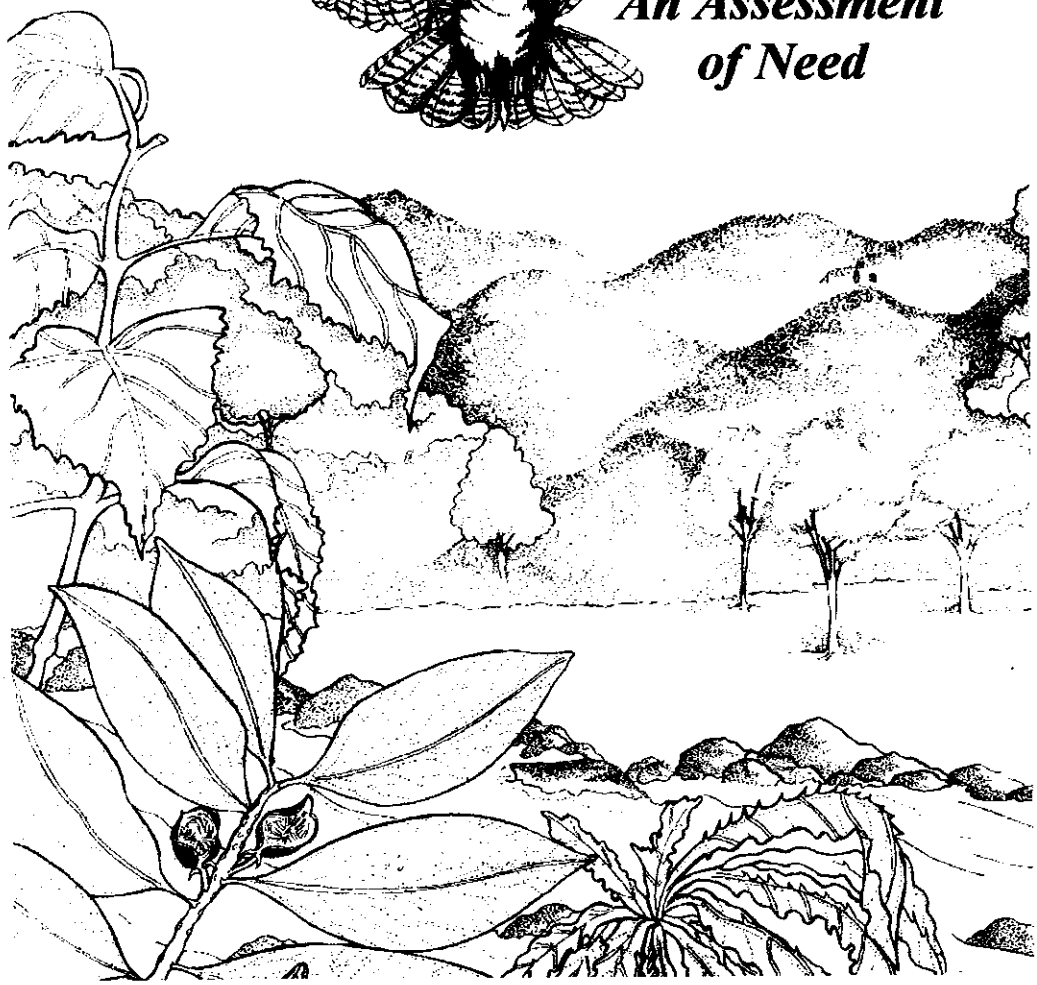
Forest Legacy for Puerto Rico

An Assessment of Need



Department of Natural and Environmental Resources
Forest Service Bureau

U.S. Department of Agriculture
Forest Service

International Institute of Tropical Forestry

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Department of Natural and Environmental Resources
Forest Service Bureau
P.O. Box 9066600 Puerta de Tierra Station
San Juan, Puerto Rico 00906-6600

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Abstract...

In the 1940's Puerto Rico was one of the most severely deforested and eroded regions in the world with only six percent (6%) of its land area under forest cover. Today, still recovering from this devastation, only thirty two percent (32%) of its territory is currently in forest use, down from approximately thirty four percent (34%) in 1985. It is estimated that eighty two pecent (82%) of all current forested land is in private ownership.

The forests of Puerto Rico are currently threatened by conversion to non-forest uses because of increasing pressures stemming from population growth and demand for land development. Puerto Rico is one of the most densely populated areas in the world. Population encroachment on forested areas have begun to affect the capacity of the natural ecosystem to provide renewable resources that have been taken for granted, such as a clean water supply. Valuable forest reserves, including two which have been named Biosphere Reserves by the United Nations in recognition of their uniqueness, are receiving increasing pressures to develop non-forest uses on their buffer zones. With the disappearance and/or fragmentation of forested areas many unique plant and animal species are increasingly coming to be endangered with extinction.

Puerto Rico's participation in the Forest Legacy Program is an important step to address the urgent need to protect private forest lands threatened by conversion to non-forest uses. Eight Forest Legacy Areas have been identified.

As appropriate, periodic review and revision to this Assessment of Need will be made to meet the future needs of the citizens of the Commonwealth of Puerto Rico.

Daniel Pagán Rosa
Department of Natural and Environmental Resources
Commonwealth of Puerto Rico
San Juan, Puerto Rico

Date: 9/30/97

TABLE OF CONTENTS

FOREST LEGACY PROGRAM
AN ASSESSMENT OF NEED FOR PUERTO RICO

INTRODUCTION

Located between 18°31' and 17°55' N latitude and 63°37' and 67°17' W longitude lies the Island of Puerto Rico, the easternmost and smallest of the Greater Antilles. The Puerto Rico consists of a large main island, and several smaller islands, the largest of which are Vieques, and Culebra to the East and Isla de Mona to the West. Puerto Rico is roughly rectangular in shape measuring approximately 100 miles East to West and 35 miles North to South. It is a small mountainous island with a remarkable diversity in its physical environment (Picó,1974). Within its 3,500 square miles there are over 2,600 species of flowering plants, more than 400 species of ferns, 21 species of mammals, 68 species of reptiles and amphibians, 106 species of resident birds and an even more diverse fauna of invertebrates (Natural Heritage Division, 1985).

The island is inhabited by 3.7 million people, averaging over 1,000 persons per square mile, making Puerto Rico one of the most densely populated places in the world. The projected population change from 1990 to 1996 was 7.4%. Increasing commercial, industrial and residential land use needs are generating pressure and conflicting demands over limited resources. These demands are creating stress in the delicate natural balance of the island's ecosystem which have already resulted in costly water shortages, flooding, endangerment of habitats and indigenous species and loss of bio-diversity and other irreplaceable natural resources.

Forests are the most important plant formations in Puerto Rico. They provide an ample array of benefits, including clean water, control of erosion and floods, recreational opportunities, thriving wildlife populations and an astounding variety of species. In fact, the Caribbean National Rain Forest (localy known as El Yunque), admininstered by the USDA Forest Service and the Guánica State Forest, administered by the Commonwealth of Puerto Rico, have been distinguished by the United Nations as Biosphere Reserves of planetary importance.

Concerned by increasing pressures for commercial, industrial and residential land development on valuable privately owned forest lands in Puerto Rico, including the buffer zones of protected reserves, the Commonwealth's Department of Natural and Environmental Resources is applying for participation in the USDA Forest Legacy Program. This Program was created by Congress as part of the 1990 Farm Bill to identify and protect environmentally important private forest lands threatened with conversion to non forest uses. The Forest Legacy Program will be an important instrument in retaining and expanding the role of forests in this natural ecosystem balance, protecting them also for the benefits of future generations.

To be eligible to participate in the Forest Legacy Program, Puerto Rico must prepare an islandwide assessment of need that documents the necessity of the Program, identifies eligibility requirements for designation and recommends areas meeting these requirements for inclusion in the Forest Legacy Program. This document was prepared to fulfill this requirement.

I. THE FORESTS OF PUERTO RICO

A. THE SETTING

The island of Puerto Rico was created by the combined effects of volcanic and tectonic stresses along a submarine fault line, beginning with the extension of the fault (the Antillean Geosyncline) into the Caribbean Region about 120 million years ago. The accumulation of volcanic deposits and uplifting land mass which, in the course of succeeding millions of years was reduced by subsidence and rising sea levels, formed Puerto Rico, the neighboring Virgin Islands and Hispaniola (Dominican Republic and Haiti). Although the character of Puerto Rico's geology and topography largely reflects its volcanic origin, a temporary re-submergence of the island's margins between 40 and 50 million years ago led to the formation of the extensive limestone deposits so widely found today.

The most prominent physical and geological feature of the island is the central mountain range, the Cordillera Central. The highland region extends almost the whole length of the island, the crest averaging more the 3,500 feet in elevation along its length, with the highest peak rising 4,389 feet. The range is largely composed of volcanic lavas with masses of intrusive rock, mainly granodiorite and diorite. Second in its prominence to the central range, in geological and physiographic terms, are the extensive karst regions formed by the deep deposition of limestone during submergence of the land over several millions of years. In the course of Puerto Rico's geological history these areas, which were originally flatland, have been deeply dissected by dissolution and erosion. Though the peaks found in these areas are of almost uniform height, the region is characterized by river valley formations and very broken solution topography. Distinctive karst formations abound and much of the surface karst is underlained by extensive caves and underground waterways.

Most important to human activity are the coastal plains formed by soils created from the volcanic and limestone formations in the interior of the island. The coastal plain is most hospitable to economic and agricultural activity and is where the great majority of the population lives and works.

A high proportion of the Puerto Rican landscape is very steeply sloped. Over 80 percent of the land is either hill or mountain land and 38 percent has a slope of 45° or more. Much of its area is physically unsuited for extensive agriculture, industry or even domestic settlement on a wide scale.

The soils of Puerto Rico are exceptionally diverse in proportion to the size of the island and closely reflect the rock formations from which they are derived. Upland soils are mainly residual in nature and contain the same minerals as the dioritic and volcanic supporting bedrock.

The island has a typical ocean-island tropical climate. Warm temperatures with little variation, steady breezes and abundant rainfall result from constantly high levels of solar radiation, the presence of the marine Trade winds and the mountainous nature of the island itself.

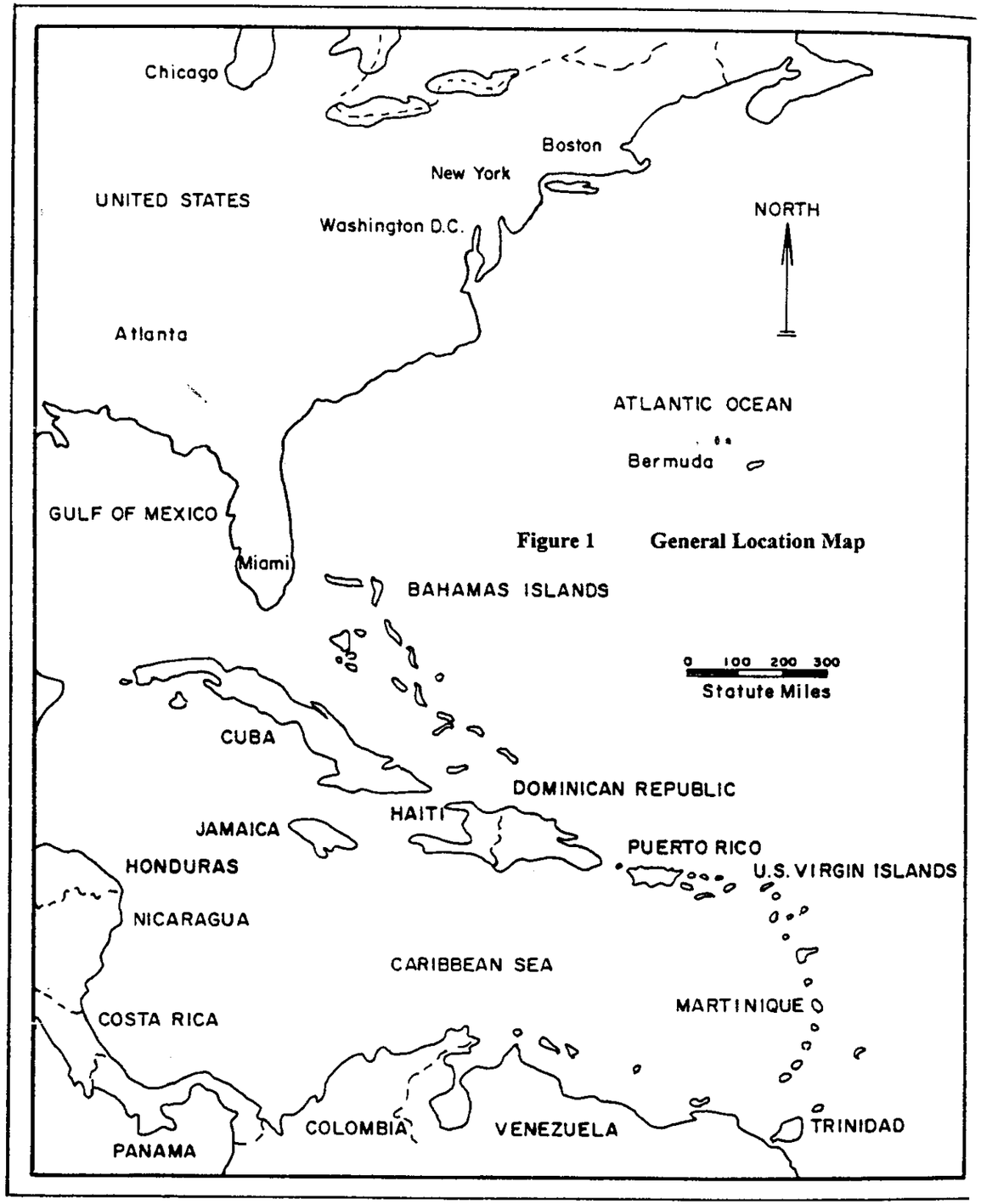


Figure 1 General Location Map

The north slope of Puerto Rico, from the crest of the Cordillera Central Mountain Range to the sea, receives most of the island's rainfall. The heaviest rainfall area in the island is the Rain Forest on the ridges of the El Yunque mountain, area which receives a yearly average of 3810 mm. Lying in the "rain shadow" of the Cordillera Central, the southern slopes receive substantially less rainfall, with some areas, such as the Guánica State Forest, receiving less than 762 mm a year.

Puerto Rico also experiences occasional hurricanes, most of which pass through the Caribbean between August and September. In 1898, 1928, 1932, 1956, 1989, and 1995, storms have passed over the island. Hurricane Hugo in 1989 caused wide destruction of trees and changes in forest composition and growth rates, particularly affecting forest lands in the east coast, including Caribbean National Forest.

Most of the rivers are short in length and none are very large in terms of size or flow. The largest river is the Río Grande de Loíza, draining an area of 296 square miles. There are only seven rivers on the island with drainage areas greater than 100 square miles, although more than 100 streams discharge into the ocean. The large number of drainage basins in the island results in a surface hydrology characterized by a multitude of small basins and catchments.

B. FORESTS IN PUERTO RICO: PAST AND PRESENT

1. The Importance of Forest Areas in Puerto Rico

The Department of Natural and Environmental Resources has identified sixty types of plant communities within its fourteen public forest. In terms of trees, Little, Wadsworth and Woodbury (1974) have identified 547 species, 109 of which can only be found in Puerto Rico. Additionally, there are 203 species naturalized (Little et al., 1974). Such striking richness of tree flora within a small area is an important consideration in an assessment of Puerto Rico's forest. The island has four distinct types of forest corresponding to different environmental conditions.

a. Mangrove Forests

They are found in the coastal zone and contain plant communities which have adapted themselves to the conditions of salinity typical of tropical coasts. The structure and functions of these forest in Puerto Rico vary according to their specific location. Those of the North coast are larger and grow behind the sand dunes. The species *Avicennia germinans* or black mangrove and *Laguncularia racemosa* or white mangrove predominate in this coast. In the South coast the mangrove forests have less extension being most frequently strips of *Rhizophora mangle* or red mangrove along the coastline. The differences in climate, tides and geomorphology of the coasts are responsible for the different types of mangrove that predominate in the area.

An assorted variety of animal life is dependent on the mangrove forest. The protected substrate provides a habitat for a large variety of organisms, which in turn serve as a food base for marine fauna. It is estimated that two thirds of all salt water fish depend directly or indirectly on these wetlands. Some fish of commercial importance are found among the mangrove roots, while others spend part of their life cycle there

breeding and spawning. Other marine animals, insects and birds find habitat in these forest at least for portions of their lives.

Mangrove forests are important in the protection and formation of coastal terrain. Their roots reduce the speed of the marine currents permitting the settling of suspended materials and thus gradually raising land level and producing organic soils. These forests, as any other land formation, also play an important role in the absorption and utilization of carbon dioxide and in the removal of dust from the atmosphere. This function is particularly important in mangrove forests that are near or surrounded by urban or industrial areas. Mangroves offer an undeveloped recreational potential and are of continuing scientific value.

In Puerto Rico, 75% of mangrove covered areas have been destroyed as the result of the dredging and filling or drainage changes affecting the salt-water wetlands, destruction of protective sand dunes, pollution from industrial sources (thermal pollution from thermoelectric plants, oil spills, petrochemical effluents, etc.) and pollution from sewage and from sanitary landfill leechate. Many of these forests have been converted to urban and agricultural uses, with the exception of very limited shoreline areas surrounding both natural and artificial fresh and salt water wetlands.

b. Dry Forests

Located in the coastal areas not influenced by rivers or tidal flooding, and that fall behind the "rain shadow" or low annual precipitation due to the interception of rain clouds by the Cordillera Central Mountain Range, we find the dry forests, plant formations which survive adapting themselves to conditions of scarcity of water, salinity and strong winds.

The variations in the size and diversity of the flora of these ecosystems relate to these three factors: the intensity of the winds, degree of salinity and the accessibility to fresh water. Strong winds limit the size and shape of the plants, salinity limits the diversity of species, as not all plants can resist high concentrations of salt, and the lack of water controls the density of the population as plants grow separated one from the other developing extensive root system where water is scarced. The combined effect of these three factors cause changes in the characteristics of the vegetation typical of the dry forest. The leaves are thick and very strong, forest ceilings are low and closely woven, tree trunks grow twisted, and plants form an impenetrable thicket. These adaptations isolate the community from the hardships of the coastal climate and moderate the micro climate where wildlife can then survive. Plant growth is slow making this type of forest very susceptible to abuses by man.

In spite of its arid appearance, the dry forest is of incalculable value for wildlife. The Guánica State Forest, for example, serves as habitat for half of all the species of land birds in Puerto Rico. Very endangered species of birds have been found in this forest, such as *Chordeiles minor vicinus* (Bahaman Nighthawk) and *Caprimulgus vociferus noctitherus* (the Puerto Rican Nightjar), once thought to be extinct.

c. Karst Forests

The land forms on the North coast limestone of Puerto Rico constitute one of the finest examples of tropical karst in the world. The terrain appears as clusters of haystack hills that vary between 50 and 300 feet of height, separated from one another by rounded depressions. These hills are remnants of thousands of years of erosion of what were limestones formations deposited during the time this area of the island was submerged. The area is abundant in sinkholes, funnel-shaped cavities which are locally known as "sumideros" and through which rainfall quickly disappears. Caves and caverns are abundant and rivers appear, disappear and reappear throughout the area.

The natural vegetation of this karst region has long disappeared except in the most inhospitable areas as man has used the fertile valleys formed by eroded soils between the hills for agricultural purposes. Plant life is scarce. Trees and other plants must extract water and minerals exploring with their roots the sinkholes in the limestone to penetrate them. This condition makes plant growth slow and poor. Existing vegetation, however, is still impressive and sustains a significant variety of wildlife and of plant species that are in the verge of extinction.

