exposed rocky point from the town of Mameya, which borders the wetlands.

PR-89 Punta Manglillo (Guanica): Patches of fringing mangroves are interspersed with coarse sand and gravel beaches and exposed rocky shoreline, all within Guanica State Forest. Hawksbill sea turtles are reported to nest on the beaches.

PR-90 Puerto Mosquito (Vieques): A narrow bay opening of rocky shores and seawalls shelter the shores of this phosphorescent bay and inland wetlands on the south side of Vieques. (No structures)

PR-91 Punto Cabras (Culebra): Mangroves line the northeast shore of Ensenada Honda, the main bay on the southeast side of Culebra.

ST. CROIX UNITS

VI-01 Rust Up Twist: This undeveloped area is characterized by a beach and landward mangrove habitat. Coral reefs occur offshore. A paved road parallels the shore.

VI-02 Altona Lagoon: Just east of Christiansted Harbor, St. Croix's major port, Altona Lagoon has mangrove-lined shores. Plankton blooms occur seasonally in the lagoon, leading to population explosions of shrimp and fish which are extensively fished at the lagoon outlet. This outlet, though small, makes the lagoon potentially subject to pollution from raw sewage and effluent from a power plant. The eastern end of the lagoon is good wintering habitat for shore birds, ducks, white crowned pigeon and herons. This partly developed unit also includes a popular beach and shallow coral reefs west and north of the lagoon, all of which are vulnerable to environmental damage if plans to dredge and fill areas for a major cruise ship port proceed.

VI-03 Southgate Pond: Recent construction of a marina in this pond led to destruction of some of the mangrove habitat. The eastern portion of the pond is relatively undisturbed. A jetty has been built at the entrance, and a paved road leads to the area. Parts of the pond are good duck habitat.

VI-04 Coakley Bay: This undeveloped bay barrier has a good sand beach with landward mangrove habitat around a relatively large pond. Turtles nest on the beach. Seagrass beds and coral reefs lie offshore. There is an unpaved road to the area.

VI-05 Robin Bay: This undeveloped bay barrier on the south side

of St. Croix is characterized by a salt pond, a beach, and an impressive coral reef offshore. The pond is good shorebird habitat.

VI-06 Great Pond: This large brackish pond, with an outlet to the sea at its eastern end, has some of the best red and black mangrove stands remaining in the U.S. Virgin Islands. The stable beach barrier between the pond and the sea has typical beach strand vegetation. This area provides a feeding/roosting site for a variety of bird species. A barrier coral reef lies 1 km seaward of the island.

VI-07 Krause Lagoon: The central portion of this unit has been completely filled in conjunction with the development of one of the world's largest oil refineries, Hess Oil. It is also the site of the Martin Marietta Alumina plant. It qualifies as a coastal barrier only in its eastern and western portions where mangroves and mudflats provide good shorebird habitat. An offshore spoil bank was created following dredging of the navigational channels in the early 1970's.

VI-08 Long Point: This undeveloped unit has an intermittent beach and a mangrove lagoon with mud flats.

VI-09 Sandy Point: This National Wildlife Refuge is a nesting site for green, hawksbill, and leatherback sea turtles. It is also important habitat for migratory and resident bird populations which use the mangroves, beaches and inland salt pond as feeding and nesting areas. Extensive sand mining has occurred here.

VI-no # Salt River: Salt River is a mangrove-lined estuary with seagrass beds and impressive coral reefs offshore. The area is good habitat for several species of birds. A marina has been built in the mangroves in the western portion of the estuary.

ST. JOHN UNITS

VI-10 Cinnamon Bay: Cinnamon Bay is a large, protected bay with a National Park Service (NPS) campground occupying the lower portion of the surrounding watershed. Beach erosion alongshore, the subject of numerous investigations, is currently threatening to undermine an old Danish warehouse. Construction of a boulder wall to prohibit or decrease erosion has had the opposite effect. The beautiful white sand beach is a popular tourist attraction. Visitor damage to inshore reefs is evident but coral communities have also apparently been affected by sedimentation. Present coral cover is sparse with few areas of good development. Hawksbill sea turtles nest here.

VI-11 Maho Bay: This protected bay has a beautiful, privately owned beach and very little coral cover along either shore. Sparse seagrass beds here and in Francis Bay (see below) are heavily grazed by one of the largest green sea turtle populations in the U.S. Virgin Islands. The small, predominantly fresh-water pond at the bottom of the watershed is frequently flushed by storm runoff.

VI-12 Francis Bay: Francis Bay is a protected bay with a narrow sand beach on NPS land. Corals are sparse and mostly confined to small colonies on boulders just offshore. A large population of green sea turtles grazes on the sparse seagrasses on the bay bottom. Hawksbill sea turtles nest on the beach. The large associated salt pond is one of the best bird habitats within the U.S. Virgin Islands. Historic ruins and pre-Columbian Indian sites occur in the watershed.

VI-13 Leinster Bay: A small fringing reef occupies the western portion of Leinster Bay. Live coral cover is moderately high on the well-developed reef which protects the shoreward lagoonal seagrass bed and mangrove fringe. The area is an important nursery habitat for lobsters and fish. The lower portion of the watershed has dense tropical vegetation cover. Several historic ruins are present.

VI-14 Newfound Bay: This exposed bay has one of the most picturesque shallow reefs around St. John. The well-developed fringing reef forms a wave-barrier which dampens the effect of storm waves. The salt pond is relatively large and surrounded by mangroves. The privately-owned but undeveloped watershed is an undisturbed wildlife (particularly shorebird) habitat.

VI-15 Lagoon Point-Johnson Reef, Coral Bay: The lower reef zones of the well-developed fringing reef here have high coral cover. Shallower zones have sparse cover with few of the typical elkhorn coral colonies, many of which were destroyed during hurricanes David and Frederic in 1979. The reef protects the shallow inshore lagoon which has a sand bottom and seagrass cover which increases in abundance northerly into Johnson Bay. Mangroves fringe the shore. The surrounding, privately owned watersheds are undergoing rapid development.

VI-16 Salt Pond Bay-Drunk Bay-Ram Head: This undeveloped area lies within NPS boundaries. Diverse marine communities, coral reefs, seagrass beds, and algal plains, provide habitat for conchs and lobsters. The shallow salt pond is very saline and rock salt forms during long dry periods. This pond has long been used as a salt source. During wet seasons, it is an important

undisturbed wildlife habitat. Hawksbill sea turtles nest on Salt Pond Bay beach.

VI-17 Kiddle Bay: Kiddle Bay is a small protected bay with sparse coral and seagrass cover. The watershed is privately owned and slightly developed. The beach is sand and cobble.

VI-18 Grootpan Bay: This bay has impressive coral cover along its western shore. Seagrass is present in the central bay. The beach is coral rubble and cobble. An extensive salt pond provides an excellent undisturbed wildlife habitat, especially for wading birds and waterfowl such as Bahama ducks. The privately-owned watershed is mostly undeveloped.

VI-19 Great Lameshur Bay: The watershed of this bay is within NPS boundaries and essentially undeveloped. A small research station operated by the College of the Virgin Islands is located in the lower portion. Coral cover along both shores is high. (The Tektite underwater habitat was located off the southeastern shore, 1969-1972.) Dense seagrasses grow in the central portion of the bay. A small salt pond on the northeastern shore is usually hypersaline. A large red and black mangrove stand grows in the northwestern portion; it is good nesting habitat for the threatened White Crowned pigeon. Open to the bay, this area flushes with the tides. Birds and land crabs are abundant. The beach is primarily coral rubble with sparse sand.

VI-20 Europa Bay: This impressive, undeveloped watershed is within NPS boundaries. Several unique species of vegetation are fringing reef has sparse coral cover with the shallow zones exhibiting storm damage. Moderately dense seagrasses cover the

bay seaward of the reef. The beach is primarily coral rubble with sparse sand. Hawksbill sea turtles nest here occasionally.

VI-21 Reef Bay: Reef Bay is a large bay with a mostly undeveloped watershed, primarily within NPS boundaries. A small privately-owned portion of the western watershed is being developed, with almost complete devegetation at one construction site. Extensive fringing reefs occur along the eastern and western shores with excellent coral cover, although shallow zones show severe storm damage. Dense seagrasses grow in the lagoonal habitats landward and seaward of the reefs. The salt pond is atypical due to previous disturbances from sugar production. Ruins of the once extensive sugar plantation are present near the pond. The beach is sand and coral rubble. The sand beaches within Reef Bay are all excellent nesting habitat for hawksbill sea turtles.

VI-22 Fish Bay: Fish Bay has a rapidly developing watershed with only a small portion within NPS boundaries. The salt pond and at one time extensive mangroves on the eastern shore have been heavily altered by construction and currently provides little wildlife habitat. The beach is sand and coral rubble. The inner bay with sparse seagrasses is protected by fringing reef. The shallow coral zone has sparse coral cover which increases with depth.

VI-23 Chocolate Hole: This watershed has extensive residential development. The salt pond has received moderate impact, but development has decreased the value of wildlife habitat. The bay has sparse coral development along the shore. Dense seagrass grows throughout the bay. The beach is primarily sand with

sparse coral rubble.

VI-24 Great Cruz Bay: Great Cruz Bay has been extensively altered by dredging and filling along the inner shore. A resort corporation is currently building a large hotel. The upper portion of the watershed has moderate residential development. Coral and seagrass cover is very sparse. This area should be considered for deletion.

ST. THOMAS UNITS

VI-25 Sprat Bay: Sprat Bay is a shallow bay on Water Island, south of St. Thomas, with moderate coral development and seagrass cover. The salt pond across the peninsula is small but within an undeveloped watershed.

