

RECOVERY PLAN

for

*Pleodendron macranthum and Eugenia haematocarpa*

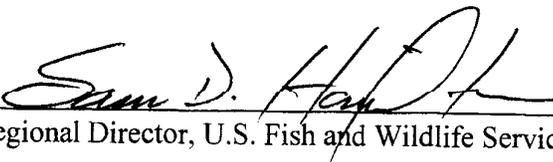
Prepared by

Kenneth W. Foote  
Boquerón Field Office  
U.S. Fish and Wildlife Service  
Boquerón, Puerto Rico

for the

U.S. Fish and Wildlife Service  
Southeast Region  
Atlanta, Georgia

Approved: \_\_\_\_\_

  
Regional Director, U.S. Fish and Wildlife Service

Date: \_\_\_\_\_

9-11-98

## DISCLAIMER

Recovery Plans delineate reasonable actions which are believed to be required to recover and/or protect species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State (Commonwealth) agencies, and others. Plans are reviewed by the public and submitted to additional peer review before they are adopted by the Service. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not obligate other parties to undertake specific tasks and may not represent the views or the official positions or approval of any individuals or agencies involved in formulating the plan, other than the U.S. Fish and Wildlife Service. Recovery plans represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

By approving this document, the Regional Director certifies that the data used in its development represent the best scientific and commercial data available at the time it was written. Copies of all documents reviewed in the development of the plan are available in the administrative record, located at the Boquerón Field Office.

### **Literature Citations should read as follows:**

U.S. Fish and Wildlife Service. 1998. Recovery Plan for *Pleodendron macranthum* and *Eugenia haematocarpa*. U.S. Fish and Wildlife Service, Atlanta, Georgia. 19 pp.

Additional copies may be purchased from:

Fish and Wildlife Reference Service  
5430 Grosvenor Lane, Suite 110  
Bethesda, Maryland 20814

Telephone: 301/492-6403  
or 1-800/582-3421

Fees for recovery plans vary, depending upon the number of pages.

---

EXECUTIVE SUMMARY OF THE RECOVERY PLAN FOR *PLEODENDRON  
MACRANTHUM* AND *EUGENIA HAEMATOCARPA*

**Current status:** *Pleodendron macranthum* (chupacallos) is historically known from the Caribbean National Forest in the Luquillo Mountains and the Río Abajo Commonwealth Forest in the northern karst region of Puerto Rico. Three distinct populations, containing a total of 11 trees, exist in the Caribbean National Forest. Two populations, consisting of fewer than 10 individuals, exist in the Río Abajo Commonwealth Forest. *Eugenia haematocarpa* (uvillo) is known only from the Caribbean National Forest in the Luquillo Mountains and on private property adjacent to the Carite Commonwealth Forest in the Sierra de Cayey. The Caribbean National Forest in the Luquillo Mountains has six distinct populations consisting of 119 individuals and the Carite population consists of 15 individuals.

**Habitat Requirements and Limiting Factors:** All known localities of these endemic tree species occur within Federal and Commonwealth lands, except a small population of *Eugenia haematocarpa* located on private property adjacent to the Carite Commonwealth Forest. *Pleodendron macranthum* is known to exist in the subtropical wet (tabonuco forest type) and the subtropical lower montane wet (palo colorado forest type) forest life zones. *Eugenia haematocarpa* is known to only exist in the subtropical lower montane wet (palo colorado forest type) forest life zone. These two species, restricted in distribution and low in population numbers, are extremely vulnerable to habitat destruction or modification, certain forest management practices, and hurricanes.

**Recovery Objective:** Downlisting and eventual delisting.

**Recovery Criteria:** Existing populations and their habitats should be protected and self-sustaining populations must be established in protected areas. The two species will be considered for downlisting when the following criteria are met:

1. An agreement between the Fish and Wildlife Service and the USDA Forest Service concerning the protection of *Pleodendron macranthum* and *Eugenia haematocarpa* within the Caribbean National Forest property has been prepared and implemented.
2. An agreement between the Fish and Wildlife Service and the Department of Natural and Environmental Resources concerning the protection of these two species in Commonwealth Forests, specifically Río Abajo for *Pleodendron macranthum*, has been prepared and implemented.
3. New populations (the number of which will be determined by appropriate scientific studies) capable of self perpetuation have been established within protected areas.

**Actions Needed:**

1. Prevent further habitat loss and population decline.
2. Collect information on the distribution and abundance of these two endangered trees.
3. Conduct research on habitat requirements, reproductive biology, and ecology.
4. Establish new populations
5. Refine recovery criteria.

---

**Date of Recovery:** Downlisting or removal from the federal list should be initiated in the year 2035, if recovery criteria are met.

**Recovery Costs:** Recovery costs for the two tree species have been estimated at \$191,000 for the first 3 years. Subsequent expenditures will depend on the results of preliminary studies and activities, therefore, cannot be estimated at this time.