The karst region is particularly valuable as a recharge area for the bountiful aquifers of the north coast which provide water for industrial as well as residencial water uses. Four State Forests are located in this karst region: Cambalache, Vega, Guajataca and Río Abajo. All of them contain unique natural areas, relatively undisturbed lands which contain distinct vegetation, wildlife and/or environmental features not readily available separately or as a composite. The karst forests are currently experiencing considerable pressures related to the construction of highways and its accompanying accessibility for future development. In fact, part of the Río Abajo State Forest has been loss to the construction of highway PR-10. Intense future development in this area is predicted for the near future due to the access that will be provided by these highways.

d. Forests of the Mountains

The forest of the mountains of Puerto Rico belong to the wet and rain forest life zones (Ewel and Whitmore, 1973) Consequently, these ecosystems are not limited by the availability of water and due to their tropical location, they develop under temperatures optimal for growth. These forests are characterized by their great diversity of species by unit of area. It is difficult to describe the typical vegetation because it changes as one ascends the mountain and also varies in relation to the orientation and soil types of the slopes. Those facing east receive more rain than those facing west but have more diverse species composition because of a larger variety of soil types or as product of less evaporation due to protection from the wind. Slopes facing north have more abundant vegetal growth than those facing south.

The Subtropical Wet Forest occupies much of the higher parts of the mountains of Puerto Rico. This is a high rainfall life zone, encompassing areas with mean annual precipitation within the approximate range of 2000 to 4000 mm per year. Abundant moisture in this life zone is evident in the characteristics of the vegetation. Epiphytic ferns, bromeliads and orchids are common, the forests are relatively rich in species and the growth rates of successional trees are rapid. Mature forest remnants in this life zone

exists in the Carite and Toro Negro State Forests and the Caribbean National Forest. This type of forest is more commonly known in the island as the tabonuco type, named for dominant tree *Dacryodes excelsa* (Tabonuco). Two other prominent species are *Sloanea berteriana* (Cacao, Motillo) and *Manilkara bidentata* (Ausubo). This is an impressive forest containing more than 150 species of trees and forming a dark, complete canopy at about 20m.

The Subtropical Rain Forest, the wettest of the sea level belt of subtropical life zones occupies very little area in Puerto Rico, occurring only in a single crescent shaped band on the windward side of the Luquillo Mountains. It lies wholly within the Caribbean National Forest. This life zone is characterized by a superabundance of precipitation. The annual total of 3400 mm of runoff is more that twice as much as most areas of the world receive as annual rainfall input.

The species found here are the same, for the most part, as those found in the surrounding Subtropical Wet Forest. Its main features are the high frequency of the Palma de Sierra, *Prestoea montaña* and a superabundance of epiphytes. Because of the small area it occupies, the Subtropical Rain Forest in Puerto Rico is primarily of academic interest and recreational value. Nearly a million people visit annually the recreation area at La Mina. The Baño de Oro natural area, much of which lies in this life zone may be the only place in the world where an example of the mature vegetation of Subtropical Rain Forest is likely to receive long-term protection, while still being readily accessible.

There are two Lower Montane life zones in Puerto Rico of which the Subtropical Lower Montane Wet Forest is by far the most extensive, occurring in both the eastern and central parts of the island up to the summits of most of the mountains above 1000 meters and occasionally extending down to almost 700 meters. The Colorado Forest type, named for the common *Cyrilla racemiflora* corresponds to the mature vegetation of this zonal association. The *Cyrilla* is the same species which grows as a shrub or small tree in the titi swamps in the southeastern U.S. but in the mountains of Puerto Rico it is a large, reddish-barked canopy tree. The hollow trunks of the older individuals are the main nesting sites for the nearly extinct Puerto Rican parrot. This forest is characterized by open-crowned trees and is poorer in species than the adjacent Subtropical Wet Forest.

Because of the high rainfall, the Lower Montane Wet Forest zone is too fragile for any commercial forestry or agriculture, although in some areas dairy cattle are pastured mostly on molasses grass. Here again, as in other life zones with exceedingly high rainfall, the primary value lies in watershed yield.

The Subtropical Lower Montane Rain Forest zone occupies less area than any other in Puerto Rico and is found only in a narrow band on the windward slopes of the Luquillo Mountains, immediately above the Subtropical Rain Forest. The vegetation of this life zone is similar to that of Lower Montane Wet Forest but has a greater abundance of epiphytes, epiphyllae, palms and tree ferns. Most of this life zone in Puerto Rico is located in the dwarf cloud forest association where much of the vegetation on the exposed ridges has a windswept appearance. This forest is primarily a biological curiosity but an invaluable one since it represents an environmental extreme and as such

is an excellent tool for investigating the response of natural ecosystems to environmental stress.

This dwarf forest is a habitat for a very distinctive flora and fauna. Moss, orchids, bromeliads and other epiphytic plants cover available surfaces in the trees. These trees are small with twisted trunks and thick small leaves with roots that grow over the surface of the ground.

2. Long term forest area trends

The dominant vegetation upon Columbus' arrival at the end of the 15th century was forest throughout the island. Out of an 890,000 hectares total, 850,000 ha (95%) were estimated to be forested in 1500.[1] However, timber use increased with the arrival of the Europeans as well as forest destruction for agricultural uses.

Most of the early farm clearing was for subsistence farming. In 1828 there were 587,000 ha in forest use and by 1899 it was down to 182,000 ha or about 20% of the island (Wadsworth, 1950). The production of field crops prior to 1900 did not involve as much land as did pasturing but required the clearing of steeper slopes. The introduction of coffee (*Coffea arabica*) in 1736 began a culture which was destined to push back into the then heavily forested mountainous interior of the island. Production of coffee increased rapidly after 1755 and soon became an important product to be exported. By 1899 more than three quarters of the land surface of Puerto Rico had been deforested and forest cover reduced to 182,000 ha. Pasture accounted for about 490,000 ha and coffee production occupied 77,000 ha. (Wadsworth, 1950)[1].

Early in the 20th century, forests covered only about 20% of the island, but only one third of this forest land could yield wood products other than charcoal or fuelwood (Murphy, 1916). The rate of forest destruction declined during the first part of the 20th century. Only the most remote and marginally productive lands remained uncultivated. During the ensuing decades, pressure on land resources came from many directions: increasing population, expanding production of export crops, and fluctuating economic conditions. During periods of high unemployment people were forced to subsistence agriculture, encroaching on the remaining lands in the interior.[2]

During the late 1940's the natural forest area of Puerto Rico declined to a minimum of 6% of the land area. Cropland[3] and pasture each accounted for about 42%, with the remaining 10% in buildings, roads and wasteland (Koenig,1953) Puerto Rico became one of the most severely deforested and eroded regions in the world.[2]

Operation Bootstrap, or the efforts to industrialize Puerto Rico, resulted in an exodus of population from the mountainous interior of the island. Many migrated in search of employment and better living conditions to the US mainland or to the cities in the coast, such as San Juan. Since then, forests gradually recovered because cropland

[1]Discussion taken from the article "Notes on the Climax Forest of Puerto Rico and their Destruction and Conservation Prior to 1900." by Frank Wadsworth in the Caribbean Forester of January, 1950.
[2]Discussion taken from: Birdsey and Weaver, *The Forest Resources of Puerto Rico,* USDA Forest Service Publication, Resource Bulletin SO-85 of October, 1982.
[3] The category "cropland" included tree-covered coffee, some 8% of Puerto Rico then. (Wadsworth)

and pasture were abandoned on eroded hillsides in the Island's mountainous region. By 1980, forest occupied about 250,000 ha and coffee shade about 30,000 ha (Birdsey and Weaver, 1982).

Forest area trends as reported by Birdsey and Weaver in their 1985 inventory update include an increase of total forest area from 279,000 in 1980 to 300,000 ha in 1985. From an all time low of 6% in 1940, forest area increased to 34% in a little over forty years. Preliminary and unpublished data from the 1990 inventory update by the USDA Forest Service shows, however, a probable declining trend will tend to occur in the future. The most probable cause for this expected declining trend is the demand for space and natural resources from a rapidly growing population.

HISTORICAL ESTIMATES OF FOREST AREA FOR PUERTO RICO[4]

YEAR OF ESTIMATE	FORESTED AREA[5] in hectares	COFFEE SHADE[6] in hectares	SOURCE OF INFORMATION
1500	850,000	0	Murphy, 1916 Wadsworth,1950
1828	587,000	7,000	Wadsworth, 1950
1899	182,000	77,000	Wadsworth,1950
1912	169,000	77,000	Murphy, 1916
1916	178,000	68,000	Murphy,1916
1931	81,000	.....	Gall,1931
1940	.....	68,000	Koenig,1953
1948	57,000	57,000	Koenig, 1953
1960	82,000	.....	Englerth,1960
1972	284,000	73,000	DNER,1972
1980	279,000		US Forest Service, 1982
1985	300,000		US Forest Service, 1987
1990	287,700		US Forest Service, 1995 (preliminary unpublished data)

3. Forest Ownership

In 1990 it was estimated that 82% of all forested land in Puerto Rico was in the property of private owners. The largest forested areas in public ownership are the State Forest System, the Caribbean National Forest, Mona Island[7] and Roosevelt Roads Navy

[4] Birdsey and Weaver, *The Forest Resources of Puerto Rico,* USDA Forest Service Publication, Resource Bulletin SO-85 of October, 1982.
[5]Does not include non-stocked forest land.
[6]"Secondary forest land resulting from the abandonment of coffee production under shade trees. Coffee shade is a multistory, multicrop system used principally for the production of coffee. An upper story of shade trees is characteristic." USDA Forest Service, Research Notes, SO-331, Februrary 1987, page 4.
[7] Although a separate island, Mona falls under the Commonwealth Forest System.

Base. The DNER also holds several areas of smaller extent that are managed by the Conservation Trust of Puerto Rico, a private non-profit corporation. Other important landholders are the Land Authority, the Land Administration, and the Industrial Foment Administration, all public corporations. Their lands may or may not be forested.

The State Forest System includes 16 States Forests scattered throughout the island. The Caribbean National Forest covers much of the Luquillo Mountains in the northeastern part of the island. Together the public forests protect valuable soil and water resources, wildlife habitats and many rare tree species. They also provide recreation and research opportunities in all the major natural ecosystems found on the island. These area include nearly all of the remaining virgin forests.

Ownership class	Area (hectares)	Source of Information
Public:		
Commonwealth forests	22,700	DNER, 1976
Commonwealth islands (Mona and Monito)	5,500	Environmental Quality Board, 1973
DNER[8]	2,000	Rusanowsky, 1978
Caribbean National forest	11,300	
U.S. Military	1,900	U.S. Fish and Wildlife Service, 1978
Total Public	**43,400**	
Total Private	**235,300**	
ALL OWNERSHIP	**278,700**	

Source: Birdsey, Richard A. and Peter Weaver, Forest Resources of Puerto Rico, USDA, Forest Services, Resource Bulletin SO-85, October, 1982.

4. Demands on Forested Areas [9]

Numerous benefits and uses are derived from forested lands in Puerto Rico, among them control of water quantity and quality, control of erosion, wildlife protection, habitat for rare and endangered species, recreation, tourism, research opportunities, scenic and cultural resources and timber.

a. Soil and Water

Of the fresh water lakes in Puerto Rico only two, Laguna Tortuguero and Laguna Cartagena, are natural. All rivers of the island rise in the forested mountainous central area of Puerto Rico. The headwaters of these rivers supply most of the island's 25 major reservoir sites which yield water to meet domestic, industrial and agricultural demands.

Forest cover is responsible for the high quality of water of the rivers and artificial lakes in these areas. Where forest cover has been eliminated, serious sedimentation and

[8] Lands previously purchased by the Conservation Trust were turned over to the DNER in 1981.
[9] Much of this discussion is taken from: Birdsey and Weaver, *The Forest Resources of Puerto Rico*. USDA Forest Service Publication, Resource Bulletin SO-85 of October, 1982.

pollution problems have developed in the rivers and the artificial lakes. Those that are surrounded partially or totally by forests of the central highlands have the highest quality of water, scenery and fishing, as characterized by Guajataca, Carite, and El Guineo Lakes. These contrast with other lakes such as Cidra, Loíza, Coamo and La Plata which lack forest protection and suffer severe problems of sedimentation, pollution, bilharzia (*Schistosoma mansoni*) and intrusion of aquatic plants. For example, the annual rate of siltation of the Loíza reservoir, which serves most of the San Juan Metropolitan Area, is reported at 1.6AF/sq. mile. If no measures are taken, this reservoir is expected to be completely silted by the year 2020. (At present the Loíza Lake is been dredged.) Severe water shortages have been plaguing the San Juan Metropolitan Area during 1994, 1995, and 1997 provoking extended water rationing periods, at a considerable economic costs for business.

Of all sources of water quality degradation, sediments brought by surface runoff is by far the most widespread and noticeable cause of this problem in Puerto Rico. The damaging effects of sedimentation include the siltation of reservoirs, destruction of spawning beds for fish and shellfish, increased nutrient inputs leading to eutrophic conditions in reservoirs and disrupting "desirable" aquatic food chains, and greatly increased turbidity in nearshore areas resulting in coral reef mortality.

Steep topography, heavy rainfall and erodable soils contribute to a high erosion potential, and rapid clearing and development of land for agriculture and other uses cause major erosion and sedimentation problems. The erosion of the topsoil seriously curtails the soil's productivity.

b. Wildlife, Rare and Endangered Species

Wildlife populations are entirely dependent on their habitat, so the link between wildlife and forests is a crucial one. Forests constitute one of the most important habitat for wildlife in Puerto Rico. For example, half of all the species of land birds in Puerto Rico can be found in the Guánica State Forest, twice the density of birds found anywhere else.

The island's native wildlife species are limited. It consists of a variety of insects and other lower groups of animals, particularly marines species, although it is scarce in mammals. Resident native mammals include 15 species of bats, manatees and dolphins. Of an estimated 200 bird species (Bond 1971, Leopold, 1963), 14 are endemic, 107 local breeders, 71 migrants and 21 strays. About 70 species of reptiles and amphibians, and 33 species of fresh water fish are native to Puerto Rico (Rivero 1978), (Erdman, 1972).

The destruction or disturbance of wildlife habitats is the most important threat to animal communities in Puerto Rico. Hunting, predators introduced to the island (such as rats and mangoose), pesticides and other chemicals are also important factors affecting wildlife survival.

The diversity of habitats has led to the establishment or evolution of many plant species on the island. However, the limited size of the land mass combines with rampant destruction of large areas for agriculture and other uses has decrease some species to dangerous rarity. Over 500 species of endemic and non-endemic plants have been

classified as rare, endangered or poorly distributed. (DNER, 1975) There are 13 rare endemic tree species classified as endangered and 22 endemic tree species that are threatened with extinction mainly because of habitat destruction and disturbance. (Little and Woodbury, 1980) Again, in the Guánica State Forest of there are 346 genera of plants and trees with 641 species represented. At least 48 of these species, if they were lost at Guánica, would virtually disappear from Puerto Rico. Sixteen species are endemic, found at no other location in the world.

c. Recreation and Tourism

Puerto Rico's numerous beaches, coral reefs, waterfalls, canyons, scenic mountain roads, limestone caves and cliffs, combined with year-round moderate weather provide the basis for outdoor recreation, particularly in the small but well distributed acreage of federal and Commonwealth forests.

The Caribbean National Forest is one of the main eco touristic attractions of the island. The forest has 11,300 ha of uninhabited woods administered by the USDA Forest Service and offers facilities for passive recreation as well as for scientific research. Puerto Rico has five other forests owned and administered by the Commonwealth government in the mountainous central region and has a total of 16 State Forests around the island. The Piñones State Forest, within the San Juan Metropolitan Area, is one of the favorite recreational and outdoor sports areas. Major activities include swimming, snorkeling, picnicking, boating, fishing, camping, hiking, water skiing, kayaking, or just driving through the forested area. Any spot on the island is within an hour's drive of a major recreation area. Given the island's limited area and high population density, the existing forested areas are a critical resource for both residents and tourists.

Puerto Rico's karst region in the north central region of the island, is one of the few places in the world with such rock formation. The Camuy Cave System, through which the Camuy River flows, is part of this unique karst topography and represents an area of natural beauty that has been developed for recreational purposes. The DNER has listed 189 caves in its inventory, many of which have been explored.

In contact with coastal forested areas lie rare bioluminescent bays, such as Bahía Fosforescente and Monsio José of Lajas in the southern coast and Caño Hondo on the offshore island of Vieques. The prominent luminescence of these bays and their rarity and importance to marine biology make them internationally significant natural areas.

d. Scenic and Cultural Resources

Puerto Rico is a tropical island of varied topography with many valuable areas of natural beauty. Being an island, beaches and other marine related areas of beauty are abundant. The interior of the island, with its rugged mountainous terrain has canyons, waterfalls, caves, forests and views of breathtaking beauty. Many of these areas have been developed into resorts with facilities to house visitors, others have been developed into sophisticated tourist resorts with hotel facilities whereas, the many others remain as virgin areas, particularly where difficult accesses is the limitation.

Important archeological sites have been found within forested areas near the coast and in the mountainous interior area of the island, mostly dating back prior to 1200AD. Important historical sites, particularly those related to early coffee and tabacco industries can also be found in the forested areas of the central mountain highlands. One of these areas, Hacienda Esperanza in the Ponce area, has been converted by the Conservation Trust of Puerto Rico into a living museum.

e. Research Opportunities

Puerto Rico's tropical forests have been a regional focus for forestry and ecological research throughout this century. Lands in the Forest Legacy Program could add signaificantly to the pool of available sites for research particularly on animals, soils, and vegetation types that are not well represented in established research sites, such as, the Caribbean National Forest. Examples include the karst region, deep sandy soils, and a range of forest types form moist to dry that are representative of tropical America. These lands have a degree of diversity in both plant and animal species. The diversity of ecological zones and stages of succession with associated bird and reptile species are unusually high. Puerto Rico also presents an unusual degree of diversity related to population and land uses. Together these factors provide numerous important research opportunites.

f. Timber

Non-timber forest resource uses are currently more important than timber production in Puerto Rico. More than 16% of the land area is covered with forests whose primary use is for watershed protection, recreation and wildlife habitat. Timber harvest occurs on a very limited basis, although a timber industry has been and will continue to be promoted by the DNER and the USDA Forest Service.

Puerto Rico originally included more than 500 species of trees in 70 botanical families. These occurred in extensive and luxuriant forests of which only scattered relics may be found today. Data from the least disturbed of remaining stands suggest that the island contained about 195 million cubic meters of wood (Wadsworth,1950) Today most of the original forest has been replaced by agricultural and other land uses, or secondary forest where agricultural activities have been abandoned.

The USDA Forest Service survey divides forest areas on the island into commercial and non-commercial forest land. Commercial or timberland is defined as forest land that is producing or capable of producing crops of industrial wood. Forest lands with higher priority uses are excluded. Coffee cultivated under tree shade is included in this category.[10] According to the 1985 USDA Forest Service Survey of forest areas, the commercial area under forest cover increased from 130,500 ha in 1980 to 160,200 ha in 1985. Preliminary 1990 figures, yet unpublished, reveal a downward tendency of estimated commercial forest land to 148,100 ha, a loss of 12,000 ha in 5 years.

[10]"Secondary forest land resulting from the abandonment of coffee production under shade trees. Coffee shade is a multistory, multicrop system used principally for the production of coffee. An upper story of shade trees is characteristic." U.S. Forest Service, Research Notes, SO-331, February 1987, page 4.

The non-commercial forest land is area incapable of yielding crops of industrial wood because of adverse site conditions, withdrawn through statute or administrative regulation, or with higher priority use (except coffee shade). The non-commercial forest land declined from 148,200 ha in 1980 to 139,300 ha in 1985.