VI-26 South Limestone Bay: This stretch of shoreline protects a small salt pond on Water Island. The surrounding watershed is mostly undeveloped.

VI-27 Perseverance Bay: This bay on the south shore of St. Thomas has a large undeveloped watershed. The large salt pond has surrounding mangroves. The narrow sand beach is flanked by coral rubble beaches on either side. A well-developed fringing reef is present in the western portion, with slightly deeper reefs in the center and to the east. Dense seagrasses grow in the bay. Green sea turtles commonly graze in the inner bay.

VI-28 Magens Bay: Magens Bay is the largest bay on the northern side of St. Thomas. The watershed is developed primarily with residential housing. The long wide white sand beach is the most popular beach on the island. Coral development is sparse and most of the bottom is sand. A remnant coconut grove is behind the beach. The pond is hyposaline and surrounded by a high diversity of tropical vegetation. The area provides good wildlife habitat.

VI-29 Mandahl Bay: Mandahl Bay is a small, exposed bay with sparse coral development. The beach is coral rubble. A large salt pond to the east has been opened into the bay. A large boulder rampart was constructed on the eastern portion of the bay

to protect the pond entrance from waves. Flushing has altered the salt pond which still has high wildlife habitat value.

VI-30 Water Bay: Water Bay has been extensively dredged with fill placed inshore for resort construction. The small pond area on the southern shore has recently been surrounded by resort development. Seagrasses are sparse. This area should probably be deleted.

VI-31 Smith Bay: The slightly developed lower portion of the watershed has extensive tropical vegetation. The area provides good wildlife habitat. A well-developed fringing reef protects the inshore habitats. The inshore bay floor and beach is composed of white sand.

VI-32 Vessup Bay: The salt pond on the northeastern shore of Vessup Bay is within a slightly developed watershed. The narrow opening into the bay results in limited flushing. This area provides good wildlife habitat although limited by road disturbance.

VI-33 Red Hook-Great Bay: This area is presently under development. Coral growth is sparse. The bay still has good seagrass bottom and green sea turtles are frequently seen.

VI-34 Mangrove Lagoon-Benner Bay: The Mangrove Lagoon-Benner Bay system is the largest mangrove system on St. Thomas. Several mangrove-covered islands provide for a highly protected, shallow bay. The watershed is very developed, especially along the Benner Bay shoreline. Development within the eastern portion of the bay has resulted in loss of a small salt pond and several mangroves.

The mangrove lagoon to the west has been developed along its northern shore with construction of a racetrack by the territorial government. The island's "sanitary" landfill is located in the western portion. Although the inner portion of Mangrove Lagoon and Benner Bay are polluted and affected by development, the seaward portions have clear waters with extensive seagrass cover. This area is an extremely valuable wildlife habitat and wetlands/marine nursery. Coral development along the southern portion of Mangrove Lagoon provides protection from storm waves.

VI-35 Northeast Capella Island: This small island is undeveloped and owned by the territorial government. The eastern portion has good coral development which protects the shoreline. The small salt pond and surrounding area is excellent wildlife (shorebird) habitat.

Key to Summary Table

ID CODE NO. - Unit identification on maps.

State initials plus number identifies a new unit. Coastal Barrier Resources System unit (CBRS) is identified by legal code letter and number.

UNIT NAME - For new units, a provisional name based on a prominent local feature. For CBRS units, the legal name.

CONG. DIST. - U.S. Congressional District in which unit is located.

QUAD(S) - The U.S. Geological Survey Topographic Map(s) used to depict the unit.

STATUS - Ownership status in one of six categories:

PROTECTED - As defined in the CBRA areas, lands publicly or privately established for conservation purposes: i.e., Federal, State and local parks; wildlife refuges; recreation areas; private holdings, such as by The Nature Conservancy or Audubon Society;

UNPROTECTED - Public lands not held for conservation purposes, i.e., military lands;

PRIVATE - Lands privately owned with no conservation protection;

MIXED - Lands partially protected, with the balance private, unprotected or unknown;

UNKNOWN - Ownership of lands not known at this time;

CBRS UNIT - Approximate boundary of the legally defined CBRS unit. The map will indicate whether additions have been identified.

IDENTIFICATION INFORMATION SUMMARY FOR COASTAL BARRIERS IN PUERTO RICO

<u>ID Code</u>	<u>Unit Name</u>	<u>County/ Parish</u>	<u>Cong. Dist.</u>	<u>USGS Topographic Quadrangle(s)</u>	<u>Shoreline Length (in miles)</u>	<u>Acreage (in acres)</u>	<u>Status</u>
PR-01	ESPIRITU SANTO	MUNICIPIO RIO GRANDE		RIO GRANDE	1.25	430	MIXED
PR-02	ENSENADA COMEZON	MUNICIPIO RIO GRANDE		RIO GRANDE	3.11	1056	PROTECTED
PR-03	RIO MAMEYES	MUNICIPIO RIO GRANDE		RIO GRANDE	1.00	166	PRIVATE
PR-04	PUNTA LA BANDERA	MUNICIPIO LOQUILLO		FAJARDO	0.35	33	UNKNOWN
PR-05	LUQUILLO SPIT	MUNICIPIO LOQUILLO		FAJARDO	0.61	72	UNKNOWN
PR-06	JUAN MARTIN SPIT	MUNICIPIO LOQUILLO		FAJARDO	0.87	107	UNKNOWN
PR-07	LAGUNA AGUAS PRIETAS	MUNICIPIO FAJARDO		FAJARDO	1.81	415	MIXED
PR-08	CABO SAN JUAN	MUNICIPIO FAJARDO		FAJARDO CAYO ICACOS	0.60	127	PROTECTED
PR-09	RIO FAJARDO	MUNICIPIO FAJARDO		FAJARDO	1.35	229	PROTECTED

<u>ID Code</u>	<u>Unit Name</u>	<u>County/ Parish</u>	<u>Cong. Dist.</u>	<u>USGS Topographic Quadrangle(s)</u>	<u>Shoreline Length (in miles)</u>	<u>Acreage (in acres)</u>	<u>Status</u>
PR-10	PUNTA BARRANCAS	MUNICIPIO FAJARDO		FAJARDO	0.27	56	UNKNOWN
PR-11	PUNTA FIGUERAS	MUNICIPIO FAJARDO		FAJARDO NAGUABO PUNTA PUERCA	2.14	130	UNPROTECTED
PR-12	PLAYA FLAMENCO	MUNICIPIO CULEBRA		CULEBRA AND ADJACENT ISLANDS	0.83	135	MIXED
PR-13	PLAYA BRAVA	MUNICIPIO CULEBRA		CULEBRA AND ADJACENT ISLANDS	0.55	35	PROTECTED
PR-14	PLAYA LARGA	MUNICIPIO CULEBRA		CULEBRA AND ADJACENT ISLANDS	0.32	28	PROTECTED
PR-15	LAGUNA DE MOLINO	MUNICIPIO CULEBRA		CULEBRA AND ADJACENT ISLANDS	0.33	13	PROTECTED
PR-16	CULEBRITA TOMBOLO	MUNICIPIO CULEBRA		CULEBRA AND ADJACENT ISLANDS	0.49	25	PROTECTED
PR-17	PUERTO DEL MANGLAR	MUNICIPIO CULEBRA		CULEBRA AND ADJACENT ISLANDS	0.66	13	PROTECTED
PR-18	PUNTA ARENAS	MUNICIPIO VIEQUES		ISLAND OF VIEQUES	3.05	625	UNPROTECTED
PR-19	PLAYA GRANDE	MUNICIPIO VIEQUES		ISLAND OF VIEQUES	0.43	32	MIXED

<u>ID Code</u>	<u>Unit Name</u>	<u>County/ Parish</u>	<u>Cong. Dist.</u>	<u>USGS Topographic Quadrangle(s)</u>	<u>Shoreline Length (in miles)</u>	<u>Acreage (in acres)</u>	<u>Status</u>
PR-20	PUERTO NEGRO	MUNICIPIO VIEQUES		ISLAND OF VIEQUES	0.35	42	UNPROTECTED
PR-21	BAHIA PLAYA BLANCA	MUNICIPIO VIEQUES		ISLAND OF VIEQUES	0.22	22	UNPROTECTED
PR-22	LAGUNA ANONES	MUNICIPIO VIEQUES		ISLAND OF VIEQUES	0.20	61	UNPROTECTED
PR-23	ENSENADA HONDA	MUNICIPIO VIEQUES		ISLAND OF VIEQUES	1.09	160	UNPROTECTED
PR-24	LAGUNA YANUEL	MUNICIPIO VIEQUES		ISLAND OF VIEQUES	0.37	80	UNPROTECTED
PR-25	BAHIA DE LA CHIVA	MUNICIPIO VIEQUES		ISLAND OF VIEQUES	0.35	67	UNPROTECTED
PR-26	BAHIA TAPON	MUNICIPIO VIEQUES		ISLAND OF VIEQUES	0.22	58	UNPROTECTED
PR-27	PUERTO FERRO	MUNICIPIO VIEQUES		ISLAND OF VIEQUES	0.18	98	UNPROTECTED
PR-28	ENSENADA SOMBE	MUNICIPIO VIEQUES		ISLAND OF VIEQUES	0.41	147	MIXED
PR-29	CAYO DE TIERRA	MUNICIPIO VIEQUES		ISLAND OF VIEQUES	0.37	12	UNKNOWN
PR-30	LAGUNA PLAYA GRANDE	MUNICIPIO VIEQUES		ISLAND OF VIEQUES	0.90	142	UNPROTECTED

