MITRACARPUS MAXWELLIAE, MITRACARPUS POLYCLADUS, AND *EUGENIA WOODBURYANA* RECOVERY PLAN

prepared by

Susan Silander
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 By: _____
Regional Director, U.S. Fish and Wildlife Service

Date: 10-6-98

Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect listed 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. 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 necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They 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 information 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 Citation should read as follows:

U.S. Fish and Wildlife Service. 1998. *Mitracarpus maxwelliae, Mitracarpus polycladus,* and *Eugenia woodburyana* Recovery Plan. 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 800/582-3421

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

EXECUTIVE SUMMARY OF THE *MITRACARPUS MAXWELLIAE, M. POLYCLADUS* AND *EUGENIA WOODBURYANA* RECOVERY PLAN

Current Status: *Mitracarpus maxwelliae,* a small shrub, and *Eugenia woodburyana*, a small evergreen tree, are both endemic to southwestern Puerto Rico. *Mitracarpus polycladus*, a small shrub, is found in the same area in Puerto Rico, but is also known from the island of Saba of the Lesser Antilles. In Puerto Rico, *M. maxwelliae* and *M. polycladus* are known from only one locality each, both in the Guánica Commonwealth Forest. *Eugenia woodburyana* is known from a range of hills known as the Sierra Bermeja on both public, the Laguna Cartagena National Wildlife Refuge and the Cabo Rojo National Wildlife Refuge, and private land. It is also known from the Guánica Commonwealth Forest.

Habitat Requirements and Limiting Factors: All areas where these three species are located are found within the subtropical dry forest life zone (Ewel and Whitmore 1973), the driest life zone in Puerto Rico. The vegetation in this zone forms a complete ground cover and is deciduous on most soils. Leaves are succulent or coriaceous, and species with spines and thorns are common. Tree heights usually do not exceed 15 meters and the crowns are typically broad, spreading and flattened. These three species are extremely limited in distribution and are variously threatened by road construction, recreational activities, wildfires, and land clearing associated with development for agriculture and rural and tourist development.

Recovery Objective: Delisting.

Recovery Criteria: *Mitracarpus maxwelliae* and *M. polycladus* could be considered for delisting when (1) a management plan which considers the protection and recovery of the species has been prepared and implemented for the Guánica Commonwealth Forest and (2) new populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas, such as other coastal areas in the Guánica Commonwealth Forest. *Eugenia woodburyana* could be considered for delisting when (1) a management plan which considers the protection and recovery of the species has been prepared and implemented for the Guánica Commonwealth Forest and for the Cabo Rojo and Laguna Cartagena National Wildlife Refuges; (2) protection has been provided for those individuals known to occur on privately owned land and (3) new populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas, such as other areas in the Guánica Commonwealth Forest.

Actions Needed:

1. Protect the existing populations and their habitat through the development and implementation of a management plan for the Guánica Commonwealth Forest, the Cabo Rojo National Wildlife Refuge, and the Laguna Cartagena National Wildlife Refuge.
2. Protect populations on privately-owned land.
3. Monitor known populations.
4. Enforce existing Commonwealth and Federal endangered species regulations.
5. Educate the public on conservation values and regulations.
6. Conduct research on the life history of the species and evaluate propagation techniques.
7. Conduct propagation and enhance existing populations or establish new ones on protected lands.

Date of Recovery: Delisting should be initiated in 2025, if recovery criteria are met.

Recovery Costs: Recovery costs for these three species have been estimated at $107,000 for the first 3 years. Subsequent expenditures will depend upon the results of these preliminary studies and, therefore, cannot be estimated at this time.

TABLE OF CONTENTS

PART I. INTRODUCTION

Mitracarpus maxwelliae, a small shrub, and *Eugenia woodburyana*, a small evergreen tree, are both endemic to southwestern Puerto Rico. *Mitracarpus polycladus*, a small shrub, is found in the same area in Puerto Rico, but is also known from the island of Saba of the Lesser Antilles. These three species are extremely limited in distribution and are variously threatened by road construction, recreational activities, wildfires, and land clearing associated with agricultural, rural, and tourist development.

These species were determined to be endangered species on September 9, 1994, pursuant to the Endangered Species Act of 1973, as amended (U.S. Fish and Wildlife Service 1994). Critical habitat has not been designated for these species because of the risks of vandalism, as well as the potential for overcollection.