II. THE FOREST LEGACY PROGRAM: ADDRESSING THE PROBLEM

The Cooperative Forest Assistance Act of 1978, as amended by the 1990 Farm Bill establishes the Forest Legacy Program *"for the purposes of ascertaining and protecting environmentally important forest areas that are threatened by conversion to non forest uses and through the use of conservation easements and other mechanisms, for promoting forest land protection and other conservation opportunities. Such purposes shall also include the protection of important scenic, cultural, fish, wildlife, and recreational resources, riparian areas, and other ecological values"*.[11]

The Department of Natural and Environmental Resources of the Commonwealth of Puerto Rico is the custodian of the island's forest resources, has recognized in the Forest Legacy Program a potentially important institutional instrument to tend to one of the most serious problems affecting forestlands in the island, the threat to conversion to non-forest uses on 82% of the island's forestlands currently in private property. Still recovering from the elimination of forest cover from all but 6% of its territory, situation that made the island one of the most severely deforested and eroded regions in the world in the 1940's, Puerto Rico again faces a similar threat from powerful economic and social forces whose land use demand has again encroached on forested areas. Preliminary unpublished data compiled by the USDA Forest Service seems to indicate a declining tendency in the amount of forest covered areas in comparison with 1985.

A. GOALS AND PRIORITIES OF THE PUERTO RICO FOREST LEGACY PROGRAM

The goal for the Puerto Rico Legacy Program is to protect environmentally important forest areas belonging to private owners that are threatened by conversion to non-forest uses and that respond to established program eligibility criteria.

Priority for program implementation has respond to the conservation objectives championed by land trust institutions and other conservation organizations in PR. These include:

a) The protection and restoration of forested areas in watersheds developed as sources of public water supply
b) Buffer zones of existing forest reserves
c) Conservation of forested areas in primary or close to primary conditions
d) Conservation of bio-diversity and unique features

Fragile coastal forests, currently severely subjected to development pressures, karst and Cordillera Central forested areas, rich in environmental resources and particularly valuable for water yield, were the primary targeted areas. Selected Legacy

[11]The Cooperative Forestry Assistance Act of 1978, amended in the 1990 Farm Bill, Section 7(a).

Areas represent a rich and varied assortment of these forest lands and have been delimited to contain identified tracts in private property given very high conservation priority originally by the DNER (the Natural Heritage Division and the Forest Service Bureau), and by the USDA Forest Service and enriched and modified by comments from the public information focus groups and meetings carried out. Area boundaries were defined using existing roads. These Legacy Areas also contain within their limits areas that are not forested and that have no protection interest for the Puerto Rico Forest Legacy Program. However, all tracts to be protected by the Puerto Rico Forest Legacy Program, are included within the specified Forest Legacy Areas.

B. ELIGIBILITY CRITERIA

The determination of Legacy Areas was taken with regards to the set goals and priorities for the Forest Legacy Program and the following eligibility criteria:

1. Present a vegetal cover typical of forests, according to the definition of the Puerto Rico Forest Act, in at least 20% of its extension;
2. Be threatened by present or future conversion to non-forest uses;
3. Contain one or more of the following important public values:
   a) watershed values, including the protection of public water supply
   b) conservation of bio-diversity and unique features
   c) aesthetic and scenic values
   d) existing or potential public recreation opportunities
   e) known cultural/historic areas
   f) fish and wildlife habitat
   g) known threatened and endangered species
   h) in primary or close to primary forest conditions
   i) other ecological values, and/or
4. Promote the development of commercial timberland, and/or
5. Promote the preservation of the forest land base

C. CRITERIA EVALUATION FACTORS

1. Present a vegetal cover typical of forests:
   This eligibility factor has to be certified by the Forest Service Bureau. Areas not in vegetal cover typical of forests or with a lower percentage of forest cover can qualify if they belong to geographical areas not adequately represented (diversity) within the existing conservation land stock, contain resources deemed unique by the FLP and/or constitute areas targeted for reforestation for water basin protection.

2. Threat by conversion to non-forest uses:
   These are lands which have characteristics that make them attractive to changes in use such that forest values are reasonably expected to be at risk. These threats can include, but are not limited to, current development trends in the area, proximity to roads, short travel time to population centers, proposed housing, industrial, commercial, public or recreational development, encroaching housing development, improvement of roads,

sewer line and power line extensions, fragmentation of land ownership in smaller, less manageable parcels.

3. Contain one or more important public values:
   a. Watershed values, including the protection of public water supply:
      i) area contributes to public or private water supply, including underground sources of water
      ii) area is important to erosion and sediment control in watersheds developed for public or private water supply
      iii) area contains major river/stream, water body, or contains and/or is the recharge area for major underground water resources
      iv) Areas that maintain flood control by naturally collecting water runoff
      v) Areas that would be most adversely impacted by non-point source pollution, such as lands where riparian buffers have been removed

   b. Conservation of bio-diversity and unique features:
      i) Areas representative of any one of the 18 geoclimatic regions currently underrepresented in the land conservation stock in Puerto Rico.
      ii) Areas with a unique or exceptional mix of ecological communities
      iii) Area contains ecological communities that are dwindling
      iv) Area has unique or exceptional geological/physiographic resources

   c. Aesthetic and scenic values:
      i) area listed in DNER's inventory of aesthetic and scenic resources
      ii) area includes locally important panoramic views
      iii) area is situated along designated scenic road

   d. Existing or potential public recreation opportunities:
      i) Existing or potential recreational uses such as water based recreation, trails, day use recreation such as hiking, picnics, horseback riding
      ii) Existing or potential natural resource based recreation such as camping, nature tours
      iii) Areas critical for access to places of outstanding recreational opportunities or tourism resources
      iv) Areas with existing or potential eco-touristic resources

   e. Known cultural/historic areas:
      Areas that contain evidence of the earlier human occupation in Puerto Rico which comprises a unique and irreplaceable resource, as do historic features, such as old coffee and tobacco plantation artifacts and structures, and vernacular landscapes.

   f. Fish and wildlife habitat:
      Preventing the fragmentation of forest tracts into smaller units is crucial objective to maintaining viable populations of particular wildlife species. Factors to be considered:
      i) Area contains outstanding habitat for one or more species
      ii) Area exhibits connective habitats, corridors, habitat linkages and areas that reduce biological isolation.
      iii) Area contains plant and animal species on federal or DNER list as endangered , rare or of special concern.
      iv) Area has unique, rare and/or important variety of vegetative cover types and size classes.
      v) Areas for nesting, resting and feeding of migratory species
      vi) Areas with significant wildlife population

   g. Known threatened and endangered species:
      i) Presence of endangered species habitat for federal, or DNER listed plant and/or animal species, or suitable habitat for such species that are documented on adjacent properties.
      ii) Rare natural habitats, communities or ecosystems and their buffers
      iii) Unusually diverse or otherwise special biological community
      iv) Forest lands necessary for the recovery or reintroduction of natural ocurring species

   h. Forest in primary or close to primary conditions:
      Areas that have over 10% of the forested parcel in primary or close to primary forest conditions

   i. Other ecological values, such as:
      i) any area that exhibits additional or exceptional conditions that are important and add value to the quality of the Forest Legacy Areas

4. Promote the development of commercial timberland:
   According to USDA Forest Service report on forest area trends, Puerto Rico´s forest resource "is approaching a stage of recovery that could support sustained removals of useful timber products from selected areas."[12] Selection criteria includes the following:
      a) Areas under a management plan for timberland development or recommended by a management plan for such uses, including those areas already participating of other local or state, public or private programs
      b) Potential areas for commercial timberland development and use
      c) productive soils with significance to forestry
      d) maintaining timbering activities

[12]Birdsey, Richard A. and Peter L. Weaver, "Forest Trends in Puerto Rico", Research Note, SO331, February 1987, USDA Forest Service, Southern Forest Experiment Station.

5. Promote the preservation of the forest land base in order to:
   a) protect and promote the creation of large blocks of protected forest land to yield greater ecological and watershed benefits
   b) buffer or simplifying management of, existing forested areas considered of high value
   c) provide contiguous land to protect wildlife habitat corridors, recreation areas, threatened watersheds and other important public values.

D. QUALIFICATIONS PROPOSED ACQUISITIONS MUST MEET

The acquisition of a track, including pre-acquisition work, must met the following:

1. Federal appraisal standards;
2. The landowner must be informed of the fair market value and that sale of the property is strictly voluntary;
3. The landowner must be notified in writing that the property will NOT be purchase if negotiation do not result in amicable agreement;
4. Payment to the landowner for lands or interest in lands is not more that fair market value determined under item 1;
5. Assure title is free and unencumbered or that title insurance is secure for the full value of the encumbered property;
6. If relocation is involved the requirements in PL-91-646 must be must be followed;
7. the track must be located within an approved Forest Legacy Area
8. the track must include a forested land threatened by present or future conversion to a non-forest use (areas not in vegetal cover typical of forests can qualify if they belong to geographical areas not adequately represented (diversity), contain resources deemed unique by the PR-FLP and /or constitute areas targeted for reforestation for water basin protection);
9. be nominated by the landowner in writing or with the written permission of the landowner;
10. be approved by the DNER-Forest Service Bureau;
11. have a forest stewardship plan or other similar multiple use management plan in place at the time of the closing if a landowner is retaining the right to harvest timber or the right to conduct other land or resource management activities. A management plan will not be required if the aforementioned rights are not retained, or if a fee interest is being acquired. Preparation of the plan is the responsibility of the landowner with the help of the Forest Service Bureau's Rural Landowner Assistance Section.

E. ACQUISITION METHODS AND TOOLS

The Commonwealth of Puerto Rico elects the State Grant Option for the implementation of the program. The following activities are eligible uses under the PR-FLP:

1. Purchase of lands or interests (conservation easements) in lands from willing sellers for inclusion in the FLP;
2. Facilitation of donations of lands or interests in lands to a qualified and will donee for FLP purposes.
3. Lands or easements purchased by Commonwealth, Municipal or land trusts are considered part of the Forest Legacy Program by contributing to the minimum 25% non-Federal share of program costs.
4. Zoning, term easements and other incentives or methods may further Forest Legacy goals, but are not part of the Federal Forest Legacy Program. Commonwealth, Municipal Governments and land trusts may pursue these methods outside of the Federal Forest Legacy Program.

F. PROGRAM IMPLEMENTATION CONSIDERATIONS

1. Contribution of Puerto Rico Forest Legacy Program to the Institutional Framework of the Commonwealth of Puerto Rico

Puerto Rico's institutional framework addressing forest protection and conservation combines federal, Commonwealth of Puerto Rico and municipal government agencies. Federal government agencies provide technical and financial assistance to local government agencies through established forest-related programs and some agencies directly manage forested areas, such as the USDA Forest Service that manages the Caribbean National Forest and the US Fish and Wild Life Service that manages the Boquerón Wildlife Refuge. In addition, the US Army and the US Navy hold extensive forested areas, specifically those in Ceiba, Cataño, and Salinas.

Within the Commonwealth of Puerto Rico, the Department of Natural and Environmental Resources is the agency that has been given by law the responsibility over all natural and environmental resources on the island, including the conservation and management of forested areas. Matters pertaining to forests fall under the Forest Service Bureau of the Living Resources Area of the Administration of Natural Resources. *(See Charts 1 and 2 in Appendix A).*

The Forest Service Bureau is in charge of implementing programs, such as, the Forest Stewardship, Forest Resource Management, Seedling, Tree and Nursery Improvement, Urban and Community Forestry Assistance, and Rural Development, that provide technical and financial assistance to rural and urban landowners. These programs have being established with the support and sponsorship of the USDA Forest Service. In addition, the Forest Service Bureau administers the Auxiliary Forest Program, that promote the conservation and restoration of forested areas and some can exercise control of uses during specified periods of time, as agreed with the owner(s). This program provides property tax exemption to participating private landowner.

The Natural Heritage Division of DNER has the authority by law "to acquire, restore and manage areas of natural interest". The Natural Heritage Act of August 4, 1988 grants the DNER a mechanism that allows for the acquisition of areas of great natural value to protect and conserve them for the use and enjoyment of present and future generations of Puerto Ricans.

The Commonwealth of Puerto Rico protects and promotes appropriate land uses in areas deemed of importance for the protection and conservation of environmental values through several instruments. In addition to the powers of purchasing, the traditional way to acquire control over a property, the Commonwealth of Puerto Rico has a Planning Board with the authority of establishing zoning districts, special planning areas and natural reserve areas. Through these the Commonwealth of Puerto Rico exercises its power to limit uses within specifically delimited areas. Currently, for example, the buffer zone of the Caribbean National Forest has a special planning area with zoning restrictions designed to protect the forest reserve.

The Municipal Reform Law (Act 81 of August 30, 1991) passed in 1991 give local municipalities the responsibility to regulate land use within their territory with the power to restrict uses within specifically zoned areas. This enables them to contribute to the protection and conservation of forested areas without resorting to acquisition procedures. They must develop Municipal Land Use Plans with the approval of the Planning Board in order to acquire this delegated authority.

Outside the governmental arena, there are several private institutions that carry out environmental protection programs. The Conservation Trust of Puerto Rico is a non-profit corporation that purchases and/or administers state owned properties of environmental and cultural values for conservation programs. It develops them for educational and recreational uses.

Within this existing institutional framework, the Puerto Rico Forest Legacy Program would have several important contributions to make to the Commonwealth of Puerto Rico :

a. Conservation easements constitute a legally binding commitment in perpetuity with property owners. At present, the Planning Board's zoning faculties are established and implemented in a precarious balance with what can constitute illegal taking of property owner rights. What can be done within the zoning restrictions is subject to reinterpretations by the Board and/or appellate instances and to all sorts of pressures exerted by owners and other interest groups. A recent example of the precarious situation for protected areas are projects in the buffer zone deemed threatening to the Caribbean National Forest by the USDA Forest Service that have received preliminary approval. Other forests lack adequate zoning protection precisely because of the Planning Board's legal difficulties with establishing and enforcing these zoning restrictions.

b. The conservation easement, which is locally very limited for protection purposes, potentially reduces the cost of acquiring land control. Funding shortage for acquisitions are one of the basic limitations of existing conservation programs. The Forest Legacy Program addresses forest value conservation through the acquisition of property control using conservation easements. The easement reduces the cost of acquiring control because only the transfer of specific rights is negotiated.

c. The Forest Legacy Program extends protection to a much larger area of forest resources, including forested areas with development potential. The Natural Heritage Division, for example, is specifically for resource conservation. Timber, recreational and tourist development, for example, is excluded. In the Forest Legacy Program the landowner retains the property and the right to use it in any way consistent with the terms of the easement. The Forest Legacy Program is not solely a protection program. In general Forest Legacy Areas will be encouraged to be 'working forests', where forest land is managed for the production of forest products and traditional forest uses maintained. This last objective is not covered by other existing protection programs in the island which are more concerned with conservation and preservation of forests. Although currently timber harvesting is a very limited activity in Puerto Rico but could be considered a potential industry.

d. Holding conservation easements can propitiate the direct involvement of landowners and/or easement overseers in forest conservation efforts, supplementing the limited surveillance capability of government agencies.

2. Possible Issues Related to Puerto Rico Forest Legacy Program Implementation

Public involvement activities brought forth several issues to be considered during the implementation phase of the project. Recommendations include the creation of a local legacy program under the DNER that actively involves and integrates efforts of community organizations active in forest protection and reforestation programs at different levels. Presentation of legislation for these purposes was suggested. *(Please refer to page 50 of this document.)*

Possible issues pertaining to the implementation of the Puerto Rico Forest Legacy Program that need to be looked into and maybe form part of the proposed legislation are the following:

a) The need to legally define and provide incentives for the conservation easement to assure its effectiveness. These incentives should be competitive with those provided for alternative agricultural uses. The implementation of the Forest Legacy Program as designed by the USDA relies on the use of the conservation easement as the basic mode of acquisition of rights. The conservation easement represents an important and needed alternative to outright ownership for conservation purposes, which more often than not, is not feasible. The use of conservation easements, where appropriate, can be a highly efficient means of stretching the limited funds currently available for land conservation. Environmental law is a relatively new addition to the

Puerto Rican legal system. This type of legislation has been adopted from the US Code. The conservation easement is not defined in Puerto Rico's Legal Code except as briefly mentioned in the law that establishes the Natural Heritage Division in the DNER (Act 150 of August 4th, 1988). The lack of legal definition of the conservation easement has several consequences. Qualifying characteristics and conditions for the recipient of the easement are not established. Rights, restrictions, permitted uses and reservations are not specifically established. Most important of all, no incentives to stimulate landowners are provided by law, such as, property and/or income tax incentives (which are given for alternative uses such as agricultural activities). (U.S. IRS Laws, except social security, are not applicable for businesses not receiving income outside of Puerto Rico.) In a highly incentive-laden economy as ours, in addition to the lack of land conservation tradition, conservation easements could be difficult to acquire.

b) Easement ownership by the federal government could entail potential jurisdictional conflicts, loss of control by the Commonwealth of Puerto Rico over participating Forest Legacy Program properties and possibly a loss in efficiency of the Forest Legacy Program was brought forth as an issue in all of the public participation activities carried out. It was recommended by the DNER staff and in the public involvement activities that federal government ownership of easements possibly be considered only for areas bordering federal owned forest property, such as the Caribbean National Forest, the Boquerón Wildlife Refuge and military property.

c) The Puerto Rico Forest Legacy Program has to establish a working coordination with the Planning Board and with those municipalities that have already acquired their territorial planning powers. The combination of mechanisms in the establishment of the Forest Legacy Areas will considerably strengthen the Forest Legacy Program.

d) A financial assistance program with lower interest rates for landowners that require financing for forest maintenance and management should also be considered.

III. THE PUERTO RICO FOREST LEGACY AREAS

A. THE GUANICA LEGACY AREA

1. General Location

The Guánica Legacy Area is located on the southwestern corner of Puerto Rico, basically including the coastal area of the municipalities of Guánica, Lajas and Cabo Rojo and a small portion of Yauco and Mayagüez. It extends from Punta Verraco on its southeastern portion, to the Cabo Rojo coast on its western portion and to Laguna Joyuda in Mayagüez on the north (see Appendix B for map and detailed information on boundaries). The size of the Area is approximately 25,767 ha.

2. Summary of Important Environmental Values

The Guánica Legacy Area contains the following significant resource areas:

a. the Guánica State Forest and Biosphere Reserve and its buffer zone,
b. the Boquerón State Forest and its buffer zone,
c. the Sierra Bermeja (Cerro Mariquita) area,
d. the Laguna Joyuda Natural Reserve Area,
e. Laguna Guaniquilla Reserve,
f. the National Wildlife Refuge of Boquerón,
g. the Mogotes de Boca Prieta and those to the east of Boca Prieta,
h. Guánica Lagoon,
i. Ciénaga Anegado of Lajas,
j. a portion of the Susua´s State Forest,
k. DNERs Bird Refuge
l. and the caves of Pedernales in Cabo Rojo.

(See Appendix B for more details.)