---

## TABLE OF CONTENTS

	<b>Page</b>
<b>PART I. INTRODUCTION</b> .....	1
Description .....	1
Distribution/Population Status .....	2
Habitat Description .....	3
Reproductive Status .....	6
Reasons for Listing .....	6
Conservation Measures .....	7
 <b>PART II. RECOVERY</b>	
A. Recovery Objective .....	8
B. Narrative Outline .....	8
C. Literature Cited .....	13
 <b>PART III. IMPLEMENTATION SCHEDULE</b> .....	14
 <b>PART IV. LIST OF REVIEWERS</b> .....	18

## PART I. INTRODUCTION

*Pleodendron macranthum* and *Eugenia haematocarpa* are two tree species endemic to Puerto Rico. *Pleodendron macranthum* (chupacallos) is only known presently in the Caribbean National Forest and Río Abajo Commonwealth Forest. This extremely rare tree species has a population of fewer than 21 individuals in five localities of the subtropical wet and the subtropical lower montane wet forests of northern and eastern Puerto Rico (U.S. Fish and Wildlife Service 1994). Three localities are found within the Caribbean National Forest and two within the Río Abajo Commonwealth Forest. The present endangered status of the chupacallo is a result of habitat destruction from intense urban and agricultural development, and forest management practices such as the establishment and maintenance of plantations, selective cutting, trail maintenance, dispersed recreation, and shelter construction.

*Eugenia haematocarpa* (uvillo) is known from seven localities in the subtropical lower montane wet forests of the Sierra de Luquillo and Sierra de Cayey. Six distinct populations in the Caribbean National Forest, managed by the USDA Forest Service, contain fewer than 125 trees (USDA Forest Service 1993). The only other known population of *Eugenia haematocarpa*, consisting of approximately 15 trees, occurs on private property adjacent to the Carite Commonwealth Forest in the Sierra de Cayey. The endangered status of the uvillo is a result of habitat destruction from intense urban and agricultural development, forest management practices such as the establishment and maintenance of plantations, selective cutting, trail maintenance, dispersed recreation, and shelter construction, and impacts by hurricanes.

*Pleodendron macranthum* and *Eugenia haematocarpa* were determined to be endangered species on December 27, 1994, pursuant to the Endangered Species Act of 1973, as amended (U.S. Fish and Wildlife Service 1994). Critical habitat was not designated for these species because of the risk of vandalism and the possibility of over collection.

### Description

*Pleodendron macranthum* (chupacallos) was discovered by the French botanist August Plée in 1822-1823 and was first described by Baillon under the genus *Cinnamodendron*. In 1889, vanTieghem placed the species in the current genus, which honors its first collector. No observation or collection of the species was made for more than 40 years (Vivaldi et al. 1981). The species was rediscovered some years ago, and is at present known from fewer than 21 individuals in five localities of the subtropical wet and the subtropical lower montane wet forests of the Caribbean National Forest and the Río Abajo Commonwealth Forest.

*Pleodendron macranthum* is a small to medium size aromatic evergreen tree reaching 10 meters (33 feet) in height, 20 centimeters (8 inches) in diameter with brownish twigs that are slender and hairless. Leaves are alternate, simple, leathery, entire, measuring 8.5 - 12.5 centimeters (3.5 - 5.0 inches) long and 4.5 - 5.0 centimeters (1.7 - 2 inches) wide. The blades are elliptic with the upper surface dark shiny green and the mid-vein sunken. The lower surface is pale green with a prominent mid-vein and with fine, parallel side veins. The leaf stalks are about 7 millimeters

(.25 inches) long and cannal-shaped (Vivaldi *et al.* 1981). The solitary flowers, whitish in color and bisexual, are axillary and are subtended by a long flower stalk 2.5 centimeters (1 inch) long. The flowers are 2 centimeters (.8 inches) wide with 3 sepals, 12 petals and many united stamens. The cup-shaped calyx is persistent in the fruit. The aromatic purplish black fruit measures 2 centimeters (.8 inches) in diameter and contains many rounded, shiny brownish black seeds. The wood is described as nearly white, hard, and heavy (Little *et al.* 1974).

*Eugenia haematocarpa* (uvillo) was first collected in 1939 from Barrio Maizales in the municipality of Naguabo by Leslie R. Holdridge but was named in 1963, 24 years later, by Henri Alain Lioger (Little *et al.* 1974; G. Proctor, Puerto Rico Department of Natural and Environmental Resources, pers. comm.). Since then, subsequent collections have been made from the El Verde area of the Luquillo mountains, and it was recently discovered, in 1990, on privately-owned property located adjacent to the Carite Commonwealth Forest.

Uvillo is a small evergreen tree reaching 6 meters (20 feet) tall and 12 - 13 centimeters (4.8 - 5.2 inches) in diameter. The bark is gray or whitish and smooth, shedding in plates. Twigs are hairless, slightly two-angled, and rusty brown (Little *et al.* 1974). The paired, relatively large, hairless, oblong to elliptical leaves are thick and leathery, 13 - 18 centimeters (5.2 - 7.2 inches) long, 6 - 8 centimeters (2.4 - 3.2 inches) wide and almost stalkless. The upper surface of the leaves is dull dark green with light green beneath. Blades contain many slender, slightly raised veins, forming a prominent network. The flowers, many in clusters, are produced on the trunks with slender, nearly equal stalks. Flowers have a four-lobed rounded calyx 1 millimeter (.04 inch) long, four rounded light pink petals 23 millimeters (.12 inch) long, many stamens, and pistil with an inferior ovary. The fruit is a dark red, round berry, 2.3 - 2.9 centimeters (.9 - 1.1 inches) in diameter and containing a rounded 1.6 centimeter (.6 inch) light brown colored seed.