Description

Mitracarpus maxwelliae, of the family Rubiaceae, was discovered on March 8, 1925, by Nathaniel L. Britton on a limestone hill in the municipality of Guánica, Puerto Rico. The site was later rediscovered by Alain Liogier in 1982 and again by George R. Proctor and Miguel Canals in 1987. *Mitracarpus maxwelliae* is a low, densely-branching, moundlike shrub which may reach approximately 20 centimeters in height. The somewhat woody branches are striate and sharply 4-angled. The leaves are opposite, sessile, linear or linear-lanceolate, densely scabrous, and from 1 to 3 centimeters long and 2 to 5 millimeters wide. The flower heads are terminal, dense, sub-globose, and from .8 to 1.3 centimeters in diameter. The corolla is white, narrowly funnelform, minutely glandular-papillose, and 5 to 6 millimeters long. The capsule is about 1.5 millimeters in diameter, opening by a transverse circular split at about the middle. The seeds are ellipsoid, brownish-black, and 1.2 millimeters long and .8 millimeter wide (Proctor 1991a).

Mitracarpus polycladus, also belonging to the family Rubiaceae, was first discovered growing on coastal rocks near Caña Gorda, Guánica, Puerto Rico, in 1886 by Paul Sintenis. It was also located on the island of Saba in the lesser Antilles by the Dutch botanist Boldingh. *Mitracarpus polycladus* is a suffrutescent perennial. It is branched near the base, and the erect or spreading stems may reach up to 45 centimeters in height. The branches are 4-angled and glabrous. Leaves are opposite, linear to linear-lanceolate, 2 to 4.5 centimeters long, .3 to .5 centimeters wide, glabrous and often with an inrolled margin and decurrent base. The inflorescence is terminal and capitate, 8 to 13 millimeters in diameter, many flowered and subtended by 3 bracht-like leaves. The corolla is white, about 5 millimeters long, with ovate leaves. The seed capsule is 1.5 millimeter in diameter, splitting open transversely below the middle, and contains black seeds (Proctor 1991b).

Eugenia woodburyana, a small evergreen tree, belongs to the family Myrtaceae, a large family that includes from 100 to 140 genera and 3,000 or more species of trees and shrubs, mostly of tropical and subtropical regions (Cronquist 1981). The largest genus is *Eugenia*, which is very diverse in the Antilles and includes more native species than any other genus of flowering

plants in the flora of Puerto Rico (Breckon and Kolterman 1994). *Eugenia woodburyana* was only recently discovered and described by Alain Liogier (Liogier 1980).

Eugenia woodburyana may reach 6 meters in height. The leaves are opposite, obovate, pilose on both sides, glandular-punctate below, and from 1.5 to 2 centimeters long and 1 to 1.5 centimeters wide. The inflorescence is axillary, 2 to 5 flowered and with a peduncle 1 to 3 millimeters long. The calyx is 4-lobed and the petals are white, 4 millimeters long and 3.5 millimeters wide. The striking fruit is red upon maturity, 8-winged and 2 centimeters in diameter (Liogier 1994).

Distribution/Population Status

Mitracarpus maxwelliae is known from only one locality, the type locality, in the Guánica Commonwealth Forest, Guánica, Puerto Rico (Figure 1). At this locality, it is found along an unpaved road, growing on dry exposed gravel. Approximately 1,443 plants, including mature flowering individuals and seedlings, were counted within an area of about 7,500 square meters (Proctor 1991a).