3. Conservation and Protection Methods

Fee simple acquisition and/or conservation easements.
Conservation easements for tracts should address:
a. Development rights
b. Management of land for traditional forest uses, recreational purposes and wildlife habitat and scenic resources
c. Public access
d. Protection of rare and endangered species
e. Mineral rights

4. List of Objectives

a. Establishment of a buffer zone for the Guánica State Forest
b. Protection of endangered species habitat
c. Protection of scenic quality
d. Public access for recreation

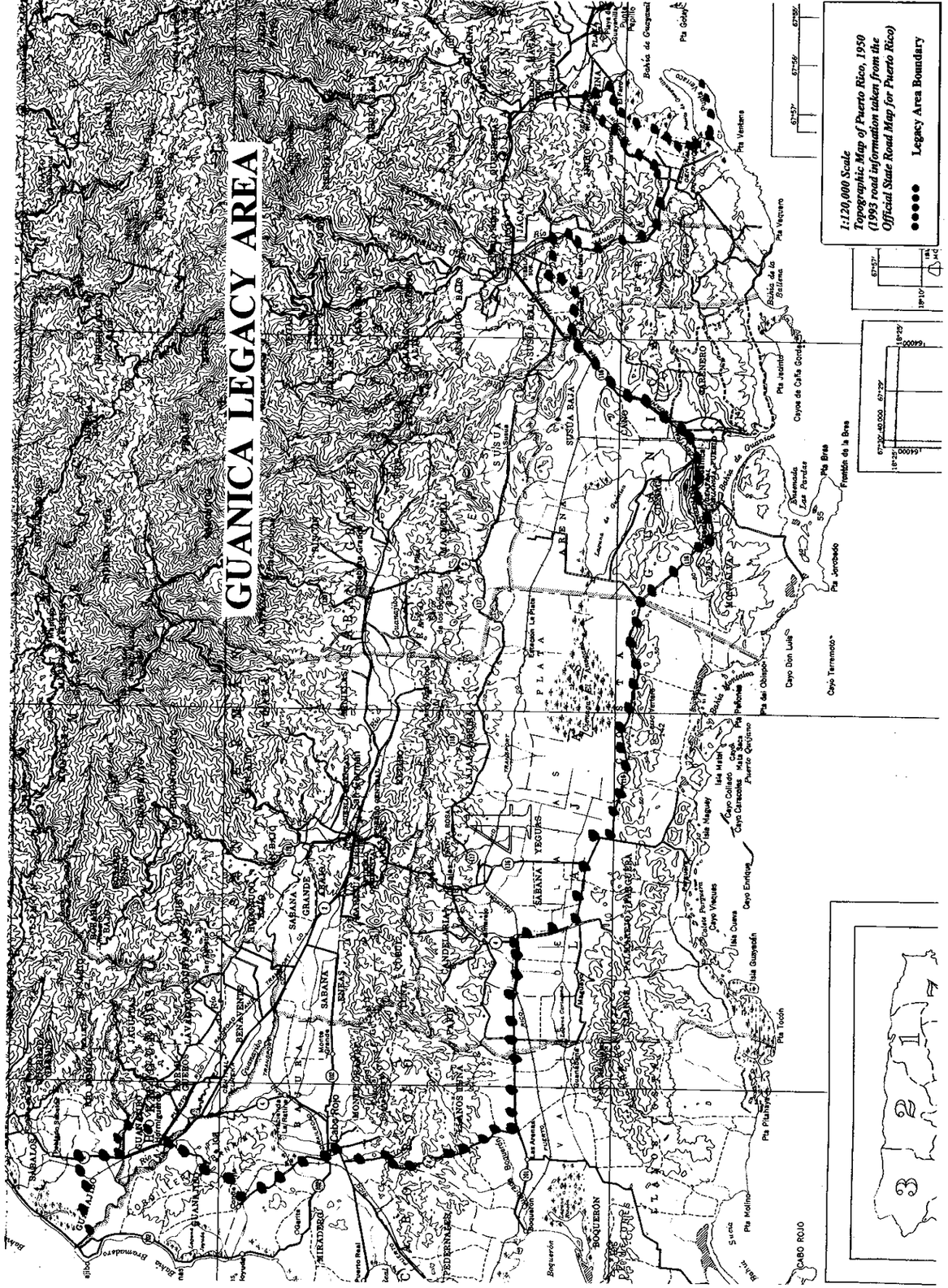
e. Conservation of wildlife habitat
f. Continuation of traditional forest uses

5. Public Benefits to be Derived

a. Enhance and maintain bio-diversity
b. Reduce potential impacts on Guánica State Forest
c. Enhance and maintain natural elements for eco-turism actitities
d. Provide traditional forest products
e. Enhancement of general quality of life

6. Entities that may be assigned administrative, monitoring and/or management responsibilities

a. Commonwealth of Puerto Rico, Department of Natural and Environmental Resources, Forest Service Bureau
b. Local municipal governments
c. The Conservation Trust of Puerto Rico



B. THE MARICAO LEGACY AREA

1. General Location

The Maricao Legacy Area is located on the southwestern portion of the Cordillera Central, extending to the west to the municipality of Mayagüez, to the east to a portion of the municipality of Yauco, including also portions of the municipalities of San Germán and Sabana Grande (see Appendix B for map and detailed information on boundaries). The size of the Area is approximately 29,013.33 ha.

2. Summary of Important Environmental Values

The Maricao Legacy Area contains the following significant resource areas:

a. the Maricao and Susúa State Forest and their buffer zones,
b. transitional tabonuco forest between these forest reserves;
c. the Rodadero Peak area,
d. the Indiera sections of Maricao
e. and the Cerro Las Mesas area of Mayagüez.

(see Appendix B for more details)

3. Conservation and Protection Methods

Fee simple acquisition and/or conservation easements.
Conservation easements for tracts should address:
a. Development rights
b. Management of land for traditional forest uses, recreational purposes and wildlife habitat and scenic resources
c. Public access
d. Protection of rare and endangered species
e. Protection of public water supply
f. Mineral Rights

4. List of Objectives

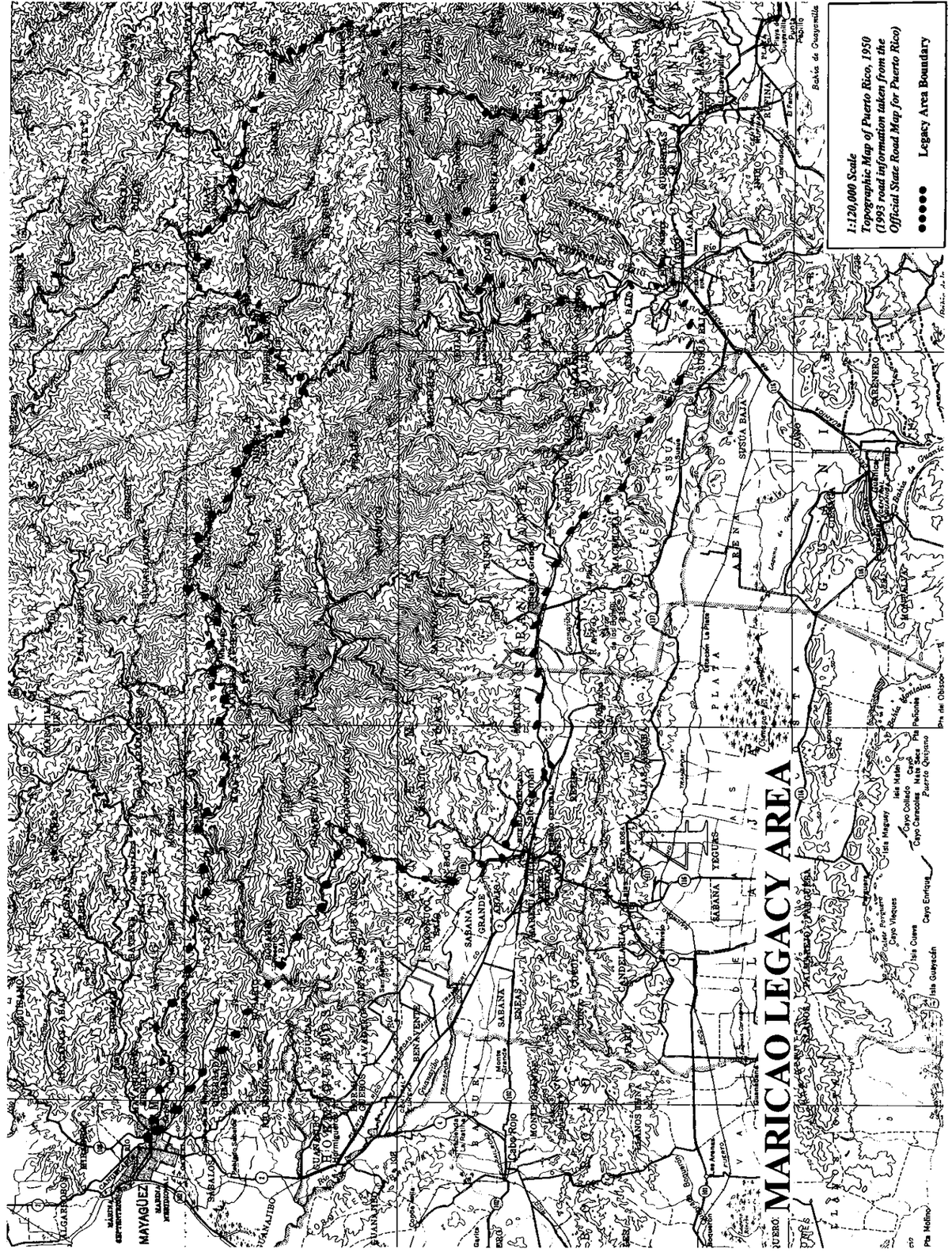
a. Establishment of a buffer zone for the Maricao and Susúa State Forests
b. Protection of endangered species habitat and corridor
c. Protection of scenic quality
d. Public access for recreation
e. Conservation of wildlife habitat
f. Continuation of traditional forest uses

5. Public Benefits to be Derived

a. Decrease potential negative impacts on the Maricao and Susúa Forests
b. Enhancement and maintenance of bio-diversity
c. Allow for development of eco-turism activities
d. Provide traditional forest products

6. Entities that may be assigned administrative, monitoring and/or management responsibilities

a. Commonwealth of Puerto Rico, Department of Natural and Environmental Resources, Forest Service Bureau
b. Local municipal governments
c. The Conservation Trust of Puerto rico



C. THE QUEBRADILLAS LEGACY AREA

1. General Location

The Quebradillas Legacy Area is located on the northwestern portion of the karst region, extending towards the west to the municipality of Isabela, to the east to a portion of the municipality of Arecibo, including also portions of the municipalities of Quebradillas, Camuy, Hatillo and San Sebastián (see Appendix B for map and detailed information on boundaries). The size of the Area is approximately 22,683.33 ha.

2. Summary of Important Environmental Values

The Quebradillas Legacy Area contains the following significant resource areas:

a. the karst forest region,
b. the Guajataca State Forest and its buffer zone,
c. the Quebrada Bellaca area,
d. the Guajataca Gorge and the immediate basin of the Guajataca Lake,
e. and the caves of Terranova and Guajataca in Camuy.

(See Appendix B for more details)

3. Conservation and Protection Methods

Fee simple acquisition and/or conservation easements.
Conservation easements for tracts should address:
a. Development rights
b. Management of land for traditional forest uses, recreational purposes and wildlife habitat and scenic resources
c. Public access
d. Protection of rare and endangered species
e. Protection of public water supply
f. Mineral Rights

4. List of Objectives

1. Establishment of a buffer zone for the Guajataca State Forest
2. Protection of endangered species habitat
3. Protection of scenic quality
4. Public access for recreation
5. Conservation of wildlife habitat
6. Continuation of traditional forest uses
7. Protection of water resources, including underground sources

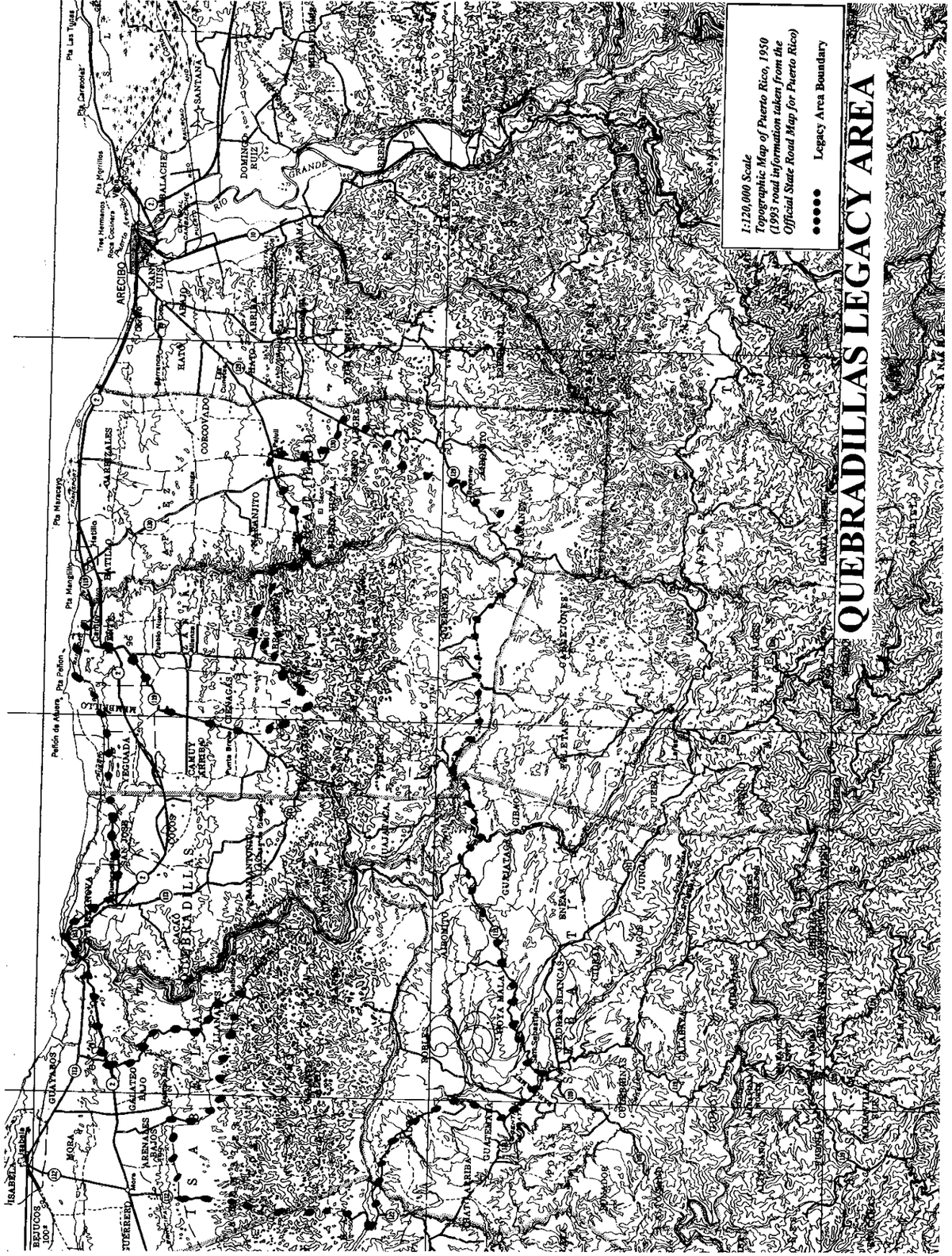
5. Public Benefits to be Derived

a. Decrease potential negative impacts on the Guajataca Forest
b. Enhancement and maintenance of bio-diversity
c. Allow for development of eco-turism activities

d. Provide traditional forest products
e. Provide reliable sources of good water quality and quantity

6. Entities that may be assigned administrative, monitoring and/or management responsibilities

a. Commonwealth of Puerto Rico, Department of Natural and Environmental Resources, Forest Service Bureau
b. Local municipal governments
c. The Conservation Trust of Puerto rico



D. THE CAONILLAS-DOS BOCAS LEGACY AREA

1. General Location

The Caonillas-Dos Bocas Legacy Area is a located on the north-central region of the island. It includes portions of the karst limestone region and the Cordillera Central, extending to the west to the municipalities of Arecibo and Lares, to the east to a portion of the municipalities of Manatí, Ciales and Orocovis, including also portions of the municipalities of Adjuntas, Jayuya, Utuado, Florida and Barceloneta (see Appendix B for map and detailed information on boundaries). The size of the Area is approximately 51,013 ha.

2. Summary of Important Environmental Values

The Caonillas-Dos Bocas Legacy Area contains the following significant resource areas:

a. the basin of the Caonillas and Dos Bocas Lakes,
b. the karst limestone region,
c. the Lago Guineo area,
d. the copper mines area,
e. the Biáfara de Arecibo, Arrozal area,
f. the Hato Viejo area,
g. the Toro Negro State Forest and its buffer zone,
h. the Rio Abajo State Forest and its buffer zone,
i. the Bosque del Pueblo de Adjuntas State Forest and its buffer zone.

(See Appendix B for more details)

3. Conservation and Protection Methods

Fee simple acquisition and/or conservation easements.
Conservation easements for tracts should address:

a. Development rights
b. Management of land for traditional forest uses, recreational purposes and wildlife habitat and scenic resources
c. Public access
d. Protection of rare and endangered species
e. Protection of public water supply
f. Mineral Rights

4. List of Objectives

a. Establishment of a buffer zone for the Toro Negro Forest
b. Establishment of a buffer zone for the Rio Abajo State Forest
c. Establishment of a buffer zone for the Bosque del Pueblo de Adjuntas State Forest
d. Protection of endangered species habitat
e. Protection of scenic quality

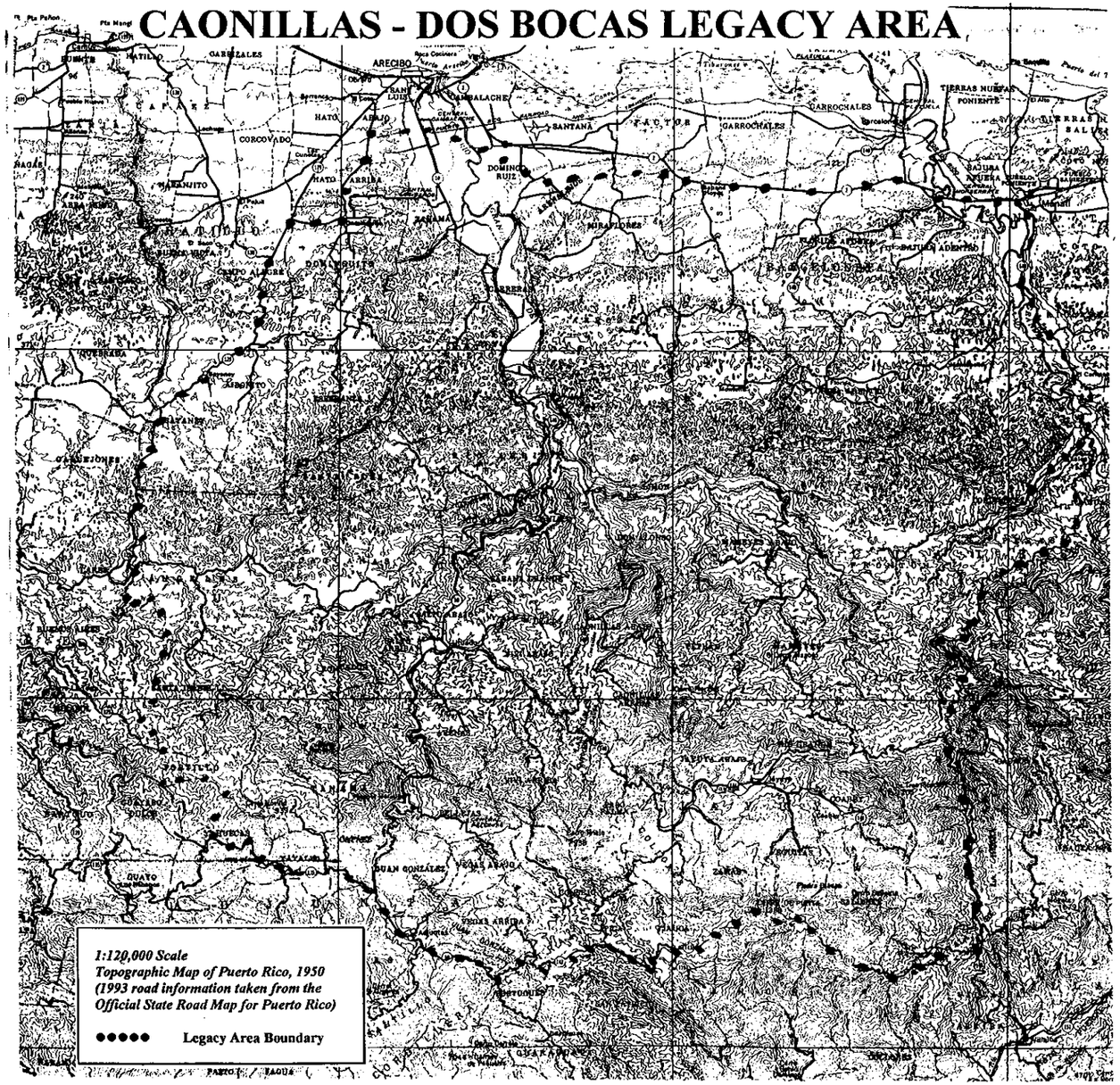
f. Public access for recreation
g. Conservation of wildlife habitat
h. Continuation of traditional forest uses

5. Public Benefits to be Derived

a. Decrease potential negative impacts on the Toro Negro State Forest
b. Decrease potential negative impacts on the Río Grande State Forest
c. Decrease potential negative impacts on the Bosque del Pueblo de Adjuntas State Forest
d. Enhancement and maintenance of bio-diversity
e. Allow for development of eco-turism activities
f. Provide traditional forest products
g. Provide reliable sources of good water quality and quantity

6. Entities that may be assigned administrative, monitoring and/or management responsibilities

a. Commonwealth of Puerto Rico, Department of Natural and Environmental Resources, Forest Service Bureau
b. Local municipal governments
c. The Conservation Trust of Puerto rico



E. THE LA PLATA-COAMO LEGACY AREA

1. General Location

The La Plata-Coamo Legacy Area is located on the central and southern portion of the Cordillera Central, including a considerable section of the basin of the La Plata River and a southern portion extending to the municipalities of Coamo and Salinas (see Appendix B for map and detailed information on boundaries). The size of the Area is approximately 45,417 ha.