#### Distribution/Population Status:

With the exception of one, all the currently known localities of *Pleodendron macranthum* and *Eugenia haematocarpa* occur within the Caribbean National Forest and the Río Abajo Commonwealth Forest, which are administered by the USDA Forest Service and the Department of Natural and Environmental Resources, respectively. The only known locality outside of these forests is a population of 15 *Eugenia haematocarpa* on private property adjacent to the Carite Commonwealth Forest (Fig. 1). The following are known sites for the species:

#### *Pleodendron macranthum*:

1. Three distinct populations exist in the Caribbean National Forest containing a total of 11 trees. The population located in the municipality of Río Grande, Jiménez Ward, contains nine individuals. It is within Integrated land allocation amid a long-standing mahogany plantation. The two remaining populations contain one individual each and are located in the Mameyes II Ward, municipality of Río Grande, and are also in the Integrated land allocation amid a long-standing mahogany plantation. One of the

---

populations lies adjacent to an area that has historically incurred recreational use and which is planned for development (USDA Forest Service 1997).

2. Two distinct populations occur in the Río Abajo Commonwealth Forest and consist of fewer than 10 trees total. One population occurs in the Río Abajo Ward, municipality of Utuado, and the second occurs in the Río Arriba Ward, municipality of Arecibo (Davila, Department of Natural and Environmental Resources, pers. comm. 1997).

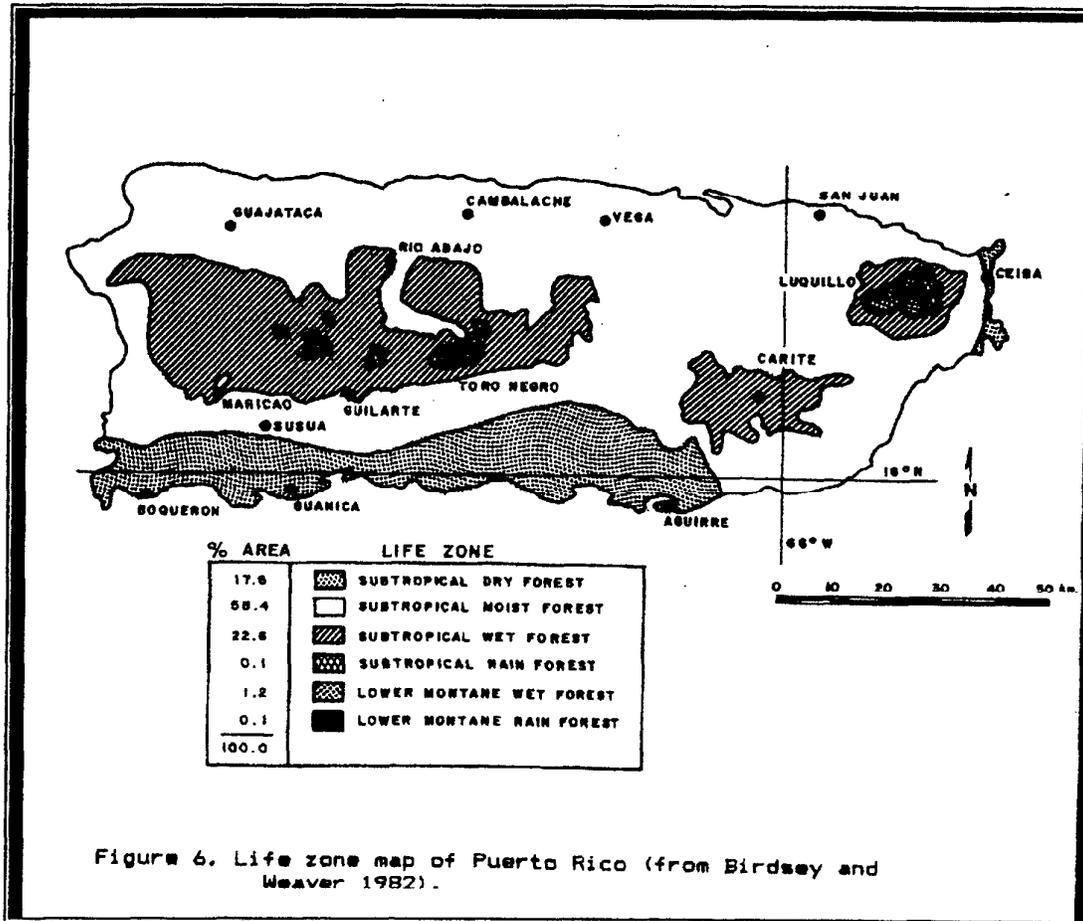
*Eugenia haematocarpa*:

1. Six distinct populations, consisting of a total of 119 trees, exist in the Caribbean National Forest. Individual populations vary in size from 10 to 25 trees. Three populations occur in the Río Espíritu Santo watershed, one in the Río Blanco watershed, one in the Río Gurabo watershed, and one in the Río Fajardo watershed. All populations are associated with riparian habitats (USDA Forest Service 1997).
2. The seventh population contains 15 individuals and is found on private property adjacent to the Carite Commonwealth Forest.