<u>ID Code</u>	<u>Unit Name</u>	<u>County/ Parish</u>	<u>Cong. Dist.</u>	<u>USGS Topographic Quadrangle(s)</u>	<u>Shoreline Length (in miles)</u>	<u>Acreage (in acres)</u>	<u>Status</u>
PR-31	MEDIO MUNDO	MUNICIPIO CEIBA		NAGUABO PUNTA PUERCA	3.02	1096	UNPROTECTED
PR-32	ISLA PINEROS	MUNICIPIO CEIBA		PUNTA PUERCA	0.85	58	UNPROTECTED
PR-33	ROOSEVELT ROADS	MUNICIPIO CEIBA		NAGUABO	1.34	160	UNPROTECTED
PR-34	PUNTA CASCAJO	MUNICIPIO CEIBA		NAGUABO	1.18	55	UNPROTECTED
PR-35	RIO DAGUAO	MUNICIPIO CEIBA		NAGUABO	1.25	448	UNPROTECTED
PR-36	BOSQUE ESTATAL DE CEIBA	MUNICIPIO NAGUABO		NAGUABO	2.18	371	PROTECTED
PR-37	PUNTA SANTIAGO	MUNICIPIO NAGUABO		NAGUABO HUMACAO	6.42	3037	MIXED
PR-38	PUNTA CANDELERO	MUNICIPIO HUMACAO		PUNTA GUYANES	1.18	268	PRIVATE
PR-39	PUERTO YABUCOA	MUNICIPIO YABUCOA		PUNTA GUYANES	0.56	43	UNKNOWN
PR-40	PUNTA TUNA	MUNICIPIO MAUNABO		PUNTA TUNA YABUCOA	0.55	42	UNKNOWN
PR-41	RIO MAUNABO	MUNICIPIO MAUNABO		PUNTA TUNA	0.87	51	UNKNOWN

<u>ID Code</u>	<u>Unit Name</u>	<u>County/ Parish</u>	<u>Cong. Dist.</u>	<u>USGS Topographic Quadrangle(s)</u>	<u>Shoreline Length (in miles)</u>	<u>Acreage (in acres)</u>	<u>Status</u>
PR-42	PUNTA VIENTO	MUNICIPIO PATILLAS		PUNTA TUNA	1.24	177	UNKNOWN
PR-43	LAS MAREAS	MUNICIPIO GUAYAMA		CENTRAL AGUIRRE	0.94	148	UNKNOWN
PR-44	BAHIA DE JOBOS	MUNICIPIO GUAYAMA		CENTRAL AGUIRRE	3.56	2010	MIXED
PR-45	MAR NEGRO	MUNICIPIO SALINAS		CENTRAL AGUIRRE SALINAS	4.10	2379	MIXED
PR-46	ARENAL	MUNICIPIO SALINAS		SALINAS	0.72	33	UNKNOWN
PR-47	PUNTA PETRONA	MUNICIPIO SANTA ISABEL		SANTA ISABEL SALINAS	5.07	801	MIXED
PR-48	RINCON KEYS	MUNICIPIO SANTA ISABEL		SANTA ISABEL SALINAS	1.54	49	UNKNOWN
PR-49	CAYO BERBERIA	MUNICIPIO SANTA ISABEL		SANTA ISABEL	1.10	80	PROTECTED
PR-50	CHARDON	MUNICIPIO SANTA ISABEL		SANTA ISABEL	0.32	11	UNKNOWN
PR-51	RIO DESCALABRADO	MUNICIPIO JUANA DIAZ		SANTA ISABEL	0.34	17	UNKNOWN
PR-52	PUNTA PASTILLO	MUNICIPIO JUANA DIAZ		SANTA ISABEL	0.42	56	UNKNOWN

<u>ID Code</u>	<u>Unit Name</u>	<u>County/ Parish</u>	<u>Cong. Dist.</u>	<u>USGS Topographic Quadrangle(s)</u>	<u>Shoreline Length (in miles)</u>	<u>Acreage (in acres)</u>	<u>Status</u>
PR-53	BAJO DE MAREA	MUNICIPIO JUANA DIAZ		PLAYA DE PONCE	0.35	17	UNKNOWN
PR-54	RIO JACAGUAS	MUNICIPIO PONCE		PLAYA DE PONCE	0.50	22	UNKNOWN
PR-55	CAYOS FRIOS	MUNICIPIO PONCE		PLAYA DE PONCE	0.45	10	UNKNOWN
PR-56	PUNTA CABULLON	MUNICIPIO PONCE		PLAYA DE PONCE	2.45	1093	UNKNOWN
PR-57	PUNTA CUCHARA	MUNICIPIO PONCE		PUNTA CUCHARA	1.95	340	MIXED
PR-58	TALLABOA KEYS	MUNICIPIO PENUELAS		PUNTA CUCHARA PUNTA VERRACO	2.11	125	UNKNOWN
PR-59	PUNTA BALLENA	MUNICIPIO YAUCO		GUANICA PUNTA VERRACO	3.16	284	MIXED
PR-60	PUNTA MESETA	MUNICIPIO GUANICA		GUANICA	1.10	22	PROTECTED
PR-61	ENSENADA LAS PARDAS	MUNICIPIO GUANICA		GUANICA	0.44	14	UNKNOWN
PR-62	PUNTA JOROBADO	MUNICIPIO GUANICA		GUANICA	0.42	11	PROTECTED

<u>ID Code</u>	<u>Unit Name</u>	<u>County/ Parish</u>	<u>Cong. Dist.</u>	<u>USGS Topographic Quadrangle(s)</u>	<u>Shoreline Length (in miles)</u>	<u>Acreage (in acres)</u>	<u>Status</u>
PR-63	CAYO DON LUIS	MUNICIPIO GUANICA		GUANICA	0.27	7	UNKNOWN
PR-64	BAHIA MONTALVA	MUNICIPIO GUANICA		PARGUERA GUANICA	4.39	110	MIXED
PR-65	MARGARITA	MUNICIPIO LAJAS		PARGUERA CABO ROJO	8.51	1489	PROTECTED
PR-66	CABO ROJO	MUNICIPIO CABO ROJO		CABO ROJO	9.45	1445	MIXED
PR-67	BAHIA DE BOQUERON	MUNICIPIO CABO ROJO		PUERTO REAL	5.43	1332	MIXED
PR-68	BOCA PRIETA	MUNICIPIO CABO ROJO		PUERTO REAL	0.23	22	UNKNOWN
PR-69	PUNTA CARENERO	MUNICIPIO CABO ROJO		PUERTO REAL	5.43	386	UNKNOWN
PR-70	BELVEDERE	MUNICIPIO CABO ROJO		PUERTO REAL	0.34	31	UNKNOWN
PR-71	GARITA	MUNICIPIO CABO ROJO		PUERTO REAL	0.82	90	UNKNOWN
PR-72	PUNTA GUANAJIBO	MUNICIPIO MAYAGUEZ		MAYAGUEZ	0.48	81	UNKNOWN
PR-73	CANO CORAZONES	MUNICIPIO MAYAGUEZ		MAYAGUEZ	0.33	187	UNKNOWN

<u>ID Code</u>	<u>Unit Name</u>	<u>County/ Parish</u>	<u>Cong. Dist.</u>	<u>USGS Topographic Quadrangle(s)</u>	<u>Shoreline Length (in miles)</u>	<u>Acreage (in acres)</u>	<u>Status</u>
PR-74	CANO BOQUILLA	MUNICIPIO MAYAGUEZ		R IN CON	0.71	144	UNKNOWN
PR-75	ESPINAR	MUNICIPIO AGUADILLA		AGUADILLA	0.83	91	UNKNOWN
PR-76	PUNTA AGUJEREADA	MUNICIPIO AGUADILLA		AGUADILLA ISABELA	0.62	97	UNKNOWN
PR-77	BAJURAS	MUNICIPIO ISABELA		ISABELA	0.47	67	UNKNOWN
PR-78	GUAYABOS	MUNICIPIO ISABELA		QUEBRADILLAS	0.46	33	UNKNOWN
PR-79	PENON BRUSI	MUNICIPIO CAMUY		CAMUY	0.60	72	UNKNOWN
PR-80	PUNTA MARACAYO	MUNICIPIO CAMUY		CAMUY	0.53	47	UNKNOWN
PR-81	PUERTO ARECIBO	MUNICIPIO ARECIBO		ARECIBO	0.51	76	UNKNOWN
PR-82	PUNTA MANATI	MUNICIPIO MANATI		BARCELONETA	0.30	26	UNKNOWN
PR-83	TORTUGUERO	MUNICIPIO MANATI		MANATI	1.48	1326	MIXED
PR-84	RIO CIBUCO	MUNICIPIO VEGA BAJA		MANATI	0.41	599	UNKNOWN

<u>ID Code</u>	<u>Unit Name</u>	<u>County/ Parish</u>	<u>Cong. Dist.</u>	<u>USGS Topographic Quadrangle(s)</u>	<u>Shoreline Length (in miles)</u>	<u>Acreage (in acres)</u>	<u>Status</u>
PR-85	RIO COCAL	MUNICIPIO TOA BAJA		BAYAMON	3.01	1417	UNKNOWN
PR-86	PUNTA SALINAS	MUNICIPIO TOA BAJA		BAYAMON	1.43	126	PROTECTED
PR-87	BOSQUE ESTATAL DE PINONES	MUNICIPIO CAROLINA		CAROLINA	6.74	7090	MIXED
Totals:					130.14	34335	