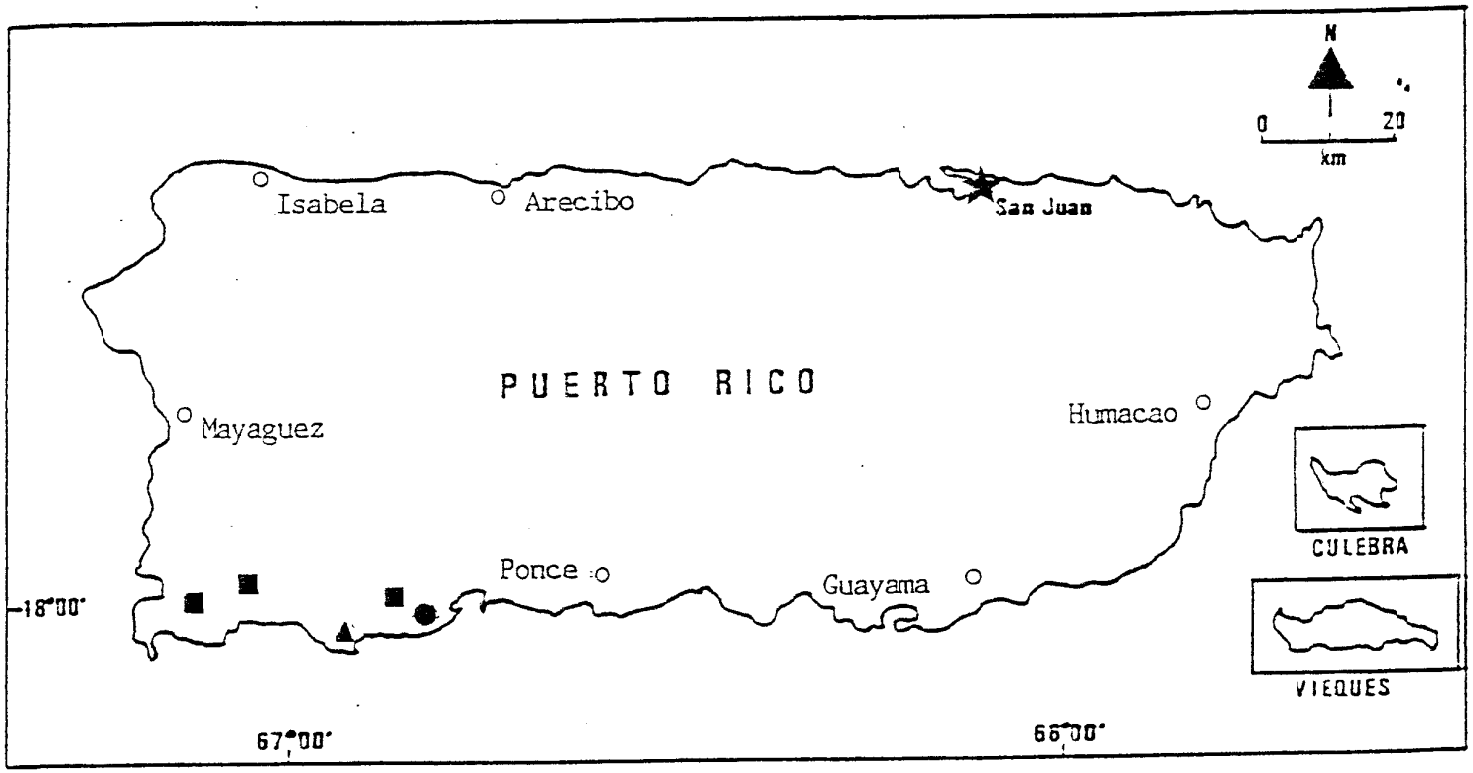
Mitracarpus polycladus is known from only one location in Puerto Rico, in the Guánica Commonwealth Forest in the municipality of Guayanilla, Puerto Rico, where it grows in crevices and soil pockets of coastal rocks in arid areas (Figure 1). Exact numbers of individuals have been difficult to estimate due to extreme drought conditions in recent years. It is also known from the island of Saba in the Lesser Antilles (Proctor 1991b).

Eugenia woodburyana is currently known from the range of hills known as the Sierra Bermeja in the municipalities of Cabo Rojo and Lajas. Some individuals are located on land recently added to the Laguna Cartagena National Wildlife Refuge and others are located on adjacent private land. The species is also known from the Guánica Commonwealth Forest in Guánica. An additional individual has been reported from the Cabo Rojo National Wildlife Refuge, adjacent to the Sierra Bermeja. Approximately 150 individuals are known from these localities (Figure 1).

Reproductive Biology

Little information is available on the reproductive biology of either *Mitracarpus maxwelliae* or *M. polycladus*. Both Proctor (1991a) and the Center for Plant Conservation (1992) state that both mature plants and numerous seedlings of *M. maxwelliae* have been observed at the known population site. The Center for Plant Conservation (1992) indicates that little seed set of *M. polycladus* occurred in cultivation. Studies of the reproductive biology of these species are currently underway.

Studies of the reproductive biology of *Eugenia woodburyana* are also currently underway. Information obtained from herbarium specimens indicates that buds and flowers were present



Locations of *Mitracarpus maxwelliae* (▲), *M. polycladus* (●), and *Eugenia woodburyana* (■) in Puerto Rico.

on specimens collected in October and May from Guánica, but that specimens collected in February and April were sterile. One specimen, collected from the Sierra Bermeja in March, had remnants of old flowers. No flowers or fruit were observed during preliminary studies of several individuals for a 1-year period.