Habitat Description

*Pleodendron macranthum* (chupacallo) is known to exist in two different habitat types or life zones. This species is found in the Subtropical Wet Forest zone and/or the Subtropical Lower Montane Wet Forest zone of Puerto Rico. *Eugenia haematocarpa* (uvillo) is known to exist only in the Subtropical Lower Montane Wet Forest zone of Puerto Rico (Fig. 1).

**Figure 1: LOCATION MAP: FORESTS OF PUERTO RICO**



Note: Map indicates the location of Commonwealth and Federal forests only. Individual population sites are not included.

Image scanned from the following publication: USDA, Forest Service, Departamento de Recursos Naturales y Ambientales, 1983. Edited by Ariel E. Lugo, Los Bosques De Puerto Rico. 321pp.

The subtropical wet forest is a high rainfall life zone, with mean annual precipitation ranging from 2,000 to 4,000 millimeters per year, that occupies much of Puerto Rico's mountains. This life zone usually encounters 3 months in which the moisture drops below field capacity; however, the water deficit is very small. During the remaining 7 months of the year, the forest encounters significant amounts of runoff (Ewell and Whitmore 1973). The abundant moisture of this life zone contributes to the character of the vegetation which is relatively rich in species. The growth rates of successional trees are rapid. Mature forest remnants of this forest type can be found in the Carite and Toro Negro Commonwealth Forests and the Caribbean National Forest. This forest type or life zone is locally referred to as the tabonuco forest type, named for the dominant tree *Dacryodes excelsa*. The subtropical wet forest contains more than 150 species of trees that form a dark, complete canopy at 20 meters. Ferns such as *Cyathea arborea*, the common tree fern (i.e., helecho gigante), and *Gleichenia bida*, which forms a thick forest mat, are found throughout this forest type. Epiphytic ferns, bromeliads, and orchids are common in this forest type.

The subtropical lower montane wet forest life zone occupies both the eastern and central parts of the island up to the summits of most mountains above 1,000 meters above sea level and occasionally extending down to almost 700 meters (Fig. 1) (Ewell and Whitmore 1973). The colorado forest type, named for the common *Cyrilla racemiflora* (palo colorado, swamp cyrilla) corresponds to the mature vegetation of the zonal association in subtropical lower montane wet forest. Annual rainfall in the palo colorado forest of the Caribbean National Forest ranges from 3,000 to 4,000 millimeters. Temperature ranges from 11.4°C to 32.5°C throughout the year, with a mean annual temperature of 21°C in the palo colorado forest (Wadsworth 1951).

The palo colorado association is an evergreen forest found at elevations greater than 600 meters and covers approximately 17 percent of the Caribbean National Forest (Silander *et al.* 1986). This forest is poorer in species than the adjacent Subtropical Wet Forest (Wadsworth 1951) with only 53 tree species reported, compared to more than 150 species in the tabonuco forest type. The canopy or upper layer is 20 meters tall and the second or lower layer is 10 meters high. The crowns are dense, with medium to low branching. Buttressing is not usually present and many old trees lean downhill. The herbaceous layer is variable or may be absent. The leaves of most species are simple and thick, many are mesophyllous but some are microphyllous (ca 5 centimeters). Plant diversity is not very high (Wadsworth 1951). *Cyrilla racemiflora*, together with *Calycogonium squamulosum* (jusillo) and *Micropholis garcinifolia* (caimitillo), are indicator species of the palo colorado vegetation type, since they are the most prominent in terms of density, frequency, and dominance (Wadsworth 1951). Other plant species include *Croton poecilanthus* (sabinón), *Micropholis chrysophylloides* (leche prieta), *Prestoea montana* (palma de sierra), and *Ocotea spathulata* (nemocá cimarrona). Epiphytes, epiphylls, and vines are common in the palo colorado forest.

The Luquillo Mountain region is of volcanic origin and of a rough topography, with cliffs and rock exposures at high elevations. Six major rivers are born in the mountains and waterfalls are numerous. Over 207 species of native trees are found in the Luquillo Mountains and eastern

---

Puerto Rico, 26 of which are known only from the Luquillo Mountains (Vivaldi and Woodbury 1981). Nineteen soils belonging to four soil associations have been identified within the Caribbean National Forest (Silander et al. 1986), of which the Los Guineos-Guayabota-Rock land association constitutes the most extensive one (USDA Forest Service 1977). This association contains acidic, shallow to deep, well drained to poorly drained steep soils. Rainfall in the Caribbean National Forest is seasonal, with a dry period from February to April. Temperature ranges from 11.4°C to 32.5°C throughout the year. Relative humidity varies from 90 to 100 percent on cloudy days and during the night.

Limestone is the primary parent material for many of the soils in the subtropical wet forest. These limestone-derived soils characterize several important azonal associations which include most of the Río Abajo Commonwealth Forest. The natural vegetation on these soils is more xerophytic than would be expected under the high rainfall of this life zone, as is true of most limestone-derived soils, thus the dry edaphic condition has an effect similar to that of reduced rainfall (Ewell and Whitmore 1973).