IDENTIFICATION INFORMATION SUMMARY FOR COASTAL BARRIERS IN UNITED STATES VIRGIN ISLANDS

<u>ID Code</u>	<u>Unit Name</u>	<u>County/ Parish</u>	<u>Cong. USGS Topographic Dist. Quadrangle(s)</u>	<u>Shoreline Length (in miles)</u>	<u>Acreage (in acres)</u>	<u>Status</u>
VI-01	RUST UP TWIST	MUNICIPALITY OF ST.CROIX	CHRISTIANSTED	0.26	31	UNKNOWN
VI-02	ALTONA LAGOON	MUNICIPALITY OF ST.CROIX	CHRISTIANSTED	1.21	230	UNKNOWN
VI-03	SOUTH GATE POND	MUNICIPALITY OF ST.CROIX	EAST POINT	0.86	11	UNKNOWN
VI-04	COAKLEY BAY	MUNICIPALITY OF ST.CROIX	EAST POINT	0.42	49	UNKNOWN
VI-05	ROBIN BAY	MUNICIPALITY OF ST.CROIX	EAST POINT	0.42	18	UNKNOWN
VI-06	GREAT POND	MUNICIPALITY OF ST.CROIX	EAST POINT	0.72	160	UNKNOWN
VI-07	KRAUSE LAGOON	MUNICIPALITY OF ST.CROIX	CHRISTIANSTED	3.72	701	PRIVATE
VI-08	LONG POINT	MUNICIPALITY OF ST.CROIX	FREDERIKSTED	0.53	41	PRIVATE
VI-09	SANDY POINT	MUNICIPALITY OF ST.CROIX	FREDERIKSTED	3.36	432	MIXED

Note: VI-01 through VI-09 are on Island of St. Croix;
 VI-10 through VI-24 are on Island of St. John;
 VI-25 through VI-35 are on Island of St. Thomas.

<u>ID Code</u>	<u>Unit Name</u>	<u>County/ Parish</u>	<u>Cong. Dist.</u>	<u>USGS Topographic Quadrangle(s)</u>	<u>Shoreline Length (in miles)</u>	<u>Acreage (in acres)</u>	<u>Status</u>
VI-10	CINNAMON BAY	MUNICIPALITY OF ST. JOHN		WESTERN ST. JOHN	0.25	14	PROTECTED
VI-11	MAHO BAY	MUNICIPALITY OF ST. JOHN		WESTERN ST. JOHN	0.08	8	PROTECTED
VI-12	MARY POINT	MUNICIPALITY OF ST. JOHN		WESTERN ST. JOHN	0.23	17	PROTECTED
VI-13	ANNABERG POINT	MUNICIPALITY OF ST. JOHN		WESTERN ST. JOHN	0.29	20	PROTECTED
VI-14	NEWFOUND BAY	MUNICIPALITY OF ST. JOHN		EASTERN ST. JOHN	0.24	12	PRIVATE
VI-15	LAGOON POINT	MUNICIPALITY OF ST. JOHN		WESTERN ST. JOHN	0.26	9	PRIVATE
VI-16	DRUNK BAY	MUNICIPALITY OF ST. JOHN		WESTERN ST. JOHN	0.26	24	PROTECTED
VI-17	KIDDEL BAY	MUNICIPALITY OF ST. JOHN		WESTERN ST. JOHN	0.10	4	PROTECTED
VI-18	GROOTPAN BAY	MUNICIPALITY OF ST. JOHN		WESTERN ST. JOHN	0.17	32	PROTECTED
VI-19	GREAT LAMESHUR BAY	MUNICIPALITY OF ST. JOHN		WESTERN ST. JOHN	0.26	20	PROTECTED
VI-20	EUROPA BAY	MUNICIPALITY OF ST. JOHN		WESTERN ST. JOHN	0.17	27	PROTECTED

<u>ID Code</u>	<u>Unit Name</u>	<u>County/ Parish</u>	<u>Cong. USGS Topographic Dist. Quadrangle(s)</u>	<u>Shoreline Length (in miles)</u>	<u>Acreage (in acres)</u>	<u>Status</u>
VI-21	REEF BAY	MUNICIPALITY OF ST. JOHN	WESTERN ST. JOHN	1.06	65	PROTECTED
VI-22	FISH BAY	MUNICIPALITY OF ST. JOHN	WESTERN ST. JOHN	0.37	38	MIXED
VI-23	CHOCOLATE HOLE	MUNICIPALITY OF ST. JOHN	WESTERN ST. JOHN	0.28	24	PRIVATE
VI-24	GREAT CRUZ BAY	MUNICIPALITY OF ST. JOHN	WESTERN ST. JOHN	0.46	21	UNKNOWN
VI-25	SPRAT POINT	MUNICIPALITY OF ST. JOHN	CENTRAL ST. THOMAS	0.40	22	UNKNOWN
VI-26	LIMESTONE BAY	MUNICIPALITY OF ST. JOHN	CENTRAL ST. THOMAS	0.15	8	UNKNOWN
VI-27	PERSEVERANCE	MUNICIPALITY OF ST. JOHN	CENTRAL ST. THOMAS	0.66	40	UNKNOWN
VI-28	ENIGHED	MUNICIPALITY OF ST. JOHN	CENTRAL ST. THOMAS	0.51	44	MIXED
VI-29	MANDAL BAY	MUNICIPALITY OF ST. JOHN	EASTERN ST. THOMAS	0.22	20	UNKNOWN
VI-30	WATER BAY	MUNICIPALITY OF ST. JOHN	EASTERN ST. THOMAS	0.42	14	UNKNOWN
VI-31	SMITH BAY	MUNICIPALITY OF ST. JOHN	EASTERN ST. THOMAS	0.73	50	UNKNOWN

<u>ID Code</u>	<u>Unit Name</u>	<u>County/ Parish</u>	<u>Cong. Dist.</u>	<u>USGS Topographic Quadrangle(s)</u>	<u>Shoreline Length (in miles)</u>	<u>Acreage (in acres)</u>	<u>Status</u>
VI-32	VES SUP BAY	MUNICIPALITY OF ST. JOHN		EASTERN ST. THOMAS	0.29	20	UNKNOWN
VI-33	GREAT BAY	MUNICIPALITY OF ST. JOHN		EASTERN ST. THOMAS	0.47	32	UNKNOWN
VI-34	JERSEY BAY	MUNICIPALITY OF ST. JOHN		EASTERN ST. THOMAS	2.49	137	UNKNOWN
VI-35	BUCK ISLAND	MUNICIPALITY OF ST. JOHN		EASTERN ST. THOMAS	0.07	3	PROTECTED
Totals:					22.39	2398	

An Ecological Examination of Coastal Barriers along the Islands

Coastal ecosystems in the U.S. Virgin Islands and Puerto Rico include coral reefs, beaches, seagrass beds, mangroves, and salt ponds (Figures 1, 2).

Mangroves

Mangroves are very productive ecosystems which support a high diversity of fish, birds, and other wildlife. The mangrove foodweb, based largely on the release of nutrients from the decomposition of mangrove leaves, supports nearshore fisheries. Mangroves are vital feeding, nesting and roosting areas for several species of birds including ospreys, pelicans, egrets, herons and ducks. Many of the species are rarely seen outside this habitat.

Red mangroves (Rhizophora mangle) grow along the shoreline often in monospecific stands. In well-developed forests, red mangroves form the seawardmost zone, and black (Avicennia germinans) and white (Laguncularia racemosa) mangroves grow behind the red mangroves. Off the south coast of Puerto Rico, there are mangrove islands with red mangroves near shore and black mangroves in the interior. Often a highly saline pond towards the cay's center will contain black mangroves which died when the salinity exceeded the tolerance of even this salt-resistant species. In places where channels to the sea exist, or where the berm is low enough that storm seas can break through to the inner forest, the salinity stays low enough that the black and white mangroves thrive.