Habitat Description

All areas where these three species are located are found within the subtropical dry forest life zone (Ewel and Whitmore 1973), the driest life zone in Puerto Rico. The vegetation in this zone forms a complete ground cover and is deciduous on most soils. Leaves are succulent or coriaceous, and species with spines and thorns are common. Tree heights usually do not exceed 15 meters and the crowns are typically broad, spreading and flattened. Fire is common on many soils, and occurs frequently on lands where the plants are located. Successional vegetation includes grasses and the accumulated organic debris serves as fuel for the frequent dry season fires.

Cabo Rojo National Wildlife Refuge

The Cabo Rojo National Wildlife Refuge consists of about 238 hectares and is located in the extreme southwestern corner of Puerto Rico at an elevation of approximately 20 meters. The vegetation is primarily grassland, but scattered individuals of *Prosopis pallida* (mesquite) and *Acacia farnesiana* (aroma) are found.

Average annual precipitation (1980 through 1993) at the Refuge is 883 millimeters, ranging from a high of 1,575 millimeters in 1991 to a low of 113 millimeters in 1981. The drier period extends from December through March and the wetter period includes May and September through November. Mean maximum monthly temperature during this same period was 29°C and mean minimum monthly temperature was 19.3°C. Soils of the Refuge belong to the Americus-Guayabo-Sosa association, which are described as well-drained to excessively drained, level to sloping, sandy soils (SCS 1965).

Sierra Bermeja/Laguna Cartagena National Wildlife Refuge

The Sierra Bermeja is a range of hills located in the municipalities of Cabo Rojo and Lajas in southwestern Puerto Rico. These hills are the oldest geologic formation in Puerto Rico and are known for their high plant endemism. Individual plants of *Eugenia woodburyana* are found both on public (Laguna Cartagena National Wildlife Refuge) and private land. The Laguna National Wildlife Refuge was expanded recently (1996) to include a 270-acre portion of the Sierra Bermeja.

Soils have been described as Guayama cherty clay loam, 20 to 60 percent slopes, a soil series which covers most of the steep slopes of the Sierra Bermeja. This soil is from 14 to 30 centimeters deep to weathered siliceous rock and is acid in nature. In stony rock outcrop areas

(approximately 15 percent of the mapping unit), from 50 to 75 percent of the surface is covered by rock outcrops and hard volcanic cobbles and stones. Outcrops may be as large as 1 meter across (SCS 1965).

Precipitation data from Ensenada, to the east of the Sierra Bermeja, show a mean annual rainfall of 791 millimeters. The driest months were January through March, with the rainiest period occurring in August through September and again in May. The evaporation measured in the nearby Lajas station was 1,940 millimeters, more than twice the precipitation recorded at Ensenada. Mean annual temperature at Ensenada was 25.3°C, with a mean minimum temperature of 23.5°C in January and a mean maximum temperature of 26.7°C during August and September (Silander *et al.* 1986).

In the Sierra Bermeja, *Eugenia woodburyana* is found growing with species such as *Comocladia dodonea* (carrasco), *Plumeria alba* (alhelí), *Bursera simaruba* (almácigo), *Bucida buceras* (úcar), *Randia aculeata* (tintillo), *Croton* sp., and *Jacquinia berterii* (G. Proctor, pers. comm.). The endangered Puerto Rican nightjar (*Caprimulgus noctitherus*) has recently been reported from the slopes of the Sierra Bermeja.

Guánica Commonwealth Forest

The Guánica Commonwealth forest is located in southwestern Puerto Rico in the municipalities of Guánica, Guayanilla, and Yauco. The Forest was designated as a forest reserve in 1919 and a United Nations Biosphere Reserve in 1981. It is managed by the Puerto Rico Department of Natural and Environmental Resources. Mean annual precipitation in the Guánica area is approximately 790 millimeters. Over 55 percent of the precipitation falls during the wetter season, from August through November. The dry season extends from January through March. Mean annual temperature has been reported to be 25.3°C, with a mean monthly minimum of 23.5°C and mean monthly maximum of 26.7°C (Silander *et al.* 1986). The Forest is underlain by limestone sedimentary rocks, Tertiary in origin, and outcrops cover much of the area. Soils are derived from limestone and are shallow, well-drained, and alkaline in nature.

The Guánica Commonwealth Forest supports a variety of vegetation types including cactus scrub, littoral forest, deciduous forest, and semi-evergreen forest. *Eugenia woodburyana* is found in the semi-evergreen forests of the bottoms of the more mesic canyons. In these canyons, trees are taller, often reaching 15 meters, and a larger number of evergreen species are found. Silty alluvial soils, which retain a greater moisture content, are found among large limestone rock outcrops in these drainages. Water runs through these canyons during heavy rainfall, but they are dry the remainder of the year. Associated species in this vegetation type are *Guaiacum officinale*, *G. sanctum*, *Coccoloba diversifolia*, *Bucida buceras*, *Bursera simaruba*, *Eugenia rhombea*, and *E. maleolens*. The endangered palo de rosa (*Ottoschulzia rhodoxylon*) is also found at this same locality.