The Río Abajo Commonwealth Forest is located in the rugged karst region of Puerto Rico. Over 175 species of trees are known from the Río Abajo Forest, of which 13 percent are endemic to Puerto Rico (Vivaldi and Woodbury 1981). The karst area is mostly underlain by limestone and solution is the most important geographic agent. The limestone strata have been divided into six formations: Lares, Cibao, Aguada, Aymamon, Camuy, and Mucarabones (Vivaldi and Woodbury 1981). Topographically, Río Abajo consists of either sharp, pointed, or oval limestone hills known as cone karst and mogotes. The rugged topography ranges in elevation from 200 to about 530 meters above sea level and contains many features such as caves, sink holes, canyons, subterranean rivers, and asymmetrical rolling hills.

#### Reproductive Status:

Very little is known about the reproductive biology of *Pleodendron macranthum* and *Eugenia haematocarpa* due to their extremely low population numbers and isolated locations.

*Pleodendron macranthum* has been collected with flowers in February, April-June, and with fruits in June-August (Little et al. 1974). This species is known to reproduce successfully on the forest; specimens with fruit have been encountered in July (USDA Forest Service 1993).

*Eugenia haematocarpa* has been collected with flower buds and fruits in May (Little et al. 1974). All known populations within the Caribbean National Forest are known to flower and fruit. Fruiting individuals have been encountered during surveys conducted in March and July (USDA Forest Service 1993).

#### Reasons For Listing:

*Pleodendron macranthum* and *Eugenia haematocarpa* are extremely rare and restricted in distribution, thus vulnerable to habitat destruction or modification. The fact that *Pleodendron macranthum* has a population fewer than 130 individuals, and *Eugenia haematocarpa* has fewer

than 21 individuals makes them highly susceptible to extinction should further losses of individuals occur. Also, the rarity of these two species could make them attractive to collectors. Three localities of *Pleodendron macranthum*, along with all but one locality of *Eugenia haematocarpa*, are found within the Caribbean National Forest, and four localities of *Pleodendron macranthum* are found in the Río Abajo Commonwealth Forest. Although these two forests are protected and managed respectively by the USDA Forest Service and Department of Natural and Environmental Resources, forest management practices such as the establishment and maintenance of plantations, selective cutting, trail maintenance, dispersed recreation, and shelter construction could affect these plants. Disease and predation have not been documented as factors in the decline of these species. The species' limited numbers and distribution increase the risk of damage caused by hurricanes. Hurricanes are frequent in the Caribbean and hit the Luquillo Mountains periodically, causing considerable forest disturbance. An extensive region of the Caribbean National Forest was severely impacted by Hurricane Hugo in 1989. Loss of genetic variation may also be a major factor in the future survival of these two species.

The only locality of these two species occurring outside of Federal and Commonwealth lands is near the Carite Commonwealth Forest in the Sierra de Cayey. A population of *Eugenia haematocarpa*, of approximately 15 plants, occurs on private property adjacent to the forest. This locality may be impacted by vegetation removal and collection.

#### Conservation Measures:

Conservation measures provided to federally listed species include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition through listing encourages and results in conservation actions by Federal, State, and private agencies, groups, and individuals. The Endangered Species Act provides for possible land acquisition in cooperation with the States and requires that recovery actions be carried out for all listed species.

The Fish and Wildlife Service coordinates with the USDA Forest Service and the Department of Natural and Environmental Resources on projects which may impact these two tree species. The Service has an Interagency Agreement with the USDA Forest Service to study distribution and collect observations on flowering and fruiting.

Section 7(a) of the Act, as amended, requires Federal agencies to evaluate their actions with respect to any species that is listed as endangered or threatened. Section 7(a)(2) requires Federal agencies to ensure that any activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of such a species or to destroy or adversely modify its critical habitat, if such is designated. If a Federal action may affect listed species or its critical habitat, the responsible Federal agency must enter into formal consultation with the Service.

---

## PART II. RECOVERY

### A. Recovery Objective and Criteria

The objective of this recovery plan is to provide direction for reversing the decline of these two tree species and for restoring the species to a self-sustaining status, thereby permitting them to be removed from the Federal Endangered Species List.

The two tree species could be considered for downlisting from the Federal list when the following criteria are met:

1. An agreement between the Fish and Wildlife Service and the USDA Forest Service concerning the protection of *Pleodendron macranthum* and *Eugenia haematocarpa* within the Caribbean National Forest property has been prepared and implemented.
2. An agreement between the Fish and Wildlife Service and the Department of Natural and Environmental Resources concerning the protection of in these two species in Commonwealth Forests, specifically Río Abajo for *Pleodendron macranthum*, has been prepared and implemented.
3. New populations (the number of which will be determined by appropriate scientific studies) capable of self perpetuation have been established within protected areas.