Sand Beach - Grass Beds - Salt Pond - Reef Associations

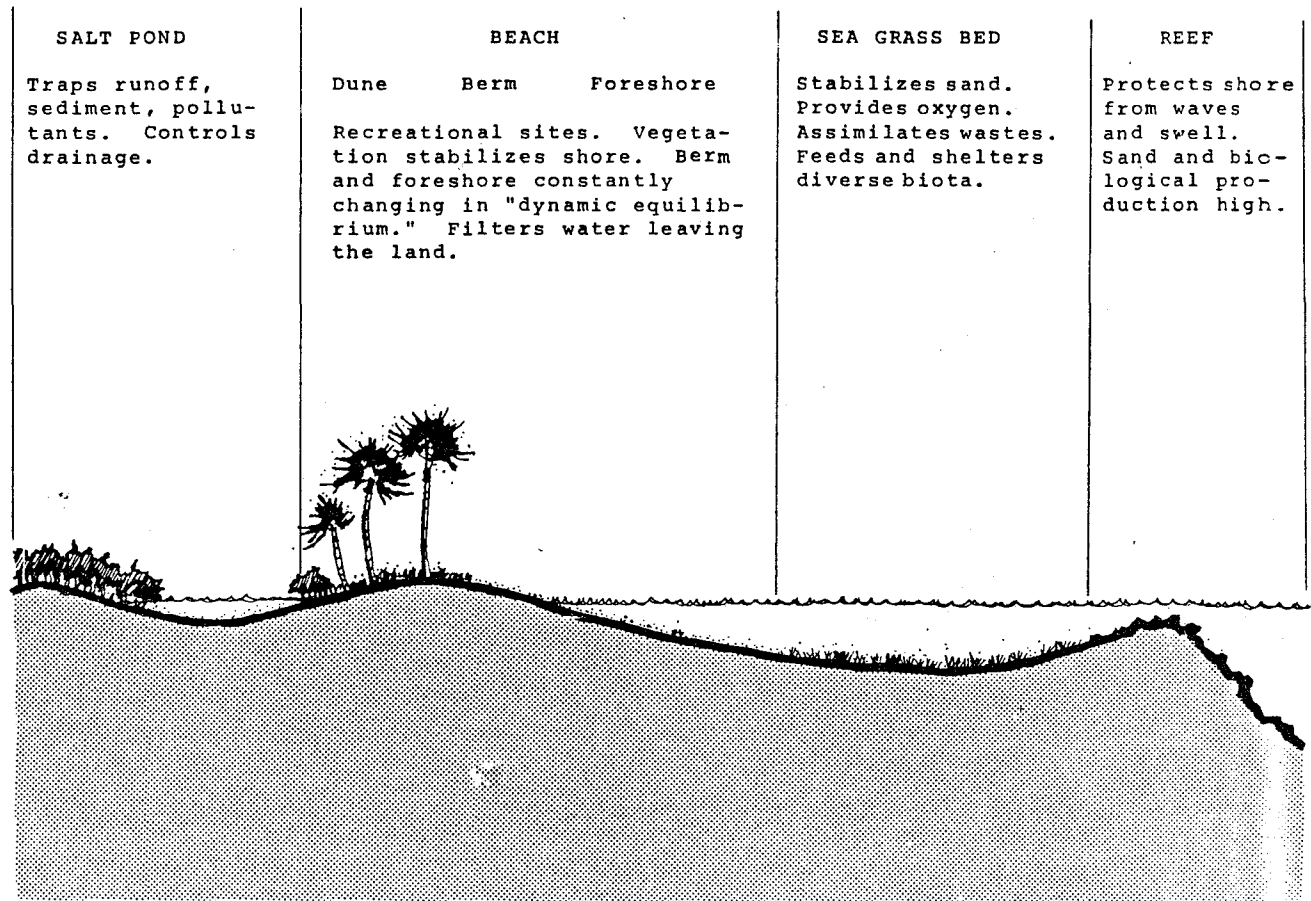


Figure 1. Typical sand beach ecosystem showing relationship of component habitats.
(From: Island Resources Foundation, 1977)

Mangrove – Lagoon – Reef Associations

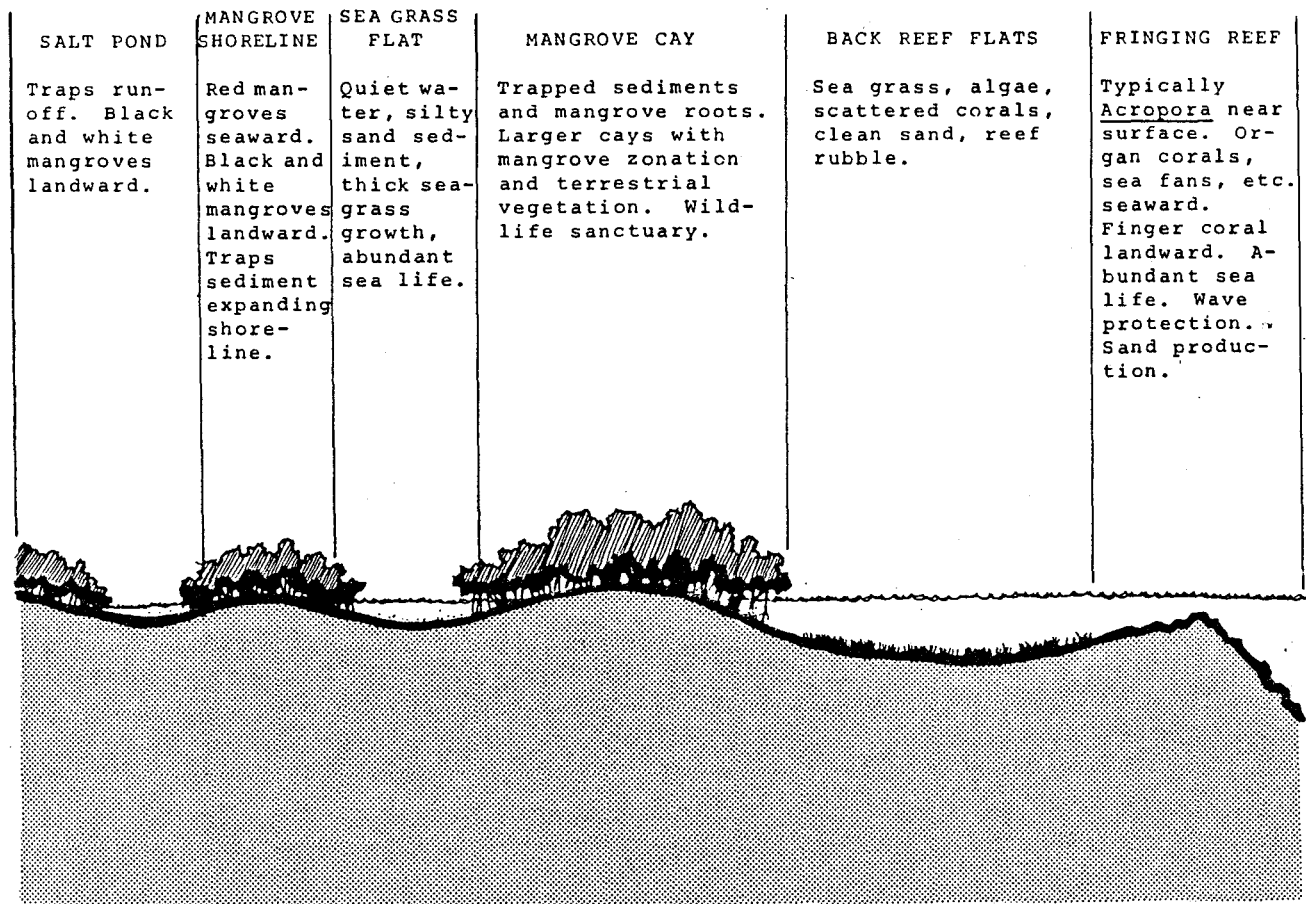


Figure 2 Mangrove dominated ecosystem with lagoonal flats and protective reef. Food chain centered on sea grasses and mangrove litter. (From Island Resources Foundation, 1977)

The red mangroves are the most distinctive of the three major tree species, with their characteristic aerial prop roots. These roots are usually partially submerged and support a diverse community of sponges, ascidians, algae and sometimes even corals. Juvenile reef and pelagic fishes as well as lobsters are abundant in these root communities. The roots also trap sediments and over a period of several years can extend the shoreline seaward. Mangroves can reduce the amount of runoff (and associated sewage and pollutants) which reaches offshore seagrass beds and coral reefs.

Salt Ponds

Most salt ponds are formed when mangroves or fringing coral reefs grow across a portion of a bay, isolating it from the waters in the rest of the bay. Coral rubble and sand transported by storm waves can contribute to the closing off of the pond. Beaches and salt ponds commonly occur together, and black and white mangroves frequently fringe the edges of the pond.

These ecosystems support a specialized biota which varies with fluctuations in salinity of the pond water. Several species of insect-eating and fish-eating birds including kingfishers, herons, ospreys, stilts, and sandpipers feed on insects, brine shrimp, and fishes in the ponds.

Rapid evaporation causes the water to be extremely saline, and salt crystals sometimes form along the shores of the pond. The most saline ponds will support a less diverse fauna than those ponds where storm waves have breached the berm creating channels where seawater of normal salinity rushes in, reducing the salinity. Barracudas, mullets, and crabs can be found in

ponds which are open to the sea.

Many salt ponds situated between an upland watershed and its associated bay function as settling or catchment basins, trapping the runoff from the land. Especially in areas where development of the watershed has occurred, the ponds reduce the amount of silt-laden water which reaches the bay, contributing to maintenance of high water quality in the bay.

Seagrass Beds

Seagrass beds are highly productive ecosystems which are extensive in the shallow waters around Puerto Rico and the U.S. Virgin Islands. In the Caribbean, turtle grass (Thalassia testudinum) and manatee grass (Syringodium filiforme) are the most abundant seagrass species. Seagrasses are true flowering plants but spread primarily through growth of roots and rhizomes. "Calcareous" algae such as Halimeda and Penicillus, which have calcium carbonate or limestone in their tissues, grow in the grass beds. Most beach sands are primarily composed of particles which arose from the decomposition and disintegration of these calcareous plants.

Several species of commercially important fishes, such as snappers and grunts, find shelter in coral reefs during the day and feed in the grass beds at night. Grass beds are the primary habitat for the commercially important queen conch (Strombus gigas) which feeds on the algae growing on the grass blades. The foodweb in grass beds is based both on direct herbivory (grazing) on grass blades and algae and on detritus from the decomposition of these plants. Conspicuous halos or bare sandy zones around coral patch reefs within grass beds are the product

of physical factors like currents but also grazing by fishes and sea urchins.

Dredging in grass beds, and boat anchors and propellers leave scars which can take years to recover. Grass beds support populations of the endangered green sea turtle (Chelonia mydas) and the West Indian manatee (Trichechus manatus). The extensive root system of seagrasses helps to stabilize the sediments and reduce erosion.