Both *Mitracarpus maxwelliae* and *M. polycladus* are found in the vegetation type which has been described as coastal scrub forest over exposed limestone rock or coastal dwarf forest. Here the species grow in crevices and soil pockets of coastal rocks. The vegetation in the area is dwarfed in stature due to the salt spray and lack of soil and consists of species such as *Bucida buceras. Bursera simaruba, Exostema caribaeum, Coccoloba microstachya, Plumeria alba*, and *Pilosocereus royenii.*

Reasons For Listing

In the Sierra Bermeja, *Eugenia woodburyana* is found on both public (managed by the Fish and Wildlife Service) and privately owned land. The privately owned land is subject to intense pressure for agricultural, rural, and tourist development. The land is currently being cleared for grazing by cattle and goats. Adjacent land is being subdivided for sale in small farms, some destined for tourist and urban development. Both public and private lands in these hills are frequently affected by wildfires, which adversely affect seedling recruitment and habitat restoration efforts.

All three species are also found within the Guánica Commonwealth Forest; however, *Mitracarpus maxwelliae* and *Mitracarpus polycladus* are found along infrequently used roadways where they may be impacted in the future. Any road improvement, widening, or increase in traffic along these roads would result in the loss of a significant portion of the only known populations. The sites of these two species are near preferred recreational areas, heavily utilized during the summer months.

One of the most important factors affecting the continued survival of these species is their limited distribution. Because so few individuals are known to occur in a limited area, the risk of extinction is extremely high. While not a natural phenomena, wildfires are a frequent occurrence in this extremely dry portion of southwestern Puerto Rico, particularly in the coastal roadside areas of Guánica where *Mitracarpus maxwelliae* and *M. polycladus* are found and in the open, abandoned pasture areas of the Sierra Bermeja.

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 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. Section 7(a) of the Act, as amended, requires Federal agencies to evaluate their actions with respect to any species that is listed as federally endangered or threatened. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into formal consultation with the Fish and Wildlife Service.

Studies of the distribution, abundance, population size and structure, and reproductive biology of these three species are currently ongoing. Some preliminary results have been incorporated into this plan. The Fish and Wildlife Service works closely with the Puerto Rico Department of Natural and Environmental Resources in their review of development projects in order to avoid adverse effects to the species. The Fish and Wildlife Service recently acquired 270 acres in the Sierra Bermeja, which were added to the Laguna Cartagena National Wildlife Refuge. This land harbors a number of endangered species, including the Puerto Rican nightjar, the yellow-shouldered blackbird (*Agelaius xanthomus*), *Aristida portoricensis, A. chaseae, Lyonia truncata*, var. *proctorii, Vernonia proctorii, and Eugenia woodburyana*.

Summary of Comments Received

Copies of the Technical/Agency Draft Recovery Plan for Mitracarpus maxwelliae, M. polycladus, and Eugenia woodburyana were sent to 11 reviewers, including three peer reviewers, for review and comment. A notice of availability of the Technical/Agency Draft was published in the *Federal Register*. No letters of comment were received.

PART II. RECOVERY

A. Recovery Objective and Criteria

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

Mitracarpus maxwelliae and *M. polycladus* could be considered for delisting when (1) a management plan that considers the protection and recovery of the species has been prepared and implemented for the Guánica Commonwealth Forest and (2) new populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas, such as other coastal areas in the Guánica Commonwealth Forest.

Eugenia woodburyana could be considered for delisting when (1) a management plan that considers the protection and recovery of the species has been prepared and implemented for the Guánica Commonwealth Forest and for the Cabo Rojo and Laguna Cartagena National Wildlife Refuges; (2) protection has been provided for those individuals known to occur on privately owned land and (3) new populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas, such as other areas in the Guánica Commonwealth Forest. However, if new populations of the species are discovered, it may be preferable to place greater emphasis of protection rather than on propagation in order to achieve the minimum number of plants necessary for recovery.

B. Narrative Outline

1. **Prevent further habitat loss and population decline**. Protection of habitat and individual plants at the known population sites should be initiated by appropriate public agencies.