### B. Narrative Outline

1. Prevent further habitat loss and population decline. Protection of habitat and individual plants at known population sites should be initiated by appropriate public agencies and entities and private organizations.
  11. Protect habitat. Habitat protection of existing populations must be given the highest priority. Ensure protection of habitat, vital to the survival of the species, on Federal and Commonwealth lands under the jurisdiction of several agencies.
    111. Develop management plans, in cooperation with the USDA Forest Service - Caribbean National Forest and the Department of Natural and Environmental Resources - Río Abajo Forest. Management plans should be developed or modified to include measures to protect known populations and their habitat and provide for long-term monitoring of species growth and reproduction. The Fish and Wildlife Service in conjunction with the Puerto Rico Department of Natural and Environmental Resources, utilizing local agencies and organizations,

should protect the population *Eugenia haematocarpa* near the Carite forest by a conservation easement, landowner agreement, or land acquisition.

12. Protect plants. Individual plants and the recruitment of new individuals at all sites must be monitored on a long-term basis. Due to the low number of existing plants, protection must be ensured to allow for the collection of additional scientific information and species' survival.
121. Monitor known populations. Basic field observations on population biology, including evidence of reproduction and growth and site changes, should be conducted.
122. Enforce existing Commonwealth and Federal endangered species regulations. Commonwealth regulation's Section 10 provides for consultations on endangered species which may be affected by a particular project, similar to Section 7 of the Federal Endangered Species Act. Since most of the populations, with the exception of the Carite and Río Abajo populations, are at present on federally-owned lands, Section 7 consultation would be necessary for any action which might affect the species on the Caribbean National Forest.

The Department of Natural and Environmental Resources' Regulation to Govern the Management of Threatened and Endangered Species of 1985 provides for criminal penalties for illegal take of listed plant species on public lands. In addition, development projects which occur in these areas are often funded through local or Federal agencies or require local permits.

123. Educate the public on plant conservation values and regulations pertaining to endangered species. Education concerning these two species, in the form of public outreach, should become an integral part of the recovery process and involve both Federal and Commonwealth agencies. Education and outreach efforts should focus on habitat protection and the value of conserving endangered species. Educational materials such as slide show presentations, species fact sheets, coloring books, etc. (available in both English and Spanish) will be presented to local school groups and interested organizations. Education/outreach efforts should incorporate these species into a general presentation to better address entire ecosystem issues. Personnel, Federal and Commonwealth, should maintain a positive line of communication concerning the protection of these species with project consultants, and permitting and funding agencies.

- 
2. Gather information on the distribution and abundance of these two trees. Additional information concerning the distribution and abundance of the species will aid in future management decisions and the development of recovery criteria.
    21. Search for new populations. Searches for new populations in the Caribbean National Forest, Río Abajo Commonwealth Forest, as well as other areas in or adjacent to the Carite Commonwealth Forest, should be carried out.
      211. Identify and inventory potential sites. Based on a characterization of known habitat types, potential sites should be identified and searched. Similar areas in the Caribbean National Forest and Río Abajo and Carite Commonwealth Forests that may contain these species should be inspected. Additional sites in other Commonwealth forests, and perhaps private lands, that meet the habitat requirements should also be identified and searched.
      212. Characterize sites to determine their suitability as future recovery sites. If new populations are discovered, this information should be added to the database of the various agencies and organizations involved. In addition, sites should be evaluated for the availability of propagative material and the potential for protection. On sites identified as potential habitat but where no plants are found, the suitability of the site for introduction of individuals should be determined.
      213. Obtain protective status for the privately-owned population sites. If, in the future, new individuals are discovered growing in privately-owned sites, these should be protected through land acquisition, the establishment of conservation easements, or through landowner agreements.
  3. Conduct research. Basic biological information is currently needed for the two tree species. Studies should focus on aspects of life history, genetic variability, methods of propagation, and evaluation of possible introduction sites. These studies may be critical in the recovery of the species.
    31. Define habitat requirements. Studies to define habitat requirements should be conducted.
    32. Study reproductive biology and ecology of the two tree species. Very little information is currently available concerning the reproductive biology of these species in their natural habitat. Effective management and recovery depend upon obtaining this information.

- 
321. Assess periodicity of flower production and pollination activity. Determine the existence of phenology patterns and environmental factors governing them. Study aspects of flower development and longevity, anthesis, and production of rewards. Determine breeding and pollination systems present.
  322. Assess periodicity of fruit and seed set and dispersion. The frequency, timing, and the physical and biological factors controlling the fruit and seed set and dispersion should be determined.
  323. Assess seed viability and germination. Evaluate the proportion of viable seeds produced and the environmental conditions required for germination.
  324. Evaluate seedling establishment and growth. Field and laboratory experiments should focus on these critical stages in order to gather information on seedling survivorship and recruitment. Determine environmental or biological factors affecting growth and development of plants up to the reproductive stages.
  325. Determine genetic structure of the species. Study intra and inter-population genetic diversity of the species using appropriate techniques.
33. Evaluate feasibility of artificial propagation and develop propagation program. Propagation techniques should be evaluated and, utilizing this information, a propagation program with local nurseries may be developed.
    331. Assess feasibility of propagation. Based on the availability of propagative material, economic and logistical considerations, and results from above research, determine the most feasible methods of propagation and transplantation to existing or new sites.
    332. Develop artificial propagation program. These tree species should be included in the ongoing artificial propagation program at local nurseries.
4. Establish new populations. Areas for the establishment of new populations of these tree species should be selected and new populations established.
    41. Select appropriate sites for population introduction or enhancement using artificially propagated material. Habitat requirements must be considered in order to assure the success and relevance of transplanting propagated material.

