

Palo de Ramón
(*Banara vanderbiltii*)



Photo by: Carlos Pacheco, USFWS biologist, 2009

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Southeast Region
Caribbean Ecological Services Field Office
Boquerón, Puerto Rico

5-YEAR REVIEW
***Banara vanderbiltii* /Palo de Ramón**

I. GENERAL INFORMATION

A. Methodology used to complete the review: On April 9, 2010, the U.S. Fish and Wildlife Service (Service) published a notice in the *Federal Register* (75 FR 18232) to announce the 5-year review of the *Banara vanderbiltii* (commonly known as Palo de ramón), and to request new information concerning the biology and status of the species. A 60-day comment period was opened. No comments were received from the public during this public comment period.

This 5-year review was finalized by the lead Service recovery biologist and summarizes the information that has been gathered in the Palo de ramón file since the plant was listed on January 14, 1987. The sources of information used for this review included the original listing rule for the species, the recovery plan for the species, peer-reviewed literature, personal communications with qualified biologist and experts on the species, and information provided by the University of Puerto Rico, Mayagüez campus (UPRM). The Service and the UPRM signed a cooperative agreement to gather and summarize new information on the Palo de ramón. Under this agreement, Dr. Duane A. Kolterman and Dr. Jesús D. Chinae provided the Service with a draft review compiling the information gathered during their literature research on the species, communication with other specialists, and examination of herbarium data from the University of Puerto Rico at Mayagüez (MAPR), Río Piedras Botanical Garden (UPR), University of Puerto Rico at Río Piedras (UPRRP), Puerto Rico Department of Natural and Environmental Resources (PRDNER), New York Botanical Garden (NY), US National Herbarium (US), and University of Illinois (ILL). Additionally, lead Service recovery biologist added unpublished information provided by the PRDNER and USDA Forest Service regarding the status and distribution of the species in Puerto Rico.

We did not seek additional peer review on this 5 year review since Dr. Kolterman and Dr. Chinae, and the interviewed PRDNER and Forest Service botanists are leading experts on this and other plants that share habitat with Palo de ramón. For this review, we believe they gathered the best available information on this species.

B. Reviewers

Lead Region: Kelly Bibb, Southeast Region, Atlanta, Georgia. (404) 679-7132

Lead Field Office: Carlos Pacheco, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico. (787) 851-7297, extension 221.

C. Background

1. Federal Register Notice citation announcing initiation of this review: April 9, 2010; 75 FR 18232

2. Species Status: 2013. Unknown. The status and distribution of the Palo de ramón has not been re-evaluated since 1991 (Service 1991). When the species recovery plan was signed in 1991, only 11 plants were known from two localities: one at the Rio Lajas ward in the municipality of Dorado, and another at Las Piedras del Collado area (also known as Las Tetas de Cayey) in the municipality of Salinas. These natural populations have been poorly monitored, and currently the status of these populations is unknown. No additional location information is available. Since the early 1990s, PRDNER has propagated approximately 190 individuals of Palo de ramón, introducing them in eight localities throughout Puerto Rico (Eduardo Cintrón, PRDNER, pers comm. 2013) on privately-owned lands and Commonwealth lands managed for conservation. However, due to the lack of updated information on its status, the current status of these introduced populations is uncertain. Because the natural and introduced populations of Palo de ramón have been poorly monitored and no status surveys on the species have been conducted recently, the status of Palo de ramón is unknown.

3. Recovery Achieved: 2 (2= 26-50% of species' recovery objectives achieved).

4. Listing History

Original Listing

FR notice: 52 FR 1459

Date listed: January 14, 1987

Entity listed: species

Classification: endangered

5. Associated rulemakings: Not applicable

6. Review History:

The January 14, 1987, final rule (52 FR 1459) and the *Banara vanderbiltii* Recovery Plan (hereafter the "Recovery Plan"), approved on March 15, 1991 (Service 1991), are the most comprehensive analyses of the species' status and were used as reference point documents for this 5-year review.

Palo de ramón is a rare shrub or small tree, about 3-10 m in height, endemic to Puerto Rico (Little et al., 1974; Liogier, 1994). Palo de ramón, family Salicaceae, was first collected in 1899 by Amos A. Heller near the municipality of Cataño, west of San Juan (Service 1991). The species was later found in Rio Lajas in the municipality of Dorado and at Las Piedras del Collado in the municipality of Salinas (Service 1991).

In the final rule listing Palo de ramón as endangered (January 14, 1987, 52 FR 1459), the Service analyzed the best scientific and commercial information available for the species and determined the main threats to be modification of habitat or direct destruction of individuals through deforestation (Factor A: present or threatened destruction, modification, or curtailment of its habitat or range) and its small geographically limited range (Factor E: other natural or manmade factors affecting its continued existence). The recovery plan was signed on March 15, 1991

(Service 1991), and included the description, information on distribution, habitat characteristics, reproductive biology, and conservation of the species.

The Service conducted a 5-year review for Palo de ramón in 1991 (56 FR 56882). This review analyzed the status of many species simultaneously with no in-depth assessment of the five factors or threats of any individual species. The notice stated that the Service was seeking any new or additional information reflecting the necessity of a change in the status of the species under review. The notice indicated that if significant data were available warranting a change in a species' classification, the Service would propose a rule to modify the species' status. No change in the Palo de ramón listing classification was found to be appropriate.

Every year the Service reviews the status of listed species and update species information in the Recovery Data Call (RDC). The last RDC for the Palo de ramón was completed in 2013. Recovery Data Call: 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012 and 2013.

7. Species' Recovery Priority Number at start of review (48 FR 43098): 5. At the time of listing, Palo de ramón was recognized as a species with a high degree of threat and low recovery potential.

8. Recovery Plan:

Name of plan: *Banara vanderbiltii* Recovery Plan

Date issued: March 15, 1991

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy

The Endangered Species Act (Act) defines species to include any distinct population segment of any species of vertebrate wildlife. This definition limits listing as distinct population segments (DPS) only to vertebrate species of fish and wildlife. Because the DPS is not applicable to plant species, it is not addressed further in this review.

B. Recovery Criteria

- 1. Does the species have a final, approved recovery plan containing objective, measurable criteria?** Yes, Palo de ramón has an approved recovery plan (Service 1991) establishing reclassification from endangered to threatened status as the recovery objective. Additionally, the recovery plan contains measurable recovery criteria for downlisting.

Recovery actions identified to help reverse the decline of these plants include the protection of existing populations and their habitats, establishment of new populations at other appropriate protected sites, monitoring of introduced populations, conducting

research on the life history of the species, evaluating methods for propagation, looking for reintroduction sites, and enhancing existing populations with propagated material.

2. Adequacy of recovery criteria

a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? Yes. When the recovery plan was signed, very little information on the species' biology, life history, habitat requirements and abundance was available. At present, we still do not know the status of the species.

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria? Yes. The species is threatened by Factor A and Factor E. When the recovery criteria are met, these threats should be reduced or eliminated.

3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.

The recovery plan established that the species could be considered for reclassification from endangered to threatened when the following criteria are met:

1. The known populations at Rio Lajas and Las Piedras del Collado are placed under protective status;
2. At least two new populations capable of self-perpetuation (basically self-sustaining) have been established within protected units of the Commonwealth Forest System in the karst region (e.g., Vega or Cambalache Commonwealth Forests), and in the central mountain region (e.g., Carite or Toro Negro Commonwealth Forests).