    11. **Protect habitat**. To prevent extinction, the protection of the existing populations should be given the highest priority.

        111. **Develop a management plan, which provides for the protection and recovery of *Mitracarpus maxwelliae, M. polycladus* and *Eugenia woodburyana*, for the Guánica Commonwealth Forest.** A management plan should be developed that includes measures to protect known individuals and their habitat and provides for long-term monitoring of their growth and reproduction. .

112. **Prepare and implement a management plan, which considers protection and recovery of these three species, for the Cabo Rojo National Wildlife Refuge (CRNWR) and the Laguna Cartagena National Wildlife Refuge (LCNWR).** A management plan should be prepared and implemented and must include measures to protect known individuals and their habitat. Provision should be made for their long-term monitoring.

113. **Protect privately-owned habitat in the Sierra Bermeja.** Privately owned habitat may be protected not only through acquisition, but also through programs designed to involve landowners in the protection. This may include landowner agreements or involvement of landowners in Partners for Fish and Wildlife. Other agencies also offer incentive programs which may be appropriate for use in the area.

12. **Protect and monitor plants.** Individual plants and the recruitment of new individuals must be monitored on a long-term basis.

121. **Monitor known population.** Individual plants should be measured and marked. Basic field observations which will contribute to the information available on population behavior (including phenology, seed production, seed dispersal, recruitment success, site changes, and growth), should be made at regular intervals. Such studies have been initiated and should be continued.

122. **Enforce existing Commonwealth and Federal endangered species regulations.** The Commonwealth Department of Natural Resources' Regulation to Govern the Management of Threatened and Endangered Species of 1985 provides for criminal penalties for the illegal take of listed plant species on public land. In addition, development projects that occur in these areas are often funded through local or Federal agencies or require local permits. The Regulation's Section 10 provides for consultations on endangered species that may be affected by a particular project similar to Section 7 of the Endangered Species Act. Section 7 of the Endangered Species Act would apply where Federal lands or federally funded or permitted projects are involved.

123. **Educate the public on plant conservation values and regulations**. These three species should be included in the illustrated brochure and slide presentation (in both English and Spanish) on endangered plants and plant communities that are presented to local school groups, organizations, and agencies. Permitting and funding agencies (those potentially involved in Section 7 consultations) should be made aware of endangered plants, the pertinent laws, and their responsibilities.

2. **Continue to gather information on the distribution and abundance of all three species**. Future management decisions and the establishment of recovery implementation priorities depend on obtaining additional information concerning the distribution and abundance of these species.

21. **Search for new populations**. Searches for new individuals and populations should be conducted in the Guánica Commonwealth Forest and areas such as the Sierra Bermeja and private forested land in the southwest.

211. **Identify and inventory potential sites**. Based on a characterization of known habitat types, potential population sites should be identified and searched. The species' known habitat is limited in extent, thereby facilitating searches.

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, newly discovered sites should be evaluated for the availability of propagative material and the potential for protection.

3. **Conduct research**. While some studies have been initiated, relatively little biological information is available on any of the three species. Studies should focus on those aspects of life history that may be critical to the recovery of the species.

31. **Define habitat requirements**. Information available from existing studies should be evaluated to more clearly define habitat requirements.

32. **Study reproductive biology and ecology of *Mitracarpus maxwelliae, M. polycladus*, and *Eugenia woodburyana***. Effective management and recovery of these species depends upon obtaining this information.

321. **Assess periodicity of flowering**. Studies to determine the frequency, timing, and abundance of flowering, pollination mechanisms, and the physical and biological factors controlling these events should be continued.

322. **Assess seed production and dispersal**. Agents of seed predation and/or dispersal should be identified.

323. **Evaluate seed viability and germination requirements**. Information on the environmental conditions required for germination should be obtained through field and laboratory studies.

324. **Evaluate requirements for establishment and growth**. Field and laboratory experiments should focus on this critical stage to determine the factors that affect establishment and survival.

325. **Determine genetic structure of the species**. Study intra and inter-population genetic diversity of the species using appropriate techniques.

33. **Evaluate techniques for artificial propagation and develop propagation program**. Propagation techniques should be evaluated so that a propagation program with local nurseries may be developed.

331. **Assess methods of propagation**. Based on the availability of propagative material, economic and logistical considerations, and results from the above research, determine the most feasible method of propagation and transplantation to existing or new sites. Sexual and asexual reproduction should be evaluated as alternatives.

332. **Develop artificial propagation program**. This species should be included in the ongoing artificial propagation program at local nurseries (e.g., the Department of Natural and Environmental Resources or the Fish and Wildlife Service at the CRNWR).