- 
411. Select sites and assess habitat suitability. Using information from Task 211 and 31 above, inventory potential sites for the introduction and establishment of new populations of the two tree species.
  412. Ensure site protection. If proposed sites are not already on protected land, steps must be taken to provide such protection for new populations. Management plans for these new sites should be developed or modified, if existing, to include considerations for these species.
  413. Introduce plants. Success of plantings and the maintenance of ecological integrity should be carefully monitored.
5. Refine recovery criteria. As additional information on the biology, ecology, propagation, and management of these two species is gathered, it will be necessary to better define, and possibly modify, recovery criteria.
51. Determine numbers of individuals and populations necessary to ensure species stability, security, and self-perpetuation. Environmental, reproductive, and genetic studies, together with the relative success of population protection measures, will allow more precise and realistic recovery criteria to be established.
  52. Determine what additional actions, if any, are necessary to achieve recovery criteria. If there are any actions not included in this recovery plan, which become recognized species' needs during the recovery process, they will be incorporated into the plan.

---

### C. Literature Cited and References

- Brown, S., A.E. Lugo, S. Silander, and L. Leigel. 1983. Research history and opportunities in the Luquillo Experimental Forest. General Technical Report SO-44. U.S. Department of Agriculture, Forest Service, Southern Experiment Station. New Orleans, Louisiana. 128 pp.
- Ewel, J.S. and J.L. Whitmore. 1973. Ecological life zones of Puerto Rico and the U.S. Virgin Islands. U.S. Department of Agriculture. Forest Service Research Paper ITF-18. 72 pp.
- Liogier, H. A. and L. F. Martorell. 1982. Flora of Puerto Rico and adjacent islands: a systematic synopsis. University of Puerto Rico, Río Piedras, Puerto Rico. 342 pp.
- Little, E.L., R.O. Woodbury, and F.H. Wadsworth. 1974. Trees of Puerto Rico and the Virgin Islands. Second Volume. U.S. Department of Agriculture, Forest Service. Handbook No. 449. Washington, D.C. 1024 pp.
- Picó, R. 1974. The geographic regions of Puerto Rico. Aldine Publ. Co.
- Silander, S.R., H. Gil de Rubio, M. Miranda, and M. Vázquez. 1986. Los Bosques de Puerto Rico, Volumen II. In: Departamento de Recursos Naturales de Puerto Rico. Rico. Compendio Enciclopédico de los Recursos Naturales de Puerto Rico. Estado Libre Asociado de Puerto Rico. Departamento de Recursos Naturales de Puerto Rico. San Juan, Puerto Rico. 389 pp.
- U.S. Department of Agriculture, Soil Conservation Service, 1977. Soil Survey of the Humacao Area of Eastern Puerto. In cooperation with the University of Puerto Rico, Mayagüez. 108 pp.
- U.S. Department of Agriculture, Forest Service, 1997. Biological Assessment for the Caribbean National Forest Revised Land and Management Plan. 29 pp.
- U.S. Fish and Wildlife Service. 1994. Endangered and Threatened Wildlife and Plants; Two Puerto Rican Trees Determined To Be Endangered. Federal Register Vol 59, No. 226.
- Vivaldi, J.L. and R.O. Woodbury. 1981. Status report on *Pleodendron macranthum* (Baill.) Van Tieghem. Submitted to the U.S. Fish and Wildlife Service. Atlanta, Georgia. 36 pp.
- Wadsworth, F.H. 1951. Forest Management in the Luquillo Mountains, I. The setting. *Caribbean Forester* 12:93-114.

---

## PART III. IMPLEMENTATION SCHEDULE

Priorities in Column 1 of the following Implementation Schedule are assigned as follows:

- |            |  |
|------------|--|
| Priority 1 | An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.                                |
| Priority 2 | An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction. |
| Priority 3 | All other actions necessary to provide for full recovery of the species.   |

### Key to Agency Designations in Column 5 and Column 6:

FWS	U.S. Fish and Wildlife Service
R4	FWS, Region 4
ES	FWS, Division of Ecological Services
LE	FWS, Division of Law Enforcement
DNER	Puerto Rico Department of Natural and Environmental Resources
USFS	USDA Forest Service
UNIV	Universities
Cons. Org.	Conservation organizations

RECOVERY PLAN IMPLEMENTATION SCHEDULE

Task Priority	Task Description	Task Number	Task Duration	Responsible Organization		Cost Estimates (\$000)			Comments
				FWS	Other	FY 1	FY 2	FY 3	
1	Develop management plans, in cooperation with the USDA Forest Service, for the Caribbean National Forest.	111.	4 yrs.	R4, ES	USFS		No cost anticipated.		
1	Obtain protective status for the privately-owned population sites.	213.	4 yrs.	R4, ES	DNER		Cost cannot be determined at present due to the possibility of conservation easements and/or landowner agreements.		
1	Monitor known populations.	121.	Cont.	R4, ES	DNER, USFS, UNIV, Cons. Org.	5	5	5	
1	Enforce existing Commonwealth and Federal endangered species regulations.	122.	Cont.	R4, ES, LE	DNER, USFS	10	10	10	One DNER ranger half-time.
2	Define habitat requirements.	31.	4 yrs.	R4, ES	DNER, USFS, UNIV	5	5	5	
2	Assess feasibility of propagation.	331.	4 yrs.	R4, ES	DNER, USFS, UNIV	10	5	5	