2. Summary of Important Environmental Values

The La Plata-Coamo Legacy Area contains the following significant resource areas:

a. the watershed of Lake La Plata, (one of the main providers of water supply to the San Juan Metropolitan Area),
b. the Pasto and Piedras Chiquitas areas,
c. primary Ucar forested areas in Salinas
d. and the Tetas de Cayey Area.

(See Appendix B for more details)

3. Conservation and Protection Methods

Fee simple acquisition and/or conservation easements.

Conservation easements for tracts should address:

a. Development rights
b. Management of land for traditional forest uses, recreational purposes and wildlife habitat and scenic resources
c. Public access
d. Protection of rare and endangered species
e. Protection of public water supply
f. Mineral Rights

4. List of Objectives

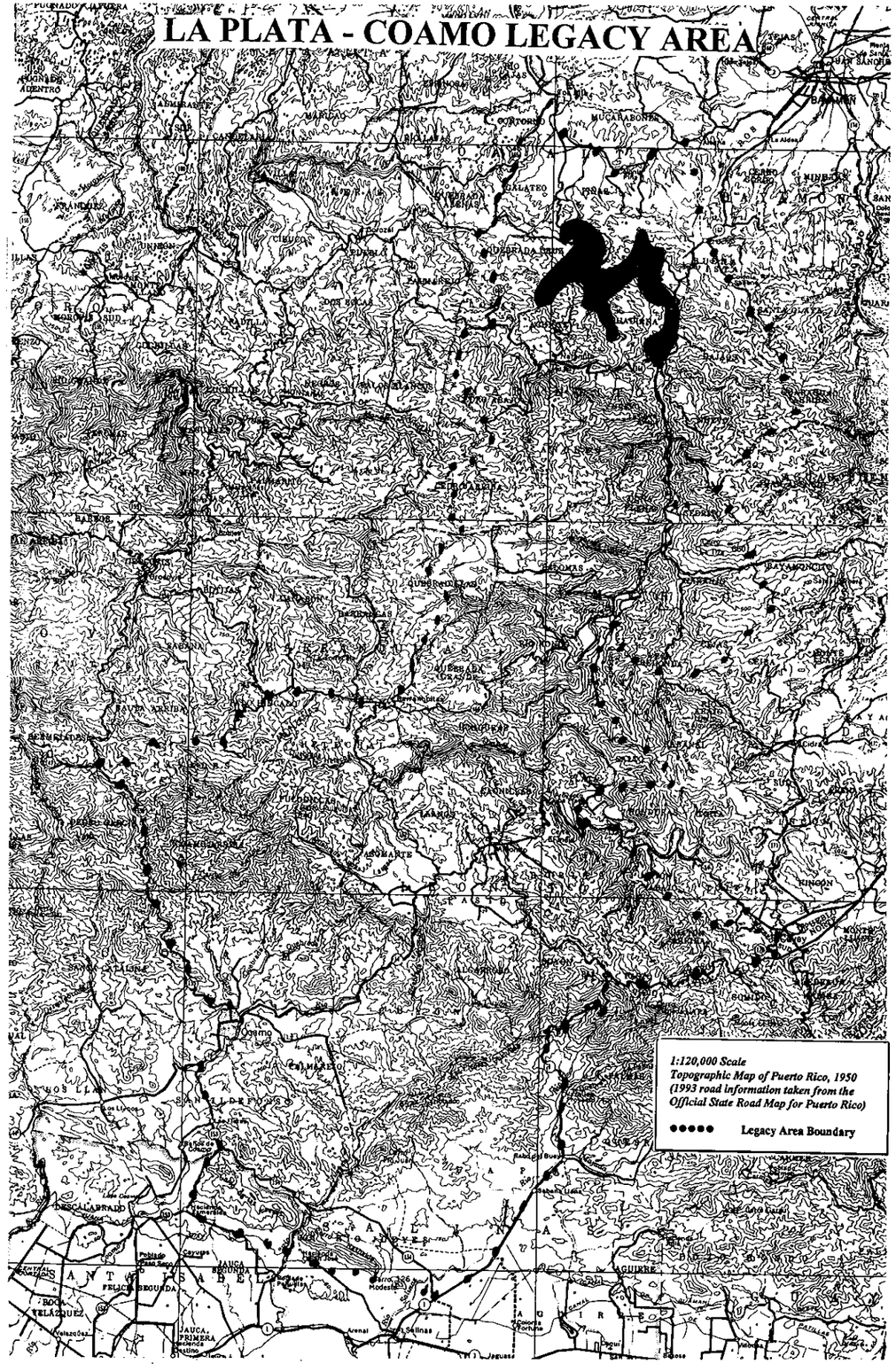
a. Protection of endangered species habitat
b. Protection of scenic quality
c. Public access for recreation
d. Conservation of wildlife habitat
e. Continuation of traditional forest uses
f. Protection of water supply systems

5. Public Benefits to be Derived

a. Enhancement and maintenance of bio-diversity
b. Allow for development of eco-turism activities
c. Provide traditional forest products
d. Provide reliable sources of good water quality and quantity

6. **Entities that may be assigned administrative, monitoring and/or management responsibilities**

   a. Commonwealth of Puerto Rico, Department of Natural and Environmental Resources, Forest Service Bureau
   b. Local municipal governments
   c. The Conservation Trust of Puerto rico



F. THE RIO GRANDE DE LOIZA LEGACY AREA

1. General Location

The Río Grande de Loíza Legacy Area is located on the central eastern portion of the Cordillera Central, extending to the west to the municipalities of Aguas Buenas and Cidra, to the east to a portion of the municipalities of Gurabo and San Lorenzo, including also portions of the municipalities of Cayey, Juncos and Trujillo Alto (see Appendix B for map and detailed information on boundaries). The size of the Area is approximately 23,410 ha.

2. Summary of Important Environmental Values

The Río Grande de Loíza Legacy Area contains the following significant resource areas:

a. the upper basin of the Carraízo Lake (Lake Loíza), (the main water supply source of the San Juan Metropolitan Area),
b. the immediate basin of the Cidra Lake, (another principal water supply source for the San Juan Metropolitan Area),
c. and the Carite Lake, (a water supply source for the southern portion of the island.)
d. the Carite State Forest and its buffer zone

(See Appendix B for more details)

3. Conservation and Protection Methods

Fee simple acquisition and/or conservation easements.
Conservation easements for tracts should address:

a. Development rights
b. Management of land for traditional forest uses, recreational purposes and wildlife habitat and scenic resources
c. Public access
d. Protection of rare and endangered species
e. Protection of public water supply
f. Mineral Rights

4. List of Objectives

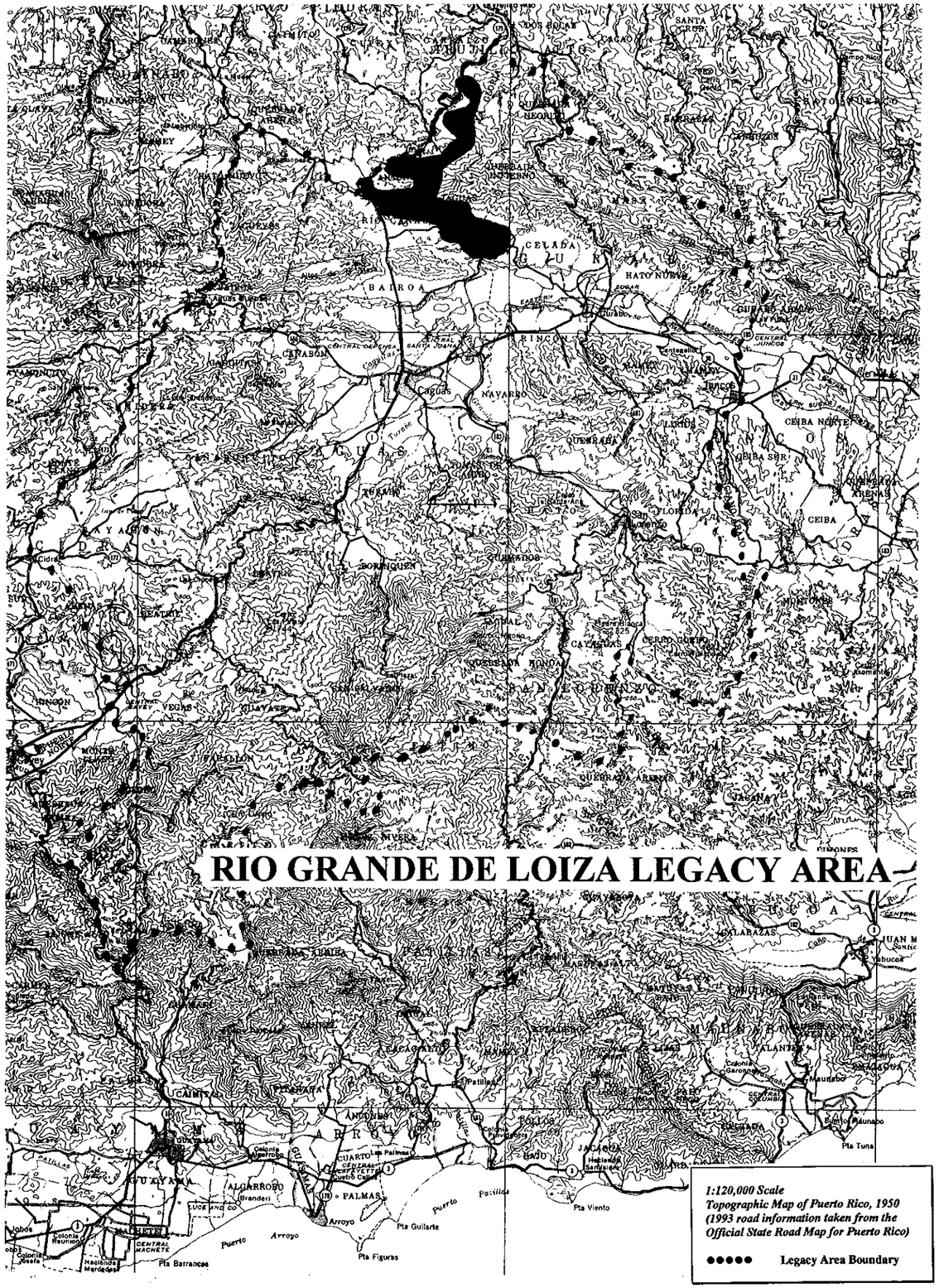
a. Establishment of a buffer zone for the Carite State Forest
b. Protection of endangered species habitat
c. Protection of scenic quality
d. Public access for recreation
e. Conservation of wildlife habitat
f. Continuation of traditional forest uses
g. Protection of public water supply

5. Public Benefits to be Derived

a. Decrease potential negative impacts on the Carite State Forest
b. Enhancement and maintenance of bio-diversity
c. Allow for development of eco-turism activities
d. Provide traditional forest products
e. Provide reliable sources of good water quality and quantity

6. Entities that may be assigned administrative, monitoring and/or management responsibilities

a. Commonwealth of Puerto Rico, Department of Natural and Environmental Resources, Forest Service Bureau
b. Local municipal governments
c. The Conservation Trust of Puerto rico



G. THE MAUNABO LEGACY AREA

1. General Location

The Maunabo Legacy Area is located on the southeastern coast of the island, including portions of the municipalities of Maunabo and Yabucoa (see Appendix B for map and detailed information on boundaries). The size of the Area is approximately 10,233 ha.

2. Summary of Important Environmental Values

The Maunabo Legacy Area contains the following significant resource areas:

a. the Cuchilla Panduras region.

(See Appendix B for more details)

3. Conservation and Protection Methods

Fee simple acquisition and/or conservation easements.

Conservation easements for tracts should address:

a. Development rights
b. Management of land for traditional forest uses, recreational purposes and wildlife habitat and scenic resources
c. Public access
d. Protection of rare and endangered species

4. List of Objectives

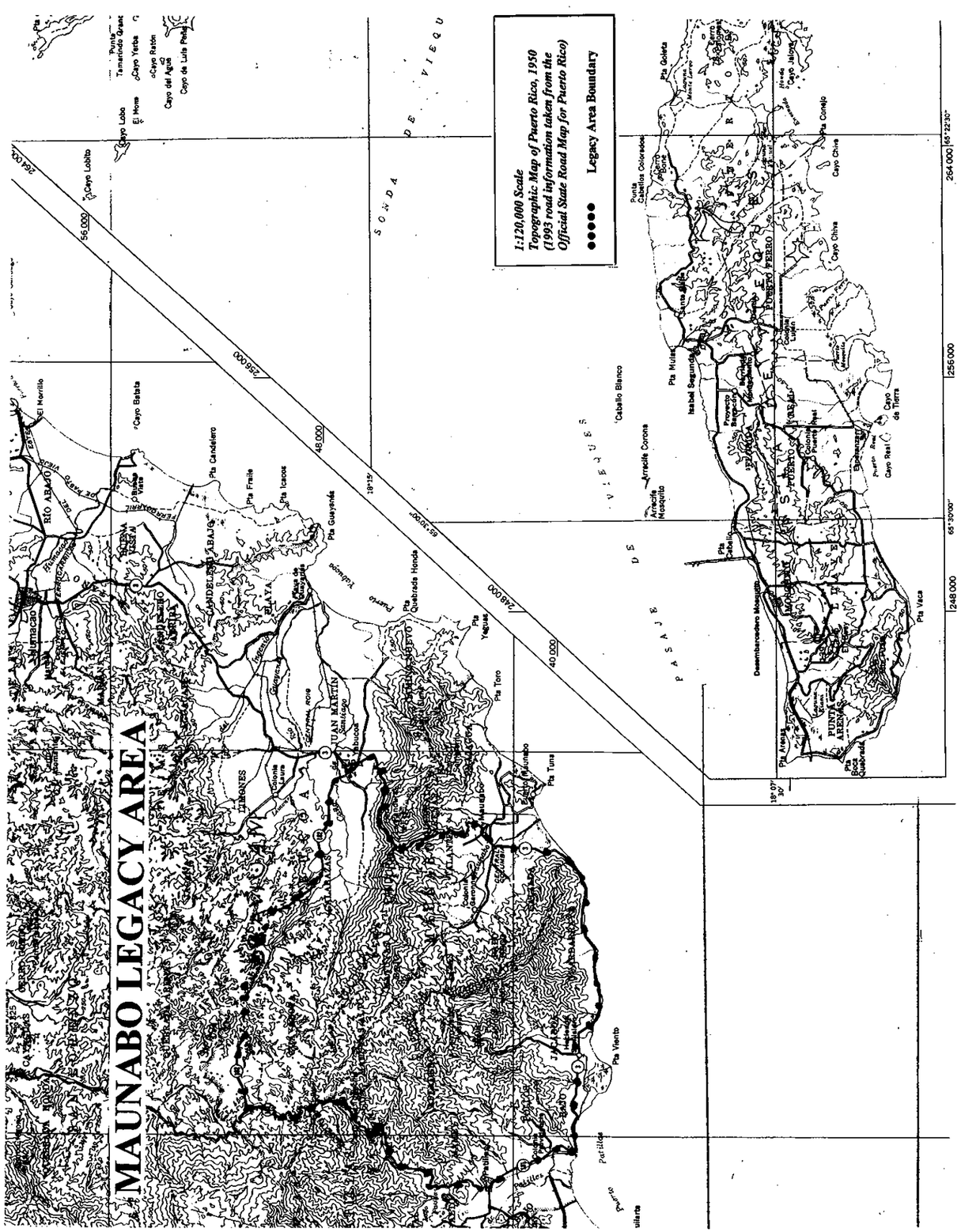
a. Protection of endangered species habitat
b. Protection of scenic quality
c. Public access for recreation
d. Conservation of wildlife habitat
e. Continuation of traditional forest uses

5. Public Benefits to be Derived

a. Enhancement and maintenance of bio-diversity
b. Allow for development of eco-turism activities
c. Provide traditional forest products
d. Provide reliable sources of good water quality and quantity

6. Entities that may be assigned administrative, monitoring and/or management responsibilities

a. Commonwealth of Puerto Rico, Department of Natural and Environmental Resources, Forest Service Bureau
b. Local municipal governments
c. The Conservation Trust of Puerto rico



H. THE EL YUNQUE LEGACY AREA

1. General Location

The El Yunque Legacy Area is located on the eastern portion of the island on the Sierra de Luquillo mountains, including the buffer zone of the Caribbean National Forest and Biosphere Reserve (see Appendix B for map and detailed information on boundaries). The size of the Area is approximately 20,890 ha.

2. Summary of Important Environmental Values

The El Yunque Legacy Area contains the following significant resource areas:

a. the Caribbean National Forest and Biosphere Reserve and its buffer zone.