Coral Reefs

Coral reefs are exceptionally beautiful, and are the most productive and diverse of all marine ecosystems. They have economic value for recreation and tourism, and provide vital protection for harbors and shorelines because they dissipate wave energies and reduce erosion. The reef system is very complex. Reefs thrive in nutrient poor waters because of efficient cycling of nutrients within the ecosystem. The numerous holes and crevices in the reef's limestone structure provide shelter for fishes and crustaceans. Harvestable coral reef resources include fish, spiny lobsters, octopuses and conchs. Commercially important fishes associated with reefs include snappers, groupers, triggerfish, and grunts. Endangered hawksbill sea turtles live on the reefs. Breakdown of hard coral skeletons produces sand for beaches.

Beaches

The beautiful beaches in Puerto Rico and the U.S.V.I. are major tourist attractions. However, particularly in Puerto Rico, they have been mined extensively for construction sand. Reefs

and seagrass beds help to buffer wave energies and reduce shoreline erosion resulting in deposition of sand and formation of beaches. The protection provided by these ecosystems results in less severe erosion than is observed along the Atlantic coast of the United States.

Human Impacts

Industrialization and tourism have placed enormous demands on the coastal resources of Puerto Rico and the U.S. Virgin Islands. The population of the Virgin Islands has tripled in the last three decades to about 100,000, and Puerto Rico has over 3.2 million people living in an area of 3435 sq. mi. The pressures on the coastal barriers are evident as marinas, hotels, and condominiums continue to be built.

One of the largest mangrove systems in the U.S. Virgin Islands, on the south side of St. Croix, was filled to make way for an alumina plant and for Hess Oil Refinery, one of the largest refineries in the western hemisphere. Shipping channels were dredged through a coral reef to accommodate super tankers and bulk ore carrier ships. Efforts to reestablish mangroves by planting seedlings in some marginal areas have been relatively successful, but the new "forest" is only a small fraction of what the old one was.

Clearing mangroves has altered drainage patterns in several locations leading to increased amounts of runoff from the land entering the bays. Mangroves have historically been thought of as insect-infested swamps with few redeeming characteristics. Consequently, they have been cleared and filled with no regard

for their ecological values and frequently used as garbage dumps. One of the largest remaining well-developed forests in the U.S. Virgin Islands, Jersey Bay ("Mangrove Lagoon") in St. Thomas, has deteriorated significantly because of upland development. Increased turbidity from runoff, sewage input from a sewage treatment plant, dredging, and the construction of several marinas have all contributed to the decline of the bay.

The steep slopes on these islands promote rapid runoff, and the soils do not have much moisture-holding capacity. Where watersheds have been extensively developed, the associated bays have siltation problems. Clearing upland vegetation on the steep hillsides has accelerated erosion and led to increased runoff. Coral reefs have suffered from the resulting turbidity. Sediment particles smother the reef organisms and reduce the amount of light necessary for photosynthesis and production of oxygen. Silt from dredging operations can continue to be resuspended for years even after dredging ceases. These sediments can inhibit coral recruitment and growth.

Several bays have been dredged for construction sand. Seagrass beds have not re-established themselves in some of these areas. For example, the dredged area in Lindberg Bay, St. Thomas, remains barren although dredging took place over 40 years ago. Aerial photographs over recent years indicate that seagrass beds have decreased in area in several bays. In some cases, the decrease seems to be associated with thermal-saline effluent from desalination plants. Seagrasses have also suffered from anchor and propeller damage.

Beaches have been mined for sand, particularly in Puerto Rico but also in the U.S.V.I. An estimated 2.2 million cubic yards of sand have been removed from Christiansted Harbor, St. Croix, alone. Legislation passed in 1973 was intended to put a stop to mining of beaches and nearshore areas, although it hasn't completely done so. Groins and other retaining structures have been built in attempts to trap sand for particular beaches, usually resulting in erosion problems in other areas. Hotels and condominiums have sprung up along large stretches of the coastline.

Filling of salt ponds has destroyed their function as catchment basins for runoff. The associated aquatic habitats, important as roosting and feeding areas for a variety of birds, have been destroyed.

Heavy metals, pesticides, and other chemicals associated with petrochemical complexes, shipyards and factories have had a largely unknown effect on coastal areas. Oil spills have resulted in the death of some mangroves in Puerto Rico.

Some activities, like dredging, actually remove the physical structure of a coral reef while others, such as release of sewage into overlying waters, can lead to death of reef organisms but leave the physical framework unimpaired.

Sewage and fertilizers stimulate the growth of marine algae which can outcompete and overgrow corals. Collection of corals, fish and shells for souvenirs and scientific purposes has caused localized damage.

Overfishing and habitat destruction have led to serious depletion of lobsters, conchs, and whelks and several species of

fishes (especially the yellowtail snapper and Nassau grouper). The Caribbean Fishery Management Council has developed management plans for reef fishes and the spiny lobster in Puerto Rico and the U.S. Virgin Islands.

Interactions of Coral Reefs, Seagrass Beds, and Mangroves

Coral reefs, seagrass beds, and mangroves interact in numerous ways, and one system cannot be managed in isolation from the others. Cutting mangroves which trap sediments can result in excessive siltation for nearby seagrass beds and coral reefs from runoff after heavy rains. Runoff will be especially severe where there has been coastal development or agriculture. Destruction of red mangroves with submerged prop roots decreases the habitat available for juvenile fishes which inhabit reefs and grass beds when mature.

It is well-documented that some species of fishes migrate from coral reefs to grass beds every night and return in the morning. The seagrass beds are therefore subsidizing the reefs in terms of energy flow. In addition to these short-term feeding migrations, there are life-history migrations between ecosystems. For example, juvenile lobsters settle in seagrasses and mangrove prop roots and move out to the coral reefs as they mature. Seagrass blades (particularly those of Syringodium) float for several days after detachment by rough seas or by grazing animals such as parrotfishes and sea turtles. They drift in open water over reefs and grass beds and decompose to become an important source of nutrients for the communities below. The dissolved nutrients from mangrove detritus enhance the productivity of

seagrasses. The links between seagrass beds, mangroves, and coral reefs have only recently begun to receive much needed attention.

Fish and Wildlife Values of Coastal Barriers in Puerto Rico and the U.S.V.I.

The major coastal ecosystems - beaches, mangroves, seagrass beds, and coral reefs - all occur in Puerto Rico and the U.S.V.I. Differences among the islands, and between one section of an island and another, consequently depend primarily on differences in the location of these ecosystems, their size, and stage of development.

Mangroves, for example, are best-developed in Puerto Rico where, unlike the U.S.V.I., there are major rivers and streams. There is a higher diversity and abundance of animal species associated with the mangroves in Puerto Rico.

There is evidence that the northern coast of Puerto Rico produces a lower harvest of commercially important fish than the east, west and south coasts (Univ. of Puerto Rico, 1976). High wave energies and large river discharges along the northern coast have inhibited reef development there. Also, mangroves are primarily associated with the eastern, western and southwestern coastal areas of Puerto Rico.

In the U.S.V.I., the most extensive reef development exists as a barrier along the southern coast of St. Croix where the submarine shelf is especially wide and shallow. Reefs around St. Thomas and St. John are primarily smaller, fringing reefs.

Puerto Rico is a large island, with an area of 3,435 sq mi compared to a combined area of 133 sq mi for the U.S.V.I., and has a greater diversity of habitats. It is not surprising that more of the endangered and threatened species occur in Puerto Rico (Table F-1).

The West Indian manatee is found near Vieques Island (Puerto Rico) and off the shores of the main island. Leatherback turtles nest most abundantly on beaches in St. Croix and Culebra (Puerto Rico). Green turtles are commonly observed within the protected waters of Virgin Islands National Park on St. John.

Table F-1. Species of special emphasis and endangered and threatened species and their occurrence within the coastal barriers of Puerto Rico and the U.S.V.I.

<u>BIRDS</u>	<u>Puerto Rico</u>	<u>St. Thomas</u>	<u>St. John</u>	<u>St. Croix</u>	<u>Endangered/Threatened *</u>
Least grebe	x	x	x		LE
Red-billed tropicbird	x	x	x		LE
White-tailed tropicbird	x	x	x	x	LE
Brown pelican	x	x	x	x	E
Blue-faced booby	x	x			
Red-footed booby	x	x			LE
Magnificent frigatebird	x	x	x	x	LE
Great blue heron	x	x	x	x	LE
Great egret	x	x	x	x	LE
Snowy egret	x	x	x	x	LE
Black-crowned night heron	x		x	x	LE
Least bittern	x				LE
Glossy ibis	x				LE
West Indian whistling duck	x				LE
Bahama duck	x	x	x	x	
American wigeon	x	x	x	x	LE
Northern pintail	x				LE
Ring-necked duck	x		x		LE
Masked duck	x				LE
Ruddy duck	x	x			LE
Osprey	x	x			LE
Peregrine falcon	x		x	x	E
Clapper rail	x	x	x	x	LE
Purple gallinule	x				LE
Caribbean coot	x	x	x	x	LE
Piping plover	x				
Snowy plover	x			x	LE
Willet	x	x	x	x	LE
Short-billed dowitcher	x	x	x	x	LT
Common tern	x	x			LT
Roseate tern	x	x	x		LE
Least tern	x	x	x	x	E
Royal tern	x	x	x	x	LT
Sandwich tern	x				LT
White-crowned pigeon	x	x	x	x	LT
Plain pigeon	x				LE
Key West quail dove	x				LT
Bridled quail dove		x	x	x	LT
Puerto Rican parrot	x				E

*Note: E=on federal endangered species list; T=on federal threatened species list; LE,LT=considered locally endangered or locally threatened

<u>REPTILES</u>	<u>Puerto Rico</u>	<u>St. Thomas</u>	<u>St. John</u>	<u>St. Croix</u>	<u>Endangered/Threatened</u>
Green sea turtle	x	x	x	x	T
Hawksbill	x	x	x	x	E
Loggerhead	x				T
Leatherback	x	x	x	x	E
Common iguana		x	x	x	
St. Croix ground lizard				x	E
Blue-tailed ground lizard	x				
Slipperyback skink	x	x			
Puerto Rican tree boa	x				E
Tree boa	x	x			T
Ground snake	x	x			

MAMMALS

Fisherman bat	x	x	x	x	
Red fruit bat	x	x	x		
Sperm whale	x	x			E
Humpback whale	x	x	x	x	E
West Indian manatee	x				E

Note: Sources for this table include: 1) Puerto Rico Coastal Atlas, 1984
2) Philobosian and Yntema, 1977
3) Norton, (no date)
4) Slayden, pers. comm.