4. **Establish new populations**. Areas for the establishment of new populations of *Mitracarpus maxwelliae, M. polycladus,* and *Eugenia woodburyana* 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 ensure the success and relevance of transplanting propagated material.

411. **Select sites and assess habitat suitability**. Using information from Task 31, inventory potential sites for the introduction and establishment of new populations of *Mitracarpus maxwelliae, M. polycladus,* and *Eugenia woodburyana*. Consideration should be given to the introduction of *Eugenia woodburyana* in other areas of the LCNWR or CRNWR as part of the ongoing reforestation program.

412. **Ensure site protection**. If proposed sites are not already on protected land, steps must be taken to provide for their protection. Management plans for these new sites should be developed or modified to include considerations for this species.

413. **Introduce and monitor plants**. Success of plantings should be carefully monitored.

5. **Refine recovery criteria**. As additional information on the biology, ecology, propagation, and management of *Mitracarpus maxwelliae, M. polycladus,* and *Eugenia woodburyana* is accumulated, it will be necessary to better define, and possibly modify, recovery criteria.

51. **Determine number of individuals and populations necessary to ensure species stability and self-perpetuation**. Environmental and reproductive 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 during the recovery process become recognized needs, they should be incorporated into the plan.

C. Literature Cited and References

Breckon, G. and D. Kolterman. 1994. *Eugenia woodburyana* Alain (Myrtaceae). Final Report under Cooperative Agreement No. 1448-0004-93-973 between the U.S. Fish and Wildlife Service and the University of Puerto Rico, Mayaguez Campus. 18 pp.

Center for Plant Conservation. 1992. Report on the Rare Plants of Puerto Rico. Missouri Botanical Garden, St. Louis, Missouri.

Ewel, J.S. and J.L. Whitmore. 1973. Ecological life zones of Puerto Rico and the U.S. Virgin Islands. USDA Forest Serv. Res. Paper ITF-18. 72 pp.

Liogier, A.H. 1980. Novitates Antillanae. VIII. Phytologia 47(3): 167-198.

Liogier, A.H. 1994. Descriptive flora of Puerto Rico and adjacent islands. Volume III, Cyrillaceae to Myrtaceae. Editorial de la Universidad de Puerto Rico. Río Piedras, Puerto Rico.

Proctor, G.R. 1991a. Status report on *Mitracarpus maxwelliae* Britton & Wilson. *In* Puerto Rican plant species of special concern: status and recommendations. Publicación Cientifica Miscelanea No. 2, Department of Natural Resources, San Juan, Puerto Rico.

Proctor, G.R. 1991b. Status report on *Mitracarpus polycladus* Urban. *In* Puerto Rican plant species of special concern: status and recommendations. Publicación Cientifica Miscelanea No. 2, Department of Natural Resources, San Juan, Puerto Rico.

Silander, S., H. Gil de Rubio, M. Miranda, and M. Vazquez. 1986. Los Bosques de Puerto Rico, Volume II. Compendio Enciclopédico de los Recursos Naturales de Puerto Rico. Puerto Rico Department of Natural Resources, San Juan, Puerto Rico.

Soil Conservation Service. 1965. Soil Survey of the Lajas Valley Area, Puerto Rico. U.S. Department of Agriculture, S.C.S. In cooperation with the University of Puerto Rico, Agricultural Experimental Station. 170 pp.

U.S. Fish and Wildlife Service. 1994. Endangered and threatened wildlife and plants; determination of endangered status for three Puerto Rican plants. *Federal Register* Vol. 59: 46715.

PART III. IMPLEMENTATION SCHEDULE

Priorities in Column 4 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.

List of Abbreviations

DNER -	Puerto Rico Department of Natural and Environmental Resources
ES -	Fish and Wildlife Service, Ecological Services Division
LE -	Fish and Wildlife Service, Law Enforcement Division
Refuges -	Fish and Wildlife Service, Refuge Division
BotGar -	Botanical Gardens
Univ. -	Universities