(See Appendix B for more details)

3. Conservation and Protection Methods

Fee simple acquisition and/or conservation easements.
Conservation easements for tracts should address:

a. Development rights
b. Management of land for traditional forest uses, recreational purposes and wildlife habitat and scenic resources
c. Public access
d. Protection of rare and endangered species
e. Protection of public water supply
f. Mineral Rights

4. List of Objectives

a. Establishment of a buffer zone for the Caribbean National Forest
b. Protection of endangered species habitat
c. Protection of scenic quality
d. Public access for recreation
e. Conservation of wildlife habitat
f. Continuation of traditional forest uses
g. Protection of public water supply

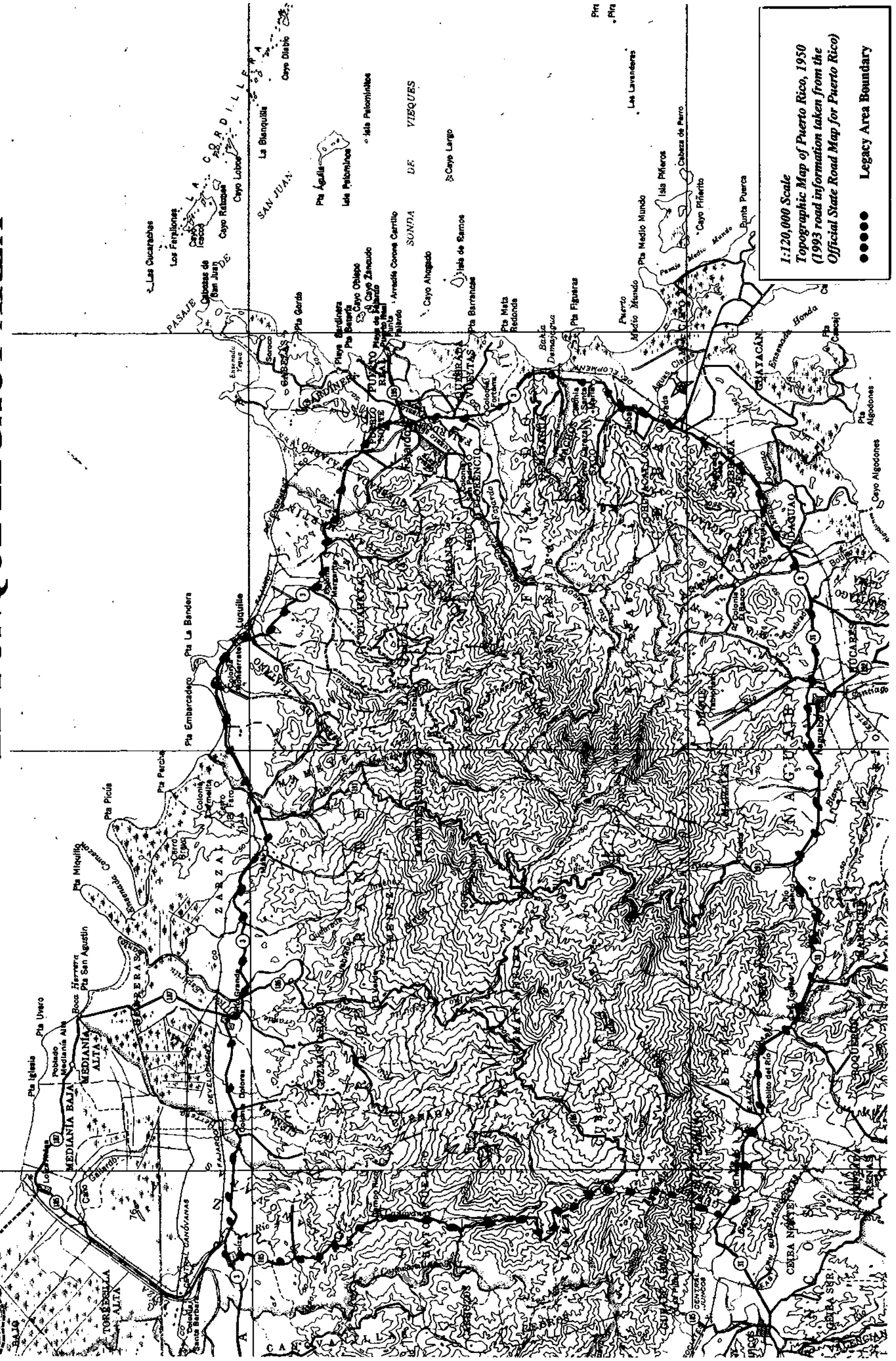
5. Public Benefits to be Derived

a. Decrease potential negative impacts on the Caribbean National Forest
b. Enhancement and maintenance of bio-diversity
c. Allow for development of eco-turism activities
d. Provide traditional forest products
e. Provide reliable sources of good water quality and quantity

6. **Entities that may be assigned administrative, monitoring and/or management responsibilities**

   a. Commonwealth of Puerto Rico, Department of Natural and Environmental Resources, Forest Service Bureau
   b. USDA Forest Service
   c. Local municipal governments
   d. The Conservation Trust of Puerto rico

EL YUNQUE LEGACY AREA



IV. PUBLIC INVOLVEMENT IN THE ASSESSMENT PHASE

The public involvement process for the preparation of the Assessment of Need for the Puerto Rico Forest Legacy Program began internally with the in-depth discussion of the program with the staff of the Forest Service Bureau, the Natural Heritage Division and other relevant areas within the Department of Natural and Environmental Resources (DNER). Issues concerning program need, interrelationships of the FLP with other federal and Commonwealth programs currently active in the DNER were discussed and goals and objectives of the program clearly defined. An important distinction in regards to the Natural Heritage Division goals and objectives was established concerning the focus of the program on "working" forests, differing from the Natural Heritage Division whose goal is strictly conservation.

The second level was the presentation of the Forest Legacy Program to the Forest Advisory/Conceptual Team (FACT), a public involvement committee organized by the Forest Service Bureau which encompasses the Forest Stewardship Committee. FACT broadly represents the spectrum of organizations involved in all aspects related to forestry and environmental issues in Puerto Rico. The FACT members agreed on the desirability of implementing Forest Legacy Program in Puerto Rico with the recommendation that its adaptation to the local realities be reviewed. The recommendations were taken into consideration in the assessment analysis.

The Forest Legacy Areas were initially nominated by the Forest Service Bureau, the Natural Heritage Division and USDA Forest Service personnel. The FACT reviewed and expressed agreement with the nominated Forest Legacy Areas.

In an effort to establish an Association of Private Forest Landowners, three focus meetings were organized with private forest landowners. These were highly successful. The desirability of the implementation of the Forest Legacy Program in Puerto Rico was highly approved by all participating landowners. The following recommendations were made:

1. That the program be also created locally as a program of the DNER. They deemed the program as so very important to Puerto Rico that it should be implemented even if the program does not continue at the federal level. The presentation of legislation for this purposes was recommended.
2. That an act be drafted and presented for the approval by the PR Legislature creating conservations easements in Puerto Rico.
3. The private forest landowner is penalized as he/she receives no incentives for maintaining the land forested and must pay taxes when these are exempted when the property is agricultural uses. Agricultural uses provide many incentives, including programs that promote the elimination of forest cover such as those promoting sun grown coffee. Additional incentives to the Forest Legacy Program are recommended because it will compete with other land uses promoted by such programs.
4. Landowners need financial assistance in reforestation processes, as this is a very expensive activity. They also need technical assistance on forest management and trained workers to perform adequately the required activities.
5. For those landowners who do not have large extensions of land, it is very hard to consider a perpetuity agreement and other ways through which these landowners can participate should be explored. Alternatives included a shorter period of time with less benefits.
6. It was recommended that alternatives be explored to raise funds for watershed reforestation and conservation from the higher income cities which are consumers of the water supplies generated by the lower income mountainous area.
7. The landowners recommended that no legacy areas be pre-defined as the program should have the flexibility to acquire important tracts anywhere on the island.

Another phase of the public involvement process included meetings and sharing of documents with pertinent government agencies, such as the Puerto Rico Planning Board and with environmental organizations such as the Conservation Trust of Puerto rico and the Puerto Rico Conservation Fundation (Fundación Puertorriqueña de Conservación). They all recognized the desirability of implementing the Forest Legacy Program in Puerto Rico.