PUERTO RICO REGULATIONS

Coastal Resource Management

The Coastal Zone Management Program in Puerto Rico was approved in 1978 with the Department of Natural Resources as the lead agency. Prior to approval of this program, several Commonwealth and Federal programs already addressed many of the problems of Puerto Rico's coastal resources. The Coastal Zone Management Program extended and improved these programs. The following Commonwealth agencies have responsibility for guiding development:

Department of Natural Resources - responsible for conservation of natural resources (water, wildlife, fisheries).

Puerto Rico Planning Board - guides land use and integrates the programs of Commonwealth agencies.

Regulations and Permits Administration - handles building and use permits.

Environmental Quality Board - establishes environmental policy and pollution control standards, also processes environmental impact statements.

The Coastal Zone Management Program in Puerto Rico established a Coastal Management Unit in the Department of Natural Resources (DNR). This unit has primary responsibility for preparing policies and plans for Special Planning Areas and Nature Reserves and recommends additional areas in these categories. All plans and recommendations go through the Secretary of Natural Resources who submits them to the Planning

Board for incorporation in the Board's Land Use Plan. The unit also assists the Secretary of Natural Resources in review of development proposals.

Regulation of Puerto Rico's coastal resources is an unusual combination of existing Spanish common law statutes enacted during Spain's dominion over the island until 1898, federal legislation and regulations, and Commonwealth laws, largely enacted in the past ten years. Since the island is only about 35 by 100 miles in size, its coastal environments have long been the focal point of industrial, maritime, urban, military and commercial activities. As such, they have suffered proportionally to their accessibility. Coastal habitats were first extensively modified for plantation agriculture (especially the clearing of mangroves for sugar cane production), then for industrial development following the introduction of Operation Bootstrap in the late 1940's, and finally for residential expansion as Puerto Rico's population increased.

Regulations pertinent to the management of coastal barriers include the following:

Commonwealth Law 23, Articles 5-8, June 20, 1972, Organic Act of the Department of Natural Resources. This act authorizes the Secretary of DNR to formulate regulations for the conservation and preservation of forests, plants, and animals; to acquire lands and aquatic habitat for these purposes, especially for the protection of endangered species; to maintain and construct facilities for recreation in these areas; and to regulate off-road vehicles. The law also guarantees public participation in such processes administered by the department. An amendment in

1975 refined DNR's responsibilities and its status vis-a-vis the Environmental Quality Board concentrating most environmental regulatory activity in DNR. Another amendment in 1983 refined public participation, penalties, and responsibilities.

Law 9, Law for Environmental Public Policy approved June 18, 1970, amended May 31, 1973. Law 9 established a public policy for the conservation of the environment and the Commonwealth's natural resources. It also established the Environmental Quality Board and defined its authority pursuant to Articles 4-6 of Law 158 of June 28, 1968.

Ports Law, amending the Spanish Ports Law of 1880, effective in Puerto Rico in 1886 by Royal decree. This law established dominion over ports, coastal lands and waters; established beaches and intidal waters as public (as well as rivers used as ports and near-shore waters); provided for free access to the sea; regulated anchorages and beach use; and classified ports and provided for their regulation by either the Governor General of the island or the Spanish Overseas Ministry (based in Spain). Section 8a established the authority to patrol and enforce these regulations.

Law 136, the Water Law. The water law declared all waters public. It obligated DNR to plan for and to regulate their use, conservation, and development; established penalties; and established the rights and responsibilities of the Authority of Aqueducts and Sewer Sytems (AAA locally) and the Authority for Aquifers (Autoridad de las Fuentes Fluviales), as well as the

Environmental Quality Board and the Puerto Rico Planning Board. DNR jurisdiction includes all mangroves, subterranean waters, lakes, standing waters, and coastal waters. All are to be regulated for the people of Puerto Rico.

Law for the Prevention of Flooding and the Conservation of Beaches and Rivers. This law transferred responsibility for beaches and rivers from the Department of Public Works to DNR and provided for control of floodable areas and the extracation of gravel and sand and conservation of beaches. It also defined a terrestrial coastal zone and provided for the protection and monitoring of all of the island's mangroves. It was amended, largely for consolidation of responsibility in DNR, in June 1972, July 1973, and again in 1975.

Law 3, the Fishing Law of February 25, 1977. Law 3 amended section 4 of Law 83 of May 13, 1936, Fishing Law of Puerto Rico, to conform with federal management and jurisdiction and International Law. It extended jurisdiction 12 nautical miles out from the island. Further, it established the responsibility for regulation of fishing with DNR.

DNR Regulations Chapter 3, Subchapter 45, Regulation of Fishing. DNR requires a permit in writing from the Secretary of Agriculture and Commerce for a company or corporation before it will permit the construction of dikes or other obstacles that prevent the free passage of fish. DNR also limits the daily catches, mode of fishing and equipment used, and the sale of fish.

Law 144. This law amends Law 132 of June 25, 1968, thereby expanding and further refining the jurisdiction of DNR to regulate public viewsheds, especially their excavation or similar disruption. It also created a public fund for DNR activities.

Puerto Rico Forest Act, No 133, July 1, 1975. This act provided for the creation and regulation of Commonwealth Forests; delineated unlawful acts in Commonwealth Forests, and established all Commonwealth Forests as refuges for wildlife. It also created a Puerto Rico Forest Service and specified its responsibilities.

DNR Regulations to Control the Extraction, Possession, Transportation, and Sale of Coral Resources in Puerto Rico, October 11, 1979. Under authority conferred to it by the Organic Act of 1972 and the Fishing Law of 1936 and its amendments, DNR adopted regulations for the protection of coral resources in the Commonwealth.

Law 82 of July 7, 1979. This law created a Corporation for the Development and Administration of Marine, Lake, and Flowing Water Resources within the DNR. It recognized Puerto Rico's dependence on marine resources for food and development and put regulations on commercial and industrial activities in coastal zones.

DNR bylaws to Regulate the Extraction of Materials from the Earth's Crust (Mining Law). This law regulated the granting of permits for the extraction, excavation, removal and dredging of sand, gravel, stone, clay or other such components not regulated

as economic minerals, on both public and private lands in Puerto Rico. Article 10 recognized deposits of special public interest and defined and regulated them.

Law 145, 1975. This law created a Corporation for the Development of the Mineral Resources of Puerto Rico. It gave the corporation the financial capacity and operational ability to develop the mineral resources of the Commonwealth, subject to the Organic Law for DNR and the Mining Law.

Law 86, July 6, 1985, Off-Road Vehicles Law: An addition to Law 141 of July 20, 1960, Law of Vehicles and Transit in Puerto Rico, which prohibits the use of off-road vehicles of all kinds on public lands and beaches of Puerto Rico.

Law 66, June 22, 1975.

This license permits the use of these lands for conservation, and proposed recreation areas on five parcels on the island totaling 1566 cuerdas (one cuerda is roughly one acre).

License for the Use of Federal Lands, August 27, 1976. This agreement between DNR, the Commonwealth, and the Navy defined the use of federal lands in 12 parcels.

U.S. Navy Lands: All federal lands are exempt from the CZM program regulations. However, Navy lands at Roosevelt Roads Naval Station on the east tip of Puerto Rico, and on Vieques, are unlikely to have significant further development without considerable effort expended in securing appropriate permits, especially in mangroves and wetlands under their control.

Memorandum of Understanding Regarding the Island of Vieques, October 11, 1983, between the U.S. Department of the Navy and Commonwealth of Puerto Rico. This agreement established a forestry program on Navy lands; provided for continual consultation with DNR on use of its lands for economic purposes and on wildlife habitat requirements; established seven lagoonal or mangrove conservation zones; provided for sea turtle, sea mammal, and brown pelican management; agreed to continue a cultural resources preservation program, and established a Management Advisory Committee to assist the Navy in managing natural resources on the island, with representatives from DNR, Navy, USFWS, and USFS.

Planning Board Regulation 16, Adoption and Regulation of Zones of Tourism Interest, March 30, 1979. This regulation provided for the development and regulation of areas of interest for tourism purposes. It established and classified zones in these areas and provided for their regulation and administration.

Planning Board Regulations for Special Planning Areas. The Bajura Isabela Special Planning Area was delineated in regulations in January 1980. The Planning Board regulates the sand dunes of Jacinto, the mangroves, beaches, and other coastal resources that are not protected by other legislation or are in need of special planning activities because of their exposure to development pressures.

Law 70, Wildlife Law, May 30, 1976. Law 70 regulated the

conservation of wildlife, native and migratory birds and animals, and the introduction of other species in Puerto Rico. It also authorized DNR to develop regulations for hunting.