Task Priority	Task Description	Task Number	Task Duration	Responsible Organization		Cost Estimates (\$000)			Comments
				FWS	Other	FY 1	FY 2	FY 3	
2	Select sites and assess habitat suitability.	411.	4 yrs.	R4, ES	DNER, USFS	No cost anticipated.			
2	Educate the public on plant conservation values and regulations pertaining to endangered species.	123.	Cont.	R4, ES	DNER, UNIV, USFS	3	1	1	The first years' cost for production of materials.
2	Identify and inventory potential sites.	211.	4 yrs.	R4, ES	DNER, USFS, UNIV, Cons. Org.	10	5	5	
2	Characterize sites to determine their suitability as future recovery sites.	212.	3 yrs.	R4, ES	DNER, USFS, UNIV, Cons. Org.	No cost anticipated			
2	Assess periodicity of flower production and pollination activity.	212.	5 yrs.	R4, ES	DNER, USFS, UNIV	15	10	10	15K includes tasks 321, 322, 323 and 324.
2	Assess seed viability.	323.	3 yrs.	R4, ES	DNER, USFS, UNIV				
2	Evaluate seedling establishment and growth.	324.	10 yrs.	R4, ES	DNER, USFS, UNIV				

Task Priority	Task Description	Task Number	Task Duration	Responsible Organization		Cost Estimates (\$000)			Comments
				FWS	Other	FY 1	FY 2	FY 3	
2	Determine genetic structure of the species.	325.	4 yrs.	R4, ES	UNIV	10	5	5	
2	Develop artificial propagation program.	332.	5 yrs.	R4, ES	DNER, USFS, UNIV	10	5	5	
2	Ensure site protection.	412.	4 yrs.	R4, ES	DNER, USFS,	No cost anticipated			
2	Introduce plants.	413.	4 yrs.	R4, ES	DNER, USFS, UNIV	3	3	3	
2	Determine numbers of individuals and populations necessary to ensure species stability, security and self-perpetuation.	51.	Cont.	R4, ES	DNER, USFS	No cost anticipated.			
2	Determine what additional actions, if any, are necessary to achieve recovery criteria.	52.	Cont.	R4, ES	DNER		1	1	

## PART IV. LIST OF REVIEWERS

Daniel Pagán Rosa  
Secretary  
Department of Natural and Environmental  
Resources  
P.O. Box 9066600  
Puerta de Tierra, Puerto Rico 00906-6600

Dr. George Proctor  
Botanist  
Department of Natural and Environmental  
Resources  
P.O. Box 9066600  
Puerta de Tierra, Puerto Rico 00906-6600

Mr. José Chabert  
Terrestrial Ecology Section  
Department of Natural and Environmental  
Resources  
P.O. Box 9066600  
Puerta de Tierra, Puerto Rico 00906-6600

(\*) Mr. Vicente Quevedo  
Natural Heritage Program  
Department of Natural and Environmental  
Resources  
P.O. Box 9066600  
Puerta de Tierra, Puerto Rico 00906-6600

Mr. Edgardo Gonzalez  
Forest Service Area  
Department of Natural and Environmental  
Resources  
P.O. Box 9066600  
Puerta de Tierra, Puerto Rico 00906-6600

Center For Plant Conservation  
Missouri Botanical Garden  
St. Louis, Missouri 63166-0299

Dr. Gary Breckon  
Department of Biology  
Mayagüez Campus - UPR  
P.O. Box 5000  
Mayagüez, Puerto Rico 00681

Dr. Duane Kolterman  
Department of Biology  
Mayagüez Campus - UPR  
P.O. Box 5000  
Mayagüez, Puerto Rico 00681

Ms. Esther Rojas  
Fundación Puertorriqueña de Conservación  
Calle O'Neill #11  
Hato Rey, Puerto Rico 00918

(\*) Mr. Ernie Garcia  
Caribbean National Forest  
Box B  
Palmer, Puerto Rico 00721

James D. Ackerman  
Director  
Department of Biology  
University of Puerto Rico  
P.O. Box 23360  
San Juan, Puerto Rico 00931-3360

(\*) Dr. Pedro Acevedo  
Department of Botany  
National Museum of Natural History  
Smithsonian Institution  
Washington, D.C. 20560

Dr. Ariel Lugo  
International Institute of Tropical Forestry  
USDA Forest Service  
Call Box 25000, Experimental Station  
Río Piedras, Puerto Rico 00928

---

Curator of Endangered Species  
Fairchild Tropical Garden  
11935 Old Cutler Road  
Miami, Florida 33156-4299

Environmental Protection Agency  
Hazard Evaluation Division - EEB  
(TS769C)  
401 M Street, SW.  
Washington, D.C. 20460

(\*) - PEER REVIEWERS