Appendix A

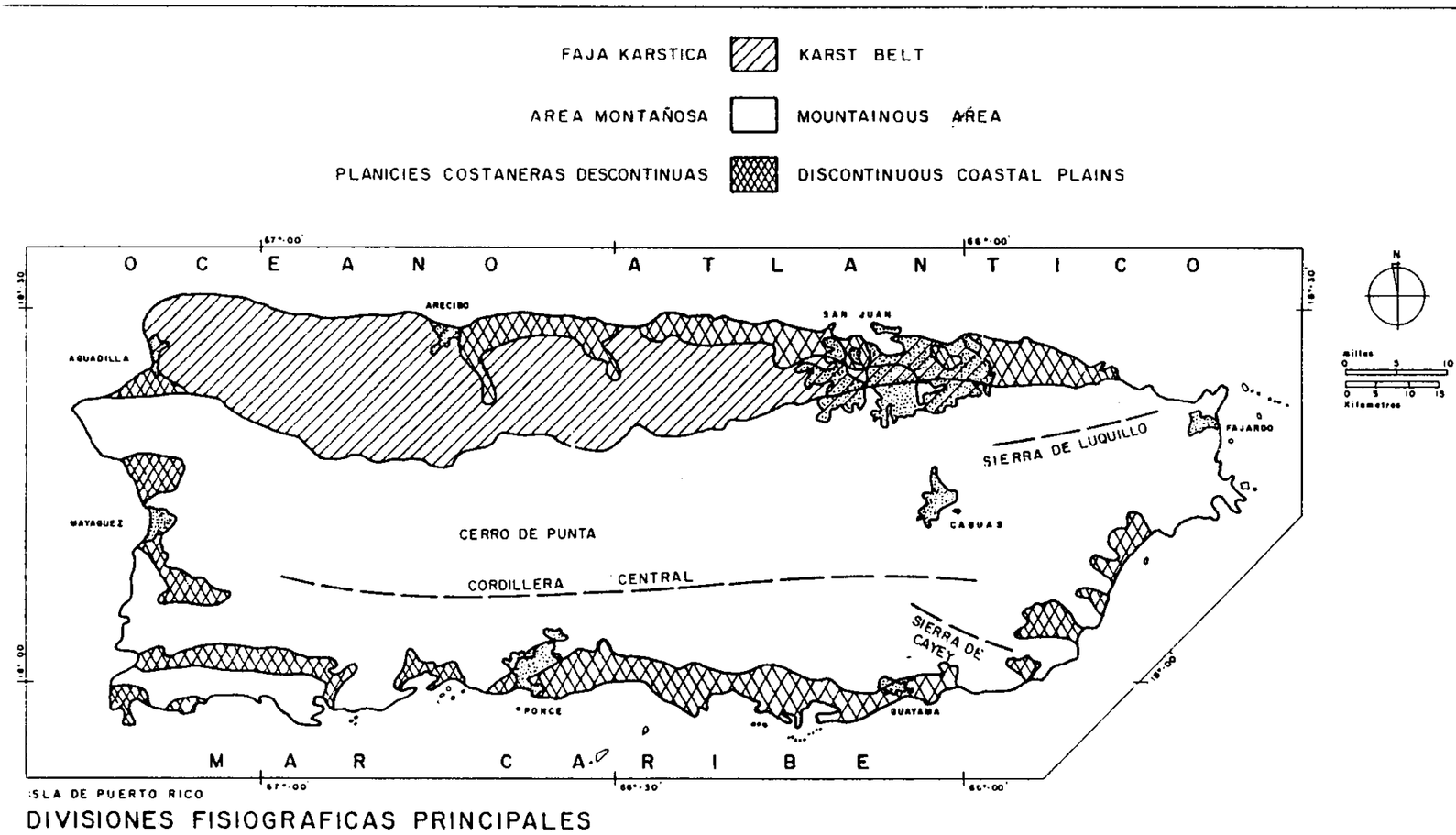


Figure 2

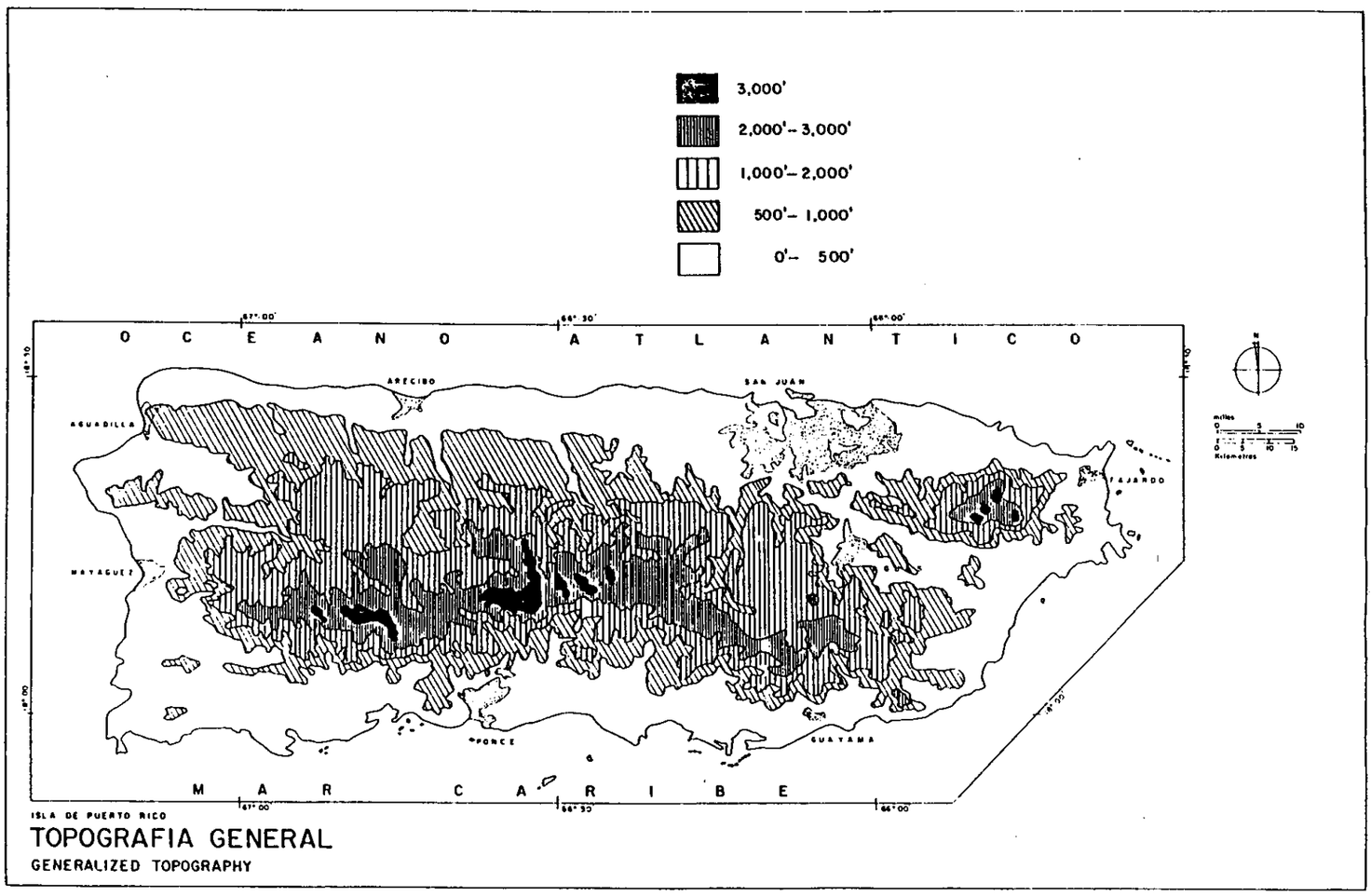


Figure 3

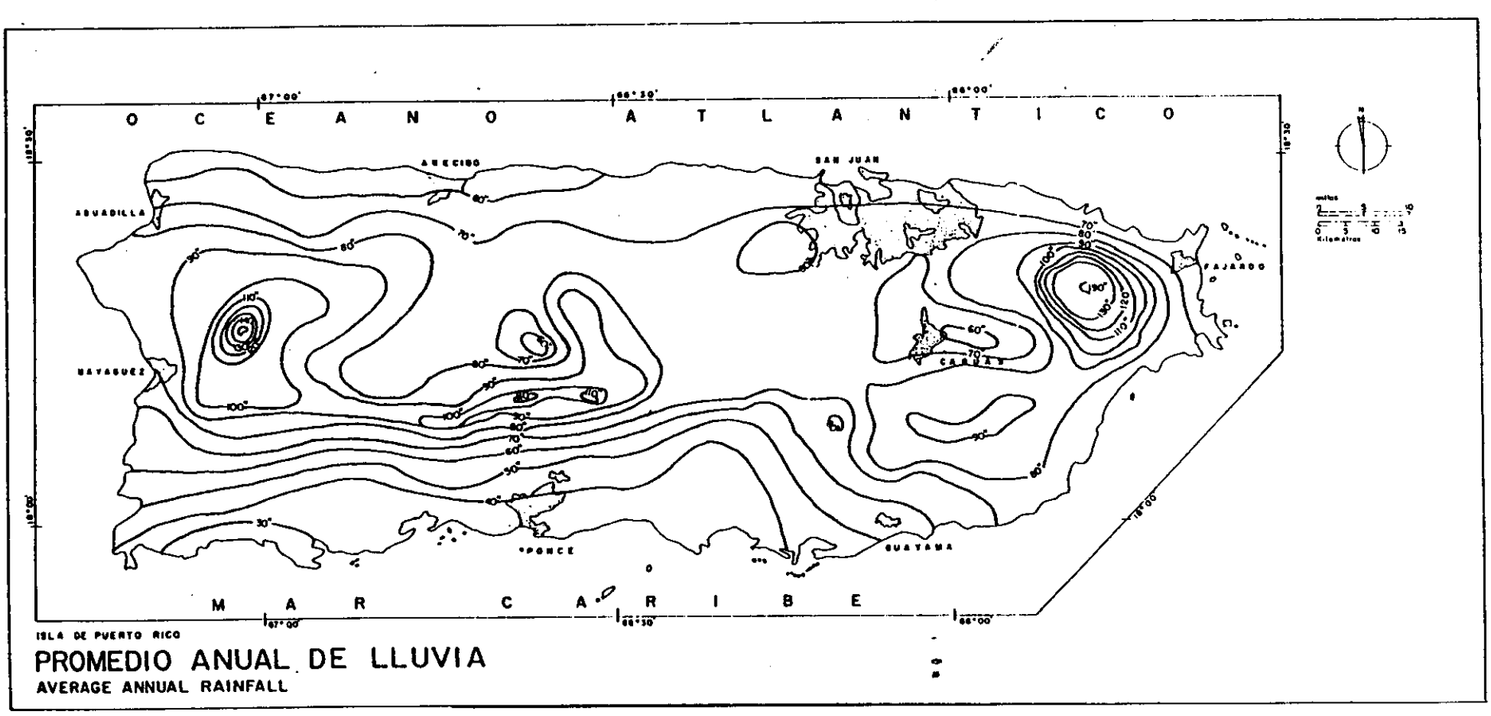


Figure 4

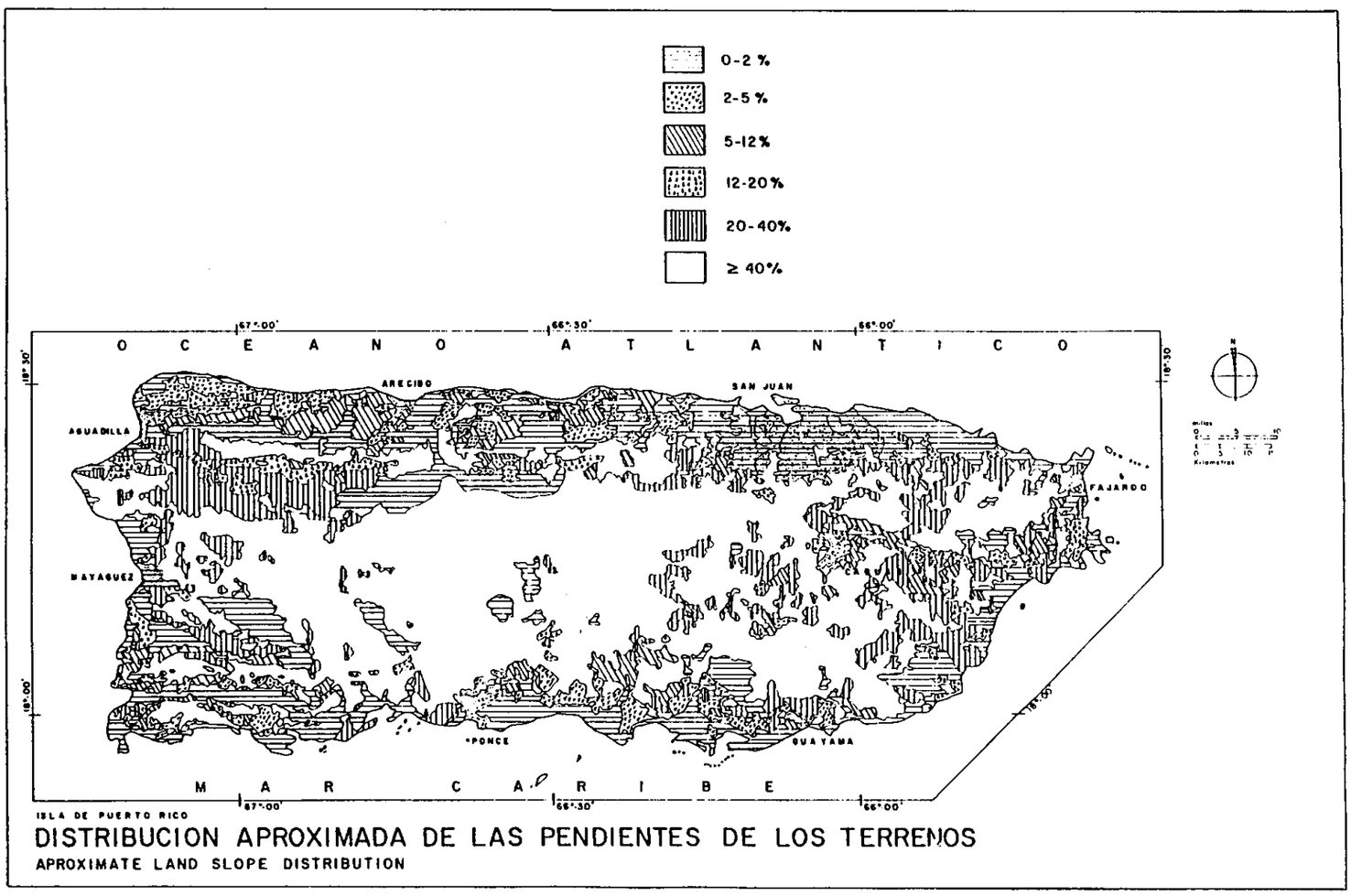


Figure 5

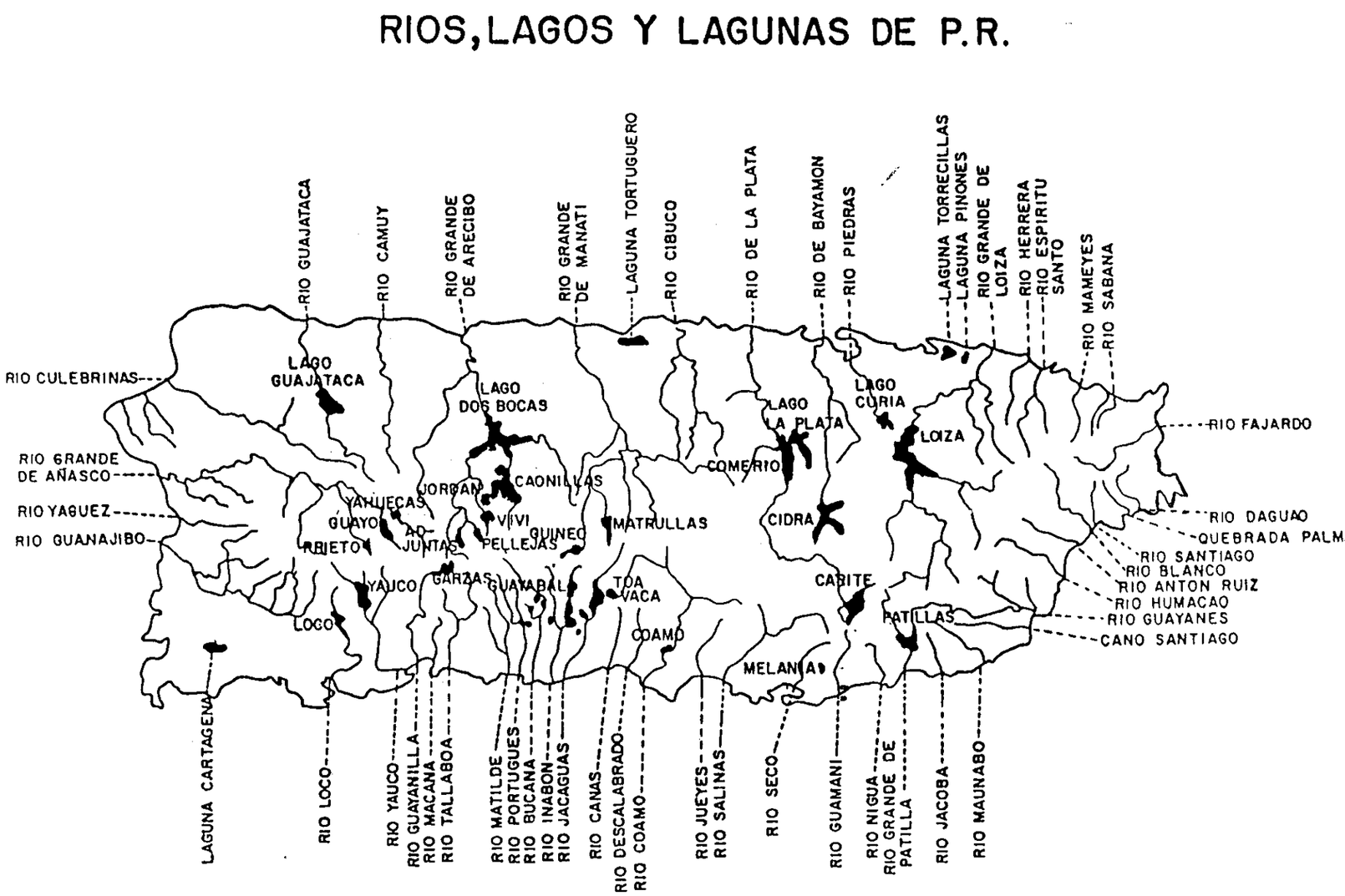
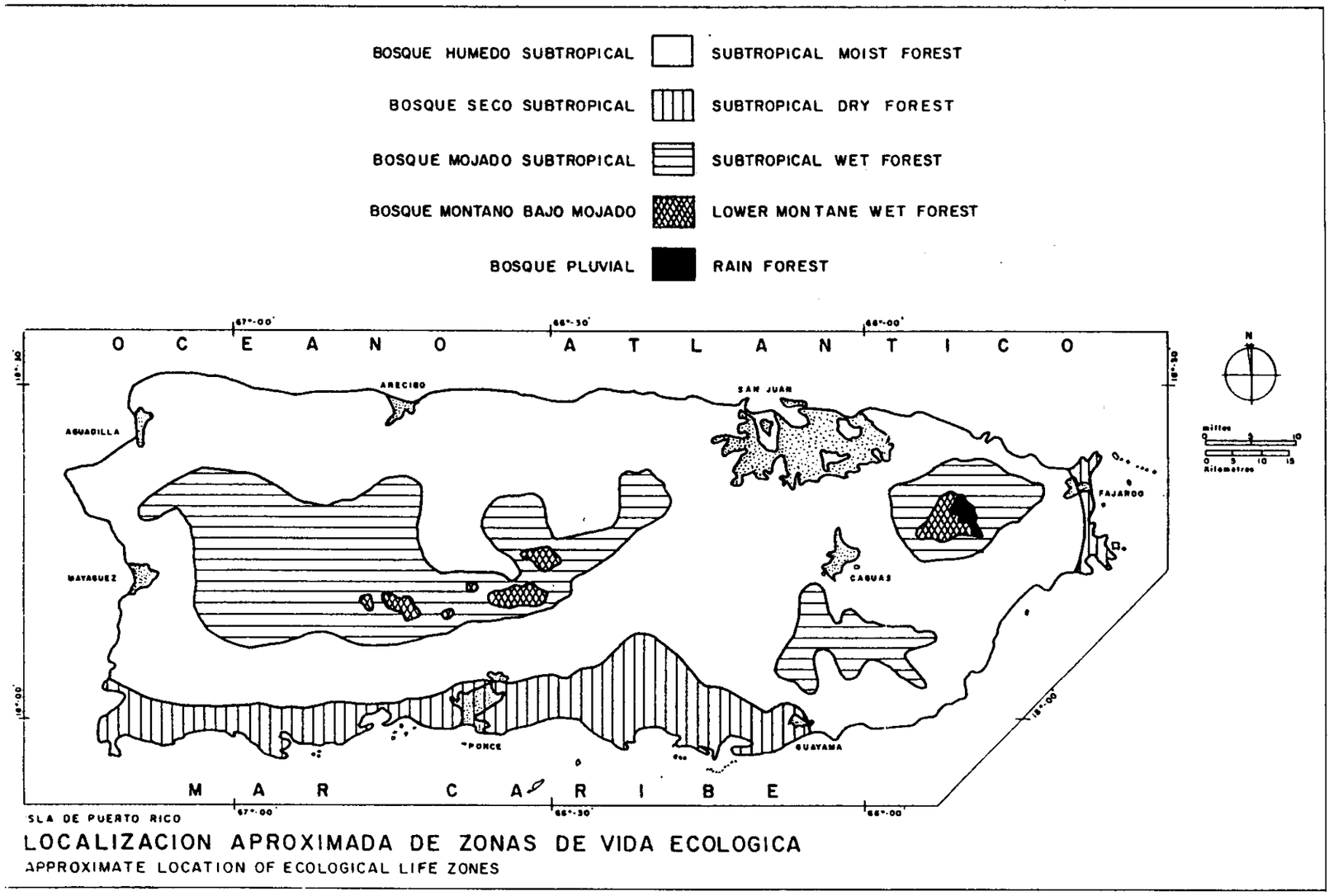


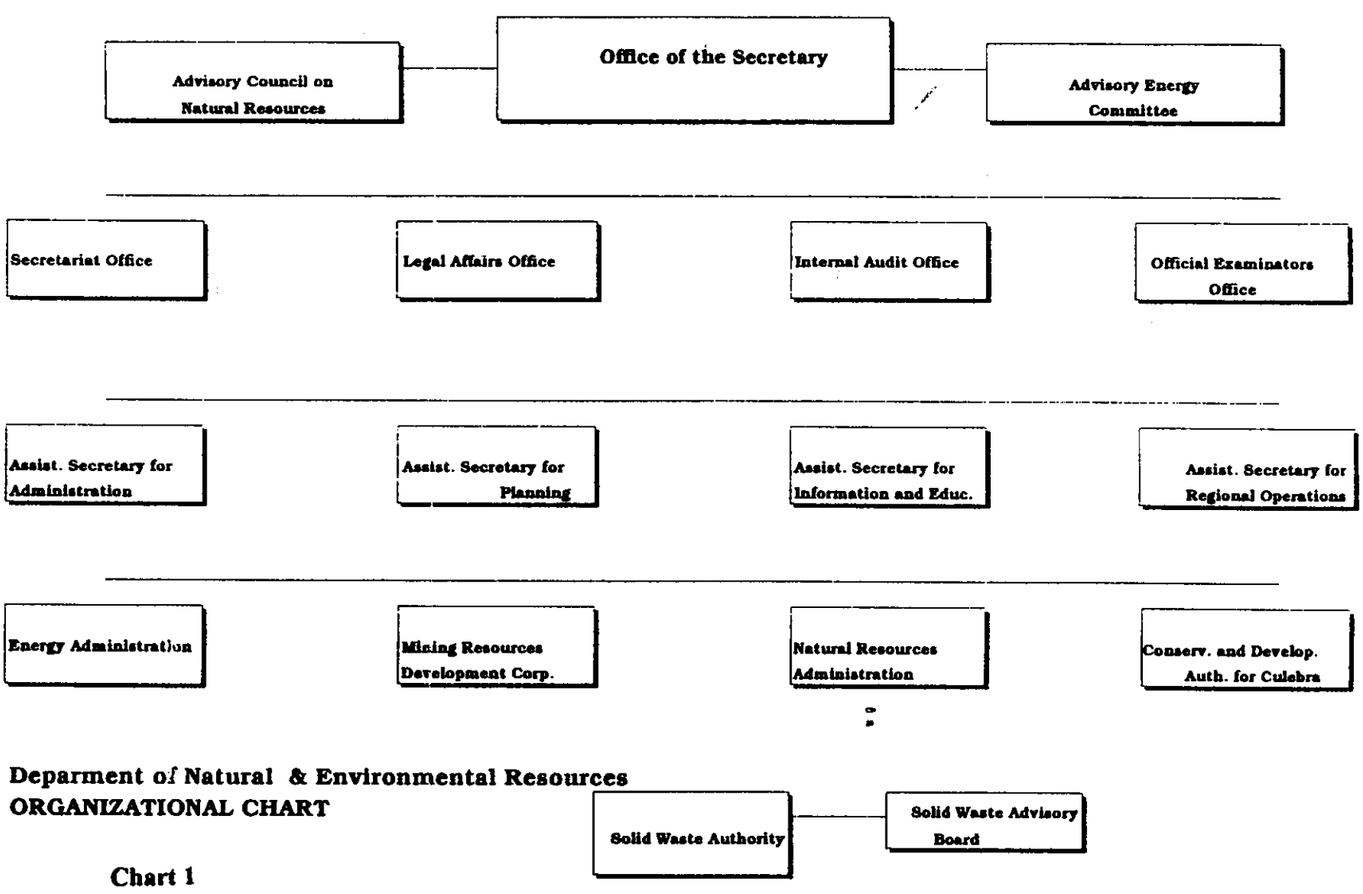
Figure 6: Water Bodies



LOCALIZACION APROXIMADA DE ZONAS DE VIDA ECOLOGICA

APPROXIMATE LOCATION OF ECOLOGICAL LIFE ZONES

Figure 7



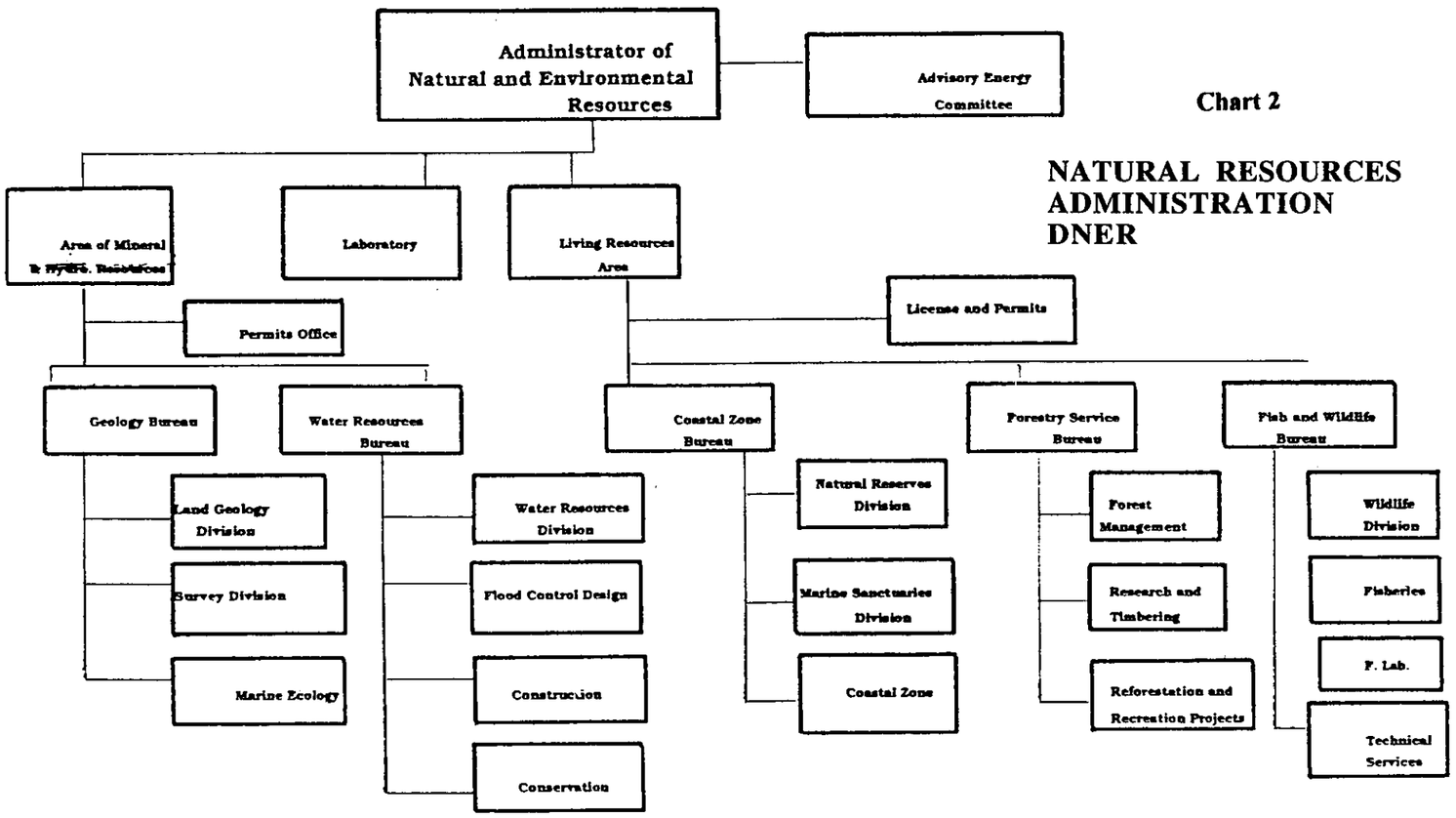
Deparment of Natural & Environmental Resources

ORGANIZATIONAL CHART

Chart 1

Chart 2

NATURAL RESOURCES ADMINISTRATION DNER



DETAILED INFORMATION ON THE PUERTO RICO FOREST LEGACY AREAS

Legacy Areas have are defined as large general delimitation within which, and only within which, tracts can be selected for the purpose of acquiring conservation easements. To simplify the delimitation, the Legacy Area boundaries are defined by existing roads, as presented in the official State Road Map for Puerto Rico prepared by the Department of Transportation and Public Works and dated December 31, 1993. Therefore, not all the territory within each Legacy Area is of interest to the Puerto Rico Legacy Program. However, all areas of interests are included within a Legacy Area.

THE GUANICA LEGACY AREA

I. Boundary Delimitation

The Guánica Legacy Area lies between its northern boundary and the coast line. The northern boundary is defined as follows, begining to the east on Punta Verraco, Municipality of Guayanilla. (Please refer to Map for this Legacy Area):

- West on PR 135 to ⊥[13] with PR 335
- West on PR 335 to ⊥ with PR 2
- West on PR2 to ⊥ with PR 117
- West on PR 117 to ⊥ with PR 322
- South on PR 322 to ⊥ with PR 116
- West on PR 116 to to ⊥ with PR 305
- West on PR305 to ⊥ with PR 303
- North on PR 303 to ⊥ with PR 101
- West on PR 101 to ⊥ with PR 100
- North on PR 100 to ⊥ with PR 2
- North on PR 2 to ⊥ with PR 340
- West on PR 340 to coastline

II. Important Environmental Values of this Legacy Area

A. The Guánica State Forest and Biosphere Reserve

This Forest Legacy Area establishes a buffer zone for the Guánica State Forest and Biosphere Reserve. This State Forest belongs to the Commonwealth of Puerto Rico and has been rightfully called "the best example of subtropical dry forest vegetation in the world." Only one percent of the dry forest vegetation originally covering the planet now remains. The relatively undisturbed Guánica forest with its mosaic of habitats, is a vital refuge for dry forest organisms that are vulnerable to hunting and degradation of their habitat. Many species of plants and animals living in this forest are found nowhere else in the world. The reserve is so valuable is has merited a designation of Biosphere Reserve of planetary importance by the United Nations.