DNR Regulations for Management of Wildlife and Hunting, May 17, 1978. These regulations enumerate dove and pigeon species and waterfowl that can be hunted, and endangered species that cannot. It also lists mangrove forests and lakes where hunting is prohibited (many of which are DNR lands).

DNR Regulations for the Use, Management, and Administration of Recreation Areas under the Jurisdiction of DNR, April 29, 1980. DNR adopted regulations for its recreation areas.

Natural Reserves: The Natural Reserve Program began in 1976 in CZM, and through it the Planning Board has designated 26 potential reserves, of which about seven have been formally put into place. At present, these Reserves have no legal protective status, and exist largely as planning mechanisms.

Local Actions

Municipalities have no powers to zone their lands or to introduce land use controls. This power is reserved for the Commonwealth and is exercised by the Planning Board. For planning purposes, the coastal zone (as defined by the CZM program) extends .62 miles inland and three miles out to sea. The CZM office in Puerto Rico is largely funded by the federal program, and is located within the offices of DNR in San Juan.

Federal Law Specific to Puerto Rico

U.S. Public Law 96205, March 1980: Extends jurisdiction of the Commonwealth out to three marine leagues (10.3 miles). Two bills are currently being considered in Congress to address coastal zone extensions from 10.3 to 12 miles.

Jacobs Bay National Estuarine Sanctuary: Administered by NOAA and DNR jointly, this is currently the only such Estuarine Sanctuary in Puerto Rico. It was established to afford federal protection to a bay undergoing considerable development, yet offering exceptional natural resources.

U.S. VIRGIN ISLANDS REGULATIONS

Coastal Resource Management

In 1917, Denmark ceded the Virgin Islands to the United States along with all Danish governmental interests in submerged lands (lands below the mean high tide line). Under the Organic Act of 1936 and the Revised Organic Act of 1954 which provide the framework for the operation of the Virgin Islands government, the territorial government has jurisdiction over federal lands, including submerged and tidelands, but no authority to sell these lands.

Territorial control over these lands was expanded with the Territorial Submerged Lands Act of 1974. Together these Acts authorized the Secretary of the Interior to transfer federal interests in submerged and other lands to the Virgin Islands upon the Governor's request and effectively conveyed all federal right, title, and interest to territorial submerged lands with certain restrictions.

The Department of Conservation and Cultural Affairs (DCCA) is the central territorial agency for administration of coastal zone management. Other principal entities include the Governor, Legislature, Planning Office, Department of Public Works and the Board of Land Use Appeals. The Coastal Zone Management Act of 1978 became effective in 1979. The Coastal Zone Management Program was prepared by the Virgin Islands Planning Office for the management of the coastal zone of the Virgin Islands and submitted by the Governor to the U.S. Department of Commerce, pursuant to the Federal Coastal Zone Management Act of 1972.

The Coastal Land and Water Use Plan is the comprehensive plan for the development of the first tier of the Coastal Zone. It is to serve as a guideline for making decisions related to development within this tier. The first tier is defined as the area extending from the outer limit of the territorial sea (including offshore islands) to distances inland as indicated on a set of maps. The second tier includes interior portions of the three islands including all areas not in the first tier.

The Coastal Zone Management Act created a Coastal Zone Management Commission within DCCA. There are three committies within the Commission, one for each major island. Each committee has authority over the issuance of Coastal Zone Permits. A Division of Coastal Zone Management was also created within DCCA to assist the Commission and the Commissioner in administration and enforcement of the Act. The Act defines major and minor coastal permits.

After completion of a major permit application, the Commissioner submits a copy to relevant public agencies for review and schedules a public hearing. Within 30 days of the hearing, the appropriate committee acts upon the application. Appeals of committee decisions can be filed with the Board of Land Use Appeals. The Board of Land Use Appeals must hold a public hearing on an appeal and then render a decision. Minor permit applications are acted upon by the Commissioner.

Within 30 days of approval by the Commissioner or the appropriate Committee, coastal zone permits that include development or occupancy of trust lands or other submerged or filled lands are forwarded to the Governor for approval or

disapproval. The Governor's approval must be ratified by the Legislature of the Virgin Islands.

Water Pollution Control Act, Act 1979, (1967). This Act provides the territorial authority to implement the Federal Water Pollution Control Act, establishing standards for water quality and pollutant discharge into Virgin Islands waters. The term "pollutant" refers to a variety of materials including rock, sand and dredged spoils. The Act as amended only regulates point sources of pollution. DCCA administers the Act through a permit system which requires a public hearing and determination by the Commissioner that all water quality standards are met. The Commissioner is to cooperate with the Virgin Islands Planning Board on zoning of waters.

Under the Federal Act, the Army Corps of Engineers (ACE) with the Environmental Protection Agency has regulatory authority over discharge of pollutants into navigable waters. Permits cannot be issued unless specified standards are met. The Secretary of the Army, acting through the Chief of the Army Corps, issues permits for the discharge of dredged or fill material.

All development in tidelands, coastal wetlands, swamps and lagoons are subject to review. Consequently, the Army Corps has independent review and determination over dredging and filling of all Virgin Islands coastal waters.

Open Shorelines Act, Act 3063, (1971). This act constituted a critical element for implementation of the Coastal Zone

Management Program by establishing a legal basis for public use of shorelines. Shorelines are defined as the area between the low tide level inland to a line of natural vegetation, a natural barrier, or a distance of 50 feet, whichever is shortest. The Act is intended to regulate extraction of natural products, including sand and marine life, with the exception of fish and wildlife. The DCCA Commissioner administers a permit program for taking all specified resources.

Earth Change Law, Act 2967, (1971). This Act created an environmental protection program for the Virgin Islands to control soil erosion and restrict environmentally damaging land alterations within entire watersheds. Earth Change Permits are issued after approval by the Virgin Islands Water and Soil Conservation District or DCCA. The Commissioner of Public Works is to enforce the Act.

Trustlands, Occupancy and Alteration Control Act, Act 3667, (1975). Along with the Open Shorelines Act and the Earth Change Act, this provides the territorial authority over the development and alteration of the Virgin Islands coastal zone, including dredging and mining of sand and coral from the shoreline. The DCCA Commissioner administers the permit system. An environmental assessment of the site or proposed development is required, and the Governor, Legislature, and Army Corps of Engineers must approve the work. A permit from the ACE is required after the applicant receives a permit from the territorial government.

Oil Spill Prevention and Pollution Control Act and Regulations, Act 3538, (1974). The objectives of the Act include 1) preservation of Virgin Islands waters and shorelines for recreation and 2) protection of environmental resources. The Act established a program to regulate the production and transport of pollutants as well as contingency plans to control the effects of pollution discharges and the cleanup of discharges. All discharges are to be reported to the U.S. Coast Guard and DCCA. The Governor has emergency powers under this act.

Zoning Law, Act 3284., (1972). This law is an important element in the system of land use and environmental regulations in the Virgin Islands. It established 17 separate zoning districts ranging from agricultural, residential, commercial, industrial and waterfront to public use classifications. Passed prior to the Coastal Zone Act, it fails to specify adequate criteria for development of the coastal zone. The Virgin Island Planning Office submits reviews of applications to the zoning administration who is the Commissioner of DCCA.

Federal Law Specific to the Virgin Islands

Any project involving potential impacts on coastal waters must be reviewed by several federal agencies. All wetlands in the Virgin Islands lie in Tier One of the Coastal Zone. Accordingly, permits must be obtained from the U.S. Army Corps of Engineers. Projects must be reported to National Marine Fisheries Service and U.S. Fish and Wildlife Service, as well as the Coastal Zone Management division of the Division of Conservation and Cultural Affairs.

The Army Corps of Engineers and the Department of Conservation and Cultural Affairs have developed a joint permit application form for use in regard to projects requiring both agencies to issue permits for work in the waters of the United States and fills affecting wetlands.

If a given proposal potentially endangers or threatens a protected species, notification must be made jointly to U.S. Fish and Wildlife Service, National Marine Fisheries Service and Virgin Islands Division of Fish and Wildlife.

The local Division of Fish and Wildlife, in the Department of Conservation and Cultural Affairs, serves as a representative of the U.S. Fish and Wildlife Service. These agencies work together under a Memorandum of Agreement for Endangered Species.

At the present time, there are two areas in the Virgin Islands that have been classified as National Wildlife Refuges:

1. Sandy Point, St. Croix. This beach area is used by leatherback turtles for nesting and was recently designated a National Wildlife Refuge to provide protection for this endangered species.

2. Green Cay, St. Croix. This is a small island Northeast of Christiansted. It is one of the last remaining habitats for the endangered lizard Ameiva polops.

The National Park Service has concurrent jurisdiction with the Virgin Islands government on federally owned land areas of the Virgin Islands National Park on St. John. Offshore water areas within the park are under the jurisdiction of the Park Service, Corps of Engineers, Virgin Islands government, and U.S. Coast Guard. Acts of the Virgin Islands government and the U.S. Code of Federal Regulations apply to lands and waters of the National Park. The Virgin Islands government has jurisdiction over the enforcement of traffic regulations on roads in the park. It retains rights-of-way for all dedicated roads, as defined by an official map that includes tracks now reverted to trails or completely overgrown.

The territorial government exerts control over lands and activities on St. John through public health and safety laws. It also has legislation providing for the protection of water resources, wildlife, and the environment. The National Park Service cooperates with the territorial government in these matters.

Zoning regulations of the territorial government were approved August 8, 1972. They permit residential development on mostly privately owned park lands.

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