IMPLEMENTATION SCHEDULE

Task Priority	Task Description	Task Number	Task Duration (Years)	Responsible Organization FWS R4	Responsible Organization Other	Cost Estimates ($000) FY1	FY2	FY 3	Comments
1	Develop a management plan, which provides for the protection and recovery of *Mitracarpus maxwelliae, M. polycladus* and *Eugenia woodburyana*, for the Guánica Commonwealth Forest.	111	2	ES	DNER				No cost anticipated.
1	Prepare and implement a management, which considers the protection of *Eugenia woodburyana*, for the CRNWR and the LCNWR.	112	2	ES Refuges	DNER	3	3		
1	Protect privately-owned land.	113	4	ES,LE Refuges	DNER				Cost not known at present.
1	Monitor known populations.	121	Cont.	ES Refuges	DNER	5	5	5	
1	Enforce existing Commonwealth and Federal endangered species regulations.	122	Cont.	ES, LE Refuges	DNER	6	6	6	
2	Educate the public on plant conservation values and regulations.	123	Cont.	ES, LE Refuges	DNER	3	3	3	
2	Identify and inventory potential sites.	211	2-4	ES Refuges	DNER	6	6	6	

Task Priority	Task Description	Task Number	Task Duration (Years)	Responsible Organization FWS R4	Other	Cost Estimates ($000) FY1	FY2	FY 3	Comments
2	Characterize sites to determine their suitability as future recovery sites.	212	2-4	ES Refuges	DNER, Univ.				
2	Define habitat requirements.	31	2-4	ES Refuges	DNER, Univ.	3	3	3	
2	Assess periodicity of flowering.	321	2-4	ES Refuges	DNER, Univ.	6	6	6	6K/year includes 321, 322, 323, 324, and 325.
2	Assess seed production and dispersal.	322	2-4	ES Refuges	DNER, Univ.				
2	Evaluate seed viability and germination requirements.	323	2-4	ES Refuges	DNER, Univ.				
2	Evaluate requirements for establishment and growth.	324	2-4	ES Refuges	DNER, Univ.				
2	Determine genetic structure of the species.	325	2-4	ES Refuges	DNER, Univ.				
2	Assess methods of propagation.	331	2-4	ES Refuges	DNER, Univ. BotGar.	2	2	2	
2	Develop artificial propagation program.	332	Cont.	ES Refuges	DNER, Univ. BotGar.	2	2	2	
2	Select sites and assess habitat suitability.	411	2-4	ES Refuges	DNER, Univ.		2		
2	Ensure site protection.	412	2-4	ES Refuges	DNER				

Task Priority	Task Description	Task Number	Task Duration (Years)	Responsible Organization FWS R4	Other	Cost Estimates ($000) FY1	FY2	FY 3	Comments
2	Introduce plants.	413	2-4	ES Refuges	DNER				
2	Determine number of individuals and populations to ensure stability and self-perpetuation.	51	Cont.	ES Refuges	DNER, Univ.				
2	Determine what additional actions are needed to achieve recovery objectives.	52	Cont.	ES Refuges	DNER, Univ.				

PART IV. LIST OF REVIEWERS

Mr. José Chabert, Director
Terrestrial Ecology Section
Department of Natural and Environmental Resources
P.O. Box 9066600
San Juan, Puerto Rico 00906-6600

Mr. Vicente Quevedo
Natural Heritage Program
Department of Natural and Environmental Resources
P.O. Box 9066600
San Juan, Puerto Rico 00906-6600

Mr. Daniel Pagan Rosa, Secretary
Department of Natural and Environmental Resources
P.O. Box 9066600
San Juan, Puerto Rico 00906-6600

Mr. Miguel Canals
Forest Biologist, Guánica Commonwealth Forest
Department of Natural and Environmental Resources
P.O. Box 9066600
San Juan, Puerto Rico 00906-6600

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

Mr. Luis Frias
Puerto Rico Planning Board
P.O. Box 41119
San Juan, Puerto Rico 00940

Ms. Ileana Echegoyen, Director
Famer's Home Administration
GPO Box 6106-G
San Juan, Puerto Rico 00906

Dr. Gary Breckon (*)
Department of Biology
University of Puerto Rico, Mayaguez
Mayaguez, Puerto Rico 00681

Dr. Duane Kolterman (*)
Department of Biology
University of Puerto Rico, Mayaguez
Mayaguez, Puerto Rico 00681

Dr. George Proctor (*)
Terrestrial Ecology Division
Department of Natural Resources
P.O. Box 9066600
San Juan, Puerto Rico 00906-6600

Mr. Val Urban
Refuge Manager, Caribbean Islands National Wildlife Refuge
Fish and Wildlife Service
Box 491
Boquerón, Puerto Rico 00622

Fundación Puertorriqueña de Conservación
Calle O'Neill No. 11
Hato Rey, Puerto Rico 00918

Dr. Bob Cook
Arnold Arboretum
125 Arborway
Jamaica Plain, Massachusetts 02130

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

(*) - PEER REVIEWERS