[13] ⊥ = intersection

These 3,600 ha of forest reserve contain a great richness in plant and bird life. Over 700 species of plants have been reported for the Guánica Forest. Of these, 246 are trees, 48 are considered rare or endangered and 16 are only found within the forest's boundaries. According to Kepler and Kepler (1970), the diversity of birds in the Guánica forest is greater than in the Caribbean National Forest. Half of all the species of land birds found in Puerto Rico are represented in the Guánica Forest. In addition, it has twice the density of birds found anywhere else. It is by far the richest forest in Puerto Rico in avian fauna. In 1951, a bird previously considered extinct from the world, the Puerto Rican Nightjar was rediscovered in the Guánica Forest. Today it is still found nowhere else. Nine of Puerto Rico's fourteen endemic bird species occur in this forest. These are: *Sauroptera vieilloti* (the Puerto Rican Lizard Cuckoo), *Chlorostilbon maugaeus* (the Puerto Rican Emerald Hummingbird), *Melanerpes portoricensis* (the Puerto Rican Woodpecker,) the Puerto Rico Flycatcher, *Agelaius xanthomus* (the Yellow-shouldered Blackbird), *Vireo latimeri* (the Puerto Rican Vireo), *Loxigilla portoricensis* (the Puerto Rican Bullfinch), and the Puerto Rican Night Jar. Two of these, the Yellow-shouldered Blackbird and the *Caprimulgus vociferus noctitherus* (the Puerto Rican Night Jar) are endangered species.

The forest also supports an important herpetofauna that includes such rare and endemic forms as *Ameiva wetmorei* and *Anolils cooki*. Recently a large breeding population of *Peltophyrne lemur* was discovered within the forest boundaries. *Goecarcinus ruricola*, the purple land crab is abundant. This species of edible crab is very rare and is being considered for inclusion in the DNER endangered species list.

The Forest Legacy Area proposed includes land that conforms the natural buffer zone of this important biosphere reserve. Specific tracts have already been identified as many landowners in the immediate vicinity of the forest and whose properties could constitute the very needed buffer zone have expressed their willingness to sell their properties. The area has experienced pressures for hotel construction and industrial development.

B. The Boquerón State Forest

The Boquerón Forest is also a Commonwealth forest and consists of mangrove swamps on the coast, many of them cut from the mainland by channels. The forest is a wildlife refuge containing at least 58 species of fish and over 50 species of birds, many of them considered rare and endangered. The lagoons serve as feeding grounds for the acuatic birds and fishes.

This Legacy Area includes tracts of land that can conform a much needed buffer zone for this important forest reserve.

C. Sierra Bermeja (Cerro Mariquita)

Sierra Bermeja is a mountainous formation located between the municipalities of Cabo Rojo and San Germán. Cerro Mariquita is it highest peak, reaching approximately 300 meters of elevation. Sierra Bermeja is probably the oldest rock formation on the island. It contains 169 species of plants, some which are of singular importance,

Several are endemic to Puerto Rico and not known to be found elswhere, others are of restricted or scarce distribution. The following are species found in the area that are in the endangered list or candidates for such list: *Aristida chaseae, Aristida portoricensis, Leptecereus quadricostatus, Luonia truncata var proctorii, Vernonia proctorii.*

D. Laguna Joyuda Natural Reserve

The Joyuda Lagoon is located on the west coast of Puerto Rico, approximately five miles from the city of Mayagüez. It belongs to the Commonwealth of Puerto Rico and is of public use.

The lagoon has brackish water and is linked to the sea by a small channel. It is bordered by a forest of red mangroves (*Rhizophora*) forming an extensive swamp covering approximately 120 ha. with a depth of approximately 8 feet which is an extraordinary habitat for birds, insects and fish.

Currently the lagoon is used as a fishing area, a site for scientific studies by the Energy Studies Center and by the Department of Natural Resources.

This natural reserve encompasses strictly the water limits of the lagoon and the surrounding mangrove forest is not protected. The proposed legacy area includes a buffer zone for this natural reserve.

E. Other Important Areas

The proposed legacy area includes other environmentally important areas (that are not necessarily forests) such as: the National Wildlife Refuge, a dry forested area similar to the Guánica Biospheric Reserve administered by US Fish and Wildlife Service; Cabo Rojo Salines; Guaniquilla Lagoon, the Boca Prieta knolls, including those to the east of Boca Prieta, Guánica Lagoon, Ciénaga Anegado of Lajas, a portion of the Susua State Forest, DNER's Bird Refuge and the caves of Pedernales in Cabo Rojo.

THE MARICAO LEGACY AREA

I. Boundary Delimitation

The Maricao Legacy Area extends eastward from the city of Mayagüez as follows: (Please refer to Map for this Legacy Area):

- Out of Mayagüez to the southeast on PR 349 to ⊥[14] with PR 119.
- South on PR 119 to ⊥ with PR 2
- Southeast on PR 2 to the town of Sabana Grande
- Out of Sabana Grande to the east on PR 368 to the town of Yauco
- Out of Yauco to the north on PR 128 to ⊥ with PR 373
- Northeast on PR 373 to ⊥ with PR 372
- East then south on PR 372 to ⊥ with PR 375
- Southeast on PR 375 to ⊥ with PR 378

[14] ⊥ = intersection

- North on PR 378 to ⊥ with PR 131
- North on PR131 to ⊥ with PR 525
- West on PR 135 to ⊥ with PR 128
- Southwest on PR 128 to ⊥ with PR 105
- West on PR 105 into the city of Mayagüez

II. Important Environmental Values of this Legacy Area

A. The Maricao State Forest

The Maricao State Forest lies at the western end of the Cordillera Central and is divided into two separate segments comprising 4,100.8 ha. This forest represents vegetation types of serpentine soils and probably has the most diversified flora of any area of the same size in Puerto Rico. Of the avifauna recorded within the Maricao forest, 11 species are endemic to Puerto Rico, 7 are endemic subspecies, 16 are breeding residents and 10 are migrants from North America. This is the habitat of the endemic broad winged hawk and sharp-shinned hawk and the rare elfin woods warbler. There is circumstantial evidence that the supposedly extinct rodent *Isolobodon portoricensis* (jutía) may be surviving in the Maricao Forest. The headwaters of the Maricao river is the habitat of a tree frog found in only one other locality in western Puerto Rico.

The Maricao State Forest probably has the most diversified flora. The vegetation of the Maricao forest is outstanding because of the relative rarity elsewhere of many of the plant species present. The forest's total vascular flora of 845 species (278 reaching tree size) includes 123 species endemic to Puerto Rico and 20 endemic to Maricao. The rich diversity of trees resulting in unique forest types occurring only in Puerto Rico may be due to the closed nutrient cycling, adequate rainfall received on well aerated serpetine soils in addition to the unusual combination of physiographic features (serpentine and volcanic soils).

Five vegetation associations have been delineated in three bio-climatic life zones. A dwarfed vegetation of evergreen, small-leafed species occupies the narrow ridges, peaks and summits exposed to strong winds and is probably unique to Puerto Rico. Along the ridges and towards the windward lopes, large cushions of the rare raineer moss form a unique element of the forest floor.

The plant life of the Maricao State Forest is unique because of three circumstances:

1. the climate of the area is restricted to less than 10% of Puerto Rico;
2. the physiologically dry soils create a seasonal or monsoon growth environment not found elsewhere in Puerto Rico and;
3. in contrast to virtually all similar adjacent areas, the natural vegetation has never been removed from larger areas within the forest.

The Maricao State Forest provides a habitat for at least 44 species of birds including two species on endangered hawks. Scenic vistas and unique rock formations

are found in Río Cruces and Quebrada Agustina. The forest has also watershed importance for the western portion of the island[15].

The proposed Maricao Legacy Area provides a much needed buffer zone to the Maricao Forest, including connecting the wildlife corridor that exists between this forest and the Susúa Forest further south and rounding out the forest holdings.

B. The Susúa State Forest

The Susúa State Forest is property of the Commonwealth of Puerto Rico and covers 1,114 ha. The forest is important as it represents not only the influence of a climatic transition zone (dry to moist) but also a combination of volcanic and serpetine soils. The serpetine derived soils supports a unique vegetation which contains a number of endemic but does not support any significant agriculture or forestry. Common species found in the Susúa forest include: *Bursera simaraba, Exostema caribaeum, Linociera axillaris, Coccoloba microstachia* and *Terebraria resinosa.*

C. Other Important Areas

The Legacy Area includes other important forested areas, such as the Rodadero Peack, the Indiera Sections and the Cerro Las Mesas area. These are all forested areas the conform a buffer zone to the Maricao and Susúa Forests and constitute important habitat areas and wildlife corridors.

THE QUEBRADILLAS LEGACY AREA

I. Boundary Delimitation

The Quebradillas Legacy Area is located on the northwestern coast of Puerto Rico. The boundary delimitation begins at the town of Isabela:

- East along the coastline to the town of Camuy.
- Out of Camuy to the south on PR 119 to ⊥ with PR 483
- South the wast on PR 483 to ⊥ with PR 496
- East on PR 496 to ⊥ with PR 488
- Northeast the south on PR 488 to ⊥ with PR 130
- South on PR 130 to ⊥ with PR 129
- South then west on PR 129 to ⊥ with PR 454
- South on PR 454 to ⊥ with PR 111
- Northwest on PR111 to ⊥ with PR 450
- Northwest on PR 450 to ⊥ with PR 445
- North on PR 445 to ⊥ with PR 112
- North on PR 112 to the coastline (town of Isabela)

[15]Text and map of land acquisitions taken from "The Master Plan for the Commonwealth Forest" prepared by the Department of Natural and Environmental Resources.

II. Important Environmental Values of this Legacy Area

The land forms developed on the north coast limestone of Puerto Rico constitute one of the finest examples of tropical karst in the world. The terrane appears as clusters of haystack hills separated from one another by rounded depressions. The karst forest region is a unique natural area because of its tropical karst topography. Many forested areas of this region are in primary or close to primary conditions.

The Guajataca State Forest belongs to the Commonwealth of Puerto Rico and has an area of 785.66 ha. with an elevation ranging from 150 to 300 meters. Approximately 45 bird species occur commonly in this forest, 8 are endemic to Puerto Rico, 34 are breeding residents and 11 are migratory, Most of these are forest forms that require well wooded habitat for their survival. The proposed Legacy Area provides a buffer zone for this State Forest.

The Guajataca River gorge at the Quebrada Bellaca section is a densely forested area and one of two sectors on the island that provides a habitat to the species *Peltophyrne lemur* (sapo concho nativo), an amphibian in danger of extinction because of destruction to its habitat. The section also contains endemic trees in danger of extinction and/or rare such as: *Goetzea elegans* (matabuey), *Daphnopsis helleriana, Zanthosylum thomasianum* (prickly ash), *Aurodendron pauciflorum, Bumellia bellonis, Schoepfia arenaria, Manilkara pleena* (Zapote de costa), *Antirhea portoricensis* (quina), *Eupatorium oteroir, Ottoshultzia rhodoxylon* (palo de rosa), *Rollinia mucosa* (anón cimarrón), *Coccoloba pallida* (uvillo), *Coccolaba tenuifolia* (Uvillo), *Drypetes ilicifolia* (encinilla), *Licaria trianda* (Palo de Misanteco), *Chionanthys ligustrinus,* and *Chinanthus axilliflorus.*

The Quebradilla Forest Legacy Area also protects the Camuy River, portions of which are underground. This river has created one of the most complex cave systems in the world, part of which is developed for recreational purposes. The area contains several endemic species, some in danger of extinction. Species include the manaca palm, the plant *Philodendron fragantissimum*, the reptile *Diploglossus pleei*, the bat *Eptesicus fuscus wetmorei.*

The Quebradilla Forest Legacy Area also includes the buffer zone to the Guajataca Lake for watershed protection. The karst limestone region is also a recharge area for extensive aquifers that provide water for municipal and industrial uses.

THE CAONILLAS-DOS BOCAS LEGACY AREA

I. Boundary Delimitation

The Caonillas-Dos Bocas Legacy Area lies on the north coast. The boundary delimitation begin at the city of Arecibo.

- Out of Arecibo to the east on PR 22 to ⊥ with PR 2
- East on PR 2 to the town of Manatí
- Out of Manatí to the south on PR 6685 to ⊥ with PR149

- South on PR 149 to ⊥ with PR143
- West on PR 143 to the town of Adjuntas
- Out of Adjuntas to the northwest on PR 143 to ⊥ with PR135
- Northwest on PR 135 to ⊥ with PR129
- North on PR 129 to ⊥ with PR600
- North of PR 600 to ⊥ with PR134
- North on PR 134 to ⊥ with PR129
- North then east on PR 129 to ⊥ with PR165
- East then north on PR 635 to the city of Arecibo

II. Important Environmental Values of this Legacy Area

A. Caonillas and Dos Bocas Lakes

The Caonillas and Dos Bocas lakes are water reservoirs which the Puerto Rico Aqueduct and Sewer Authority (PRASA) is in the process of connecting by a pipeline to the San Juan Metropolitan Area aqueduct system in order to provide for the increasing water supply demand in the area. The legacy area proposes the protection and reforestation of the basins of these lakes.

B. The Río Abajo and the Toro Negro State Forests

The Río Abajo State Forest belongs to the Commonwealth of Puerto Rico and is a moist limestone forest with very irregular topography, subterranean drainage, caves, natural depressions or sinkholes and haystack hills, all characteristic of karst geological development. Unique natural features of the forest include its classical tropical karst topography, caves, unique areas of natural forest including endemic flora and wildlife and panoramic and scenic views. Its has been recently the object of highway development pressures. Part of the reserve has been destroyed for the construction of highway PR 10. The legacy area provides a much needed buffer zone for this forest.

The Toro Negro State Forest also belongs to the Commonwealth of Puerto Rico and is especially critical for soil and water conservation. Its high peaks and mountain ridges contain distinct flora and fauna and panoramic views. It has spectacular waterfalls that not only illustrate geologic history but also support interesting and unique plan and animal life.

The proposed legacy area includes an important buffer zone for this forest. Within this buffer zone is the El Guineo Lake and Cerro Rosa sector, densely forested terrain which contain several species candidates to the list of endangered species such as the *Accipiter straitus venator, Lepanthes dodiana, Campylocentrum pygmaeum.* It also includes Roncador Peak, a densely forested area in which 295 plant species have been identified.

C. Arrozal Biáfara Sector

This is a karst zone that contains a rich treasure of trees, including the following that are in the list of endangered species or are candidates to the list, and/or are endemic and rare or are species of very limited distribution in Puerto Rico and the Antilles, such

as: *Maytenus ponceana* (cuero de sapo), *Polygala cowelli* (árbol de violeta), *Myrcia paganii(ausu), Dyosyros sintenisii* (guayabota níspero), *Cynometra portoricensis* (oreganillo) *Drypetes ilicifolia* (encinillo) *Guatteria caribaea* (hoya blanca), *Drupetes lateriflora* (cueriduro).

THE LA PLATA-COAMO LEGACY AREA

I. Boundary Delimitation

The boundary delimitation for this legacy area begin on the south coast, at the town of Peñuelas:

- Out of the town of Peñuelas to the north on PR 153 to ⊥ with PR14
- North on PR 153 to ⊥ with PR155
- North then east on PR 155 to ⊥ with PR143
- East on PR 143 to ⊥ with PR720
- Northeast on PR 720 to ⊥ with PR156
- East then North on PR 156 to ⊥ with PR152
- North on PR 152 to ⊥ with PR811
- North then south on PR 165 to ⊥ with PR861
- East on PR 861 to ⊥ with PR829
- South on PR 829 to ⊥ with PR812
- East then south on PR 812 to ⊥ with PR879
- West then south on PR879 to ⊥ with PR791
- West on PR 791 to ⊥ with PR7774
- South on PR 7774 to ⊥ with PR775
- South on PR 775 to ⊥ with PR 730
- East then south then west on PR 739 to ⊥ with PR1
- South then west on PR1 to the town of Peñuelas

II. Important Environmental Values of this Legacy Area

A. La Plata Reservoir

La Plata Lake is one of the principal water suppliers to the San Juan Metropolitan area. Its basin is severely deforested and the lake consequently is manifesting rapid sedimentation rates. Recent reductions in rainfall averages have resulted in costly interruption of water supply services due to low reserves in the lake. This legacy area provides for crucial tracts to be reforested in the basin of this lake.

B. Other important resources

The conservation of the area known as Las Tetas de Cayey protects the only location known for the shrub *Solanum drymophyllum* and two other critical and endemic species of trees are found in the area. The Pasto sector of Coamo contains at least one species in the list of endangered species, another one which is classified as candidate to the list, the only known location in the work for a subspecies of an endemic species and

three other rare and endemic species which are unprotected. The legacy area also protects tracts that are in primary forested conditions.

THE RIO GRANDE DE LOIZA LEGACY AREA

I. Boundary Delimitation

The boundary delimitation begins to the north east of the city of Cayey at the intersection of PR 738 with the Luis A. Ferré Expressway (PR 52).

- On PR 738 (at its intersection with PR 52) to the north to ⊥ with PR1.
- On PR 1, take PR 135 west then north to ⊥ with PR 734
- North on PR 734 to ⊥ with PR 173
- North on PR 173 to ⊥ with PR 156
- North on PR 156 to ⊥ with PR 173
- North on PR 173 to ⊥ with PR 1
- East then north on PR1 to ⊥ with PR 175
- North then west on PR175 to ⊥ with PR895
- Southeast on PR895 to ⊥ with PR 852
- Southeast on PR 852 to ⊥ with PR 853
- South on PR 853 to ⊥ with PR 185
- South on PR185 to ⊥ with PR 919
- South on PR 919 to ⊥ with PR 813
- South on PR919 to ⊥ with PR 917
- South then west on PR 917 to ⊥ with PR 916
- Northwest then south on PR 916 to ⊥ with PR 912
- South on PR912 to ⊥ with PR 902
- West on PR 902 to ⊥ with PR 745
- Southwest then northwest on PR 745 to ⊥ with PR 7740 then to ⊥ with PR 184
- South on PR184 to ⊥ with PR 7740 then to ⊥ with PR 179
- South then west on PR 179 to ⊥ with PR 741 then to ⊥ with PR 738

II. Important Environmental Values of this Legacy Area

This legacy area contains three principal water supply sources, the Carraízo Lake (or Lake Loíza) which is one of the primary sources of water for the San Juan Metropolitan Area, Lake Cidra which also provides water for the SJMA and the Carite Lake which provides water to the south coast. Recent reductions in rainfall averages have resulted in costly interruption of water supply services due to low reserves in these lakes (except Carite). This legacy area provides for crucial tracts to be reforested in the basin of these group of water reservoirs.

THE MAUNABO LEGACY AREA

I. Boundary Delimitation

The boundary delimitation begins at the town of Patillas, located on the southeastern coast of Puerto Rico.

- Out of Patillas to the south on PR 3 to ⊥ with PR 53
- East on PR 53 to ⊥ with PR 3
- North on PR 3, past the town of Maunabo to the town of Yabucoa
- Out of Yabucoa to the west on PR 182 to ⊥ with PR 181
- South on PR 181 to the town of Patillas

II. Important Environmental Values of this Legacy Area

The Maunabo Legacy Area contains basically the Cuchilla Panduras Region. This is a unique forest area of volcanic and plutonic formations that include caves, grottos and cavities. It is the exclusive habitat of the *Eleutherodactylus cooki* (coquí guajón), an endangered species.

THE EL YUNQUE LEGACY AREA

I. Boundary Delimitation

The boundary delimitation begins at the town of Fajardo on the northeastern extreme of the island of Puerto Rico.

- Out of Fajardo to the south on PR 3 to the town of Ceiba
- Out of Ceiba to the west on PR 53 to ⊥ with PR 31
- West on PR 31 to ⊥ with PR 946
- North on 946 to ⊥ with PR 186 to ⊥ with PR 185 into the town of Canóvanas
- Out of Canóvanas to the east on PR3 to the town of Río Grande
- Out of Río Grande to the east of PR 3 to the town of Fajardo

II. Important Environmental Values of this Legacy Area

This legacy area will provide a buffer zone to the El Yunque Caribbean National Forest, declared Biosphere Reserve by the United Nations and administered by the USDA Forest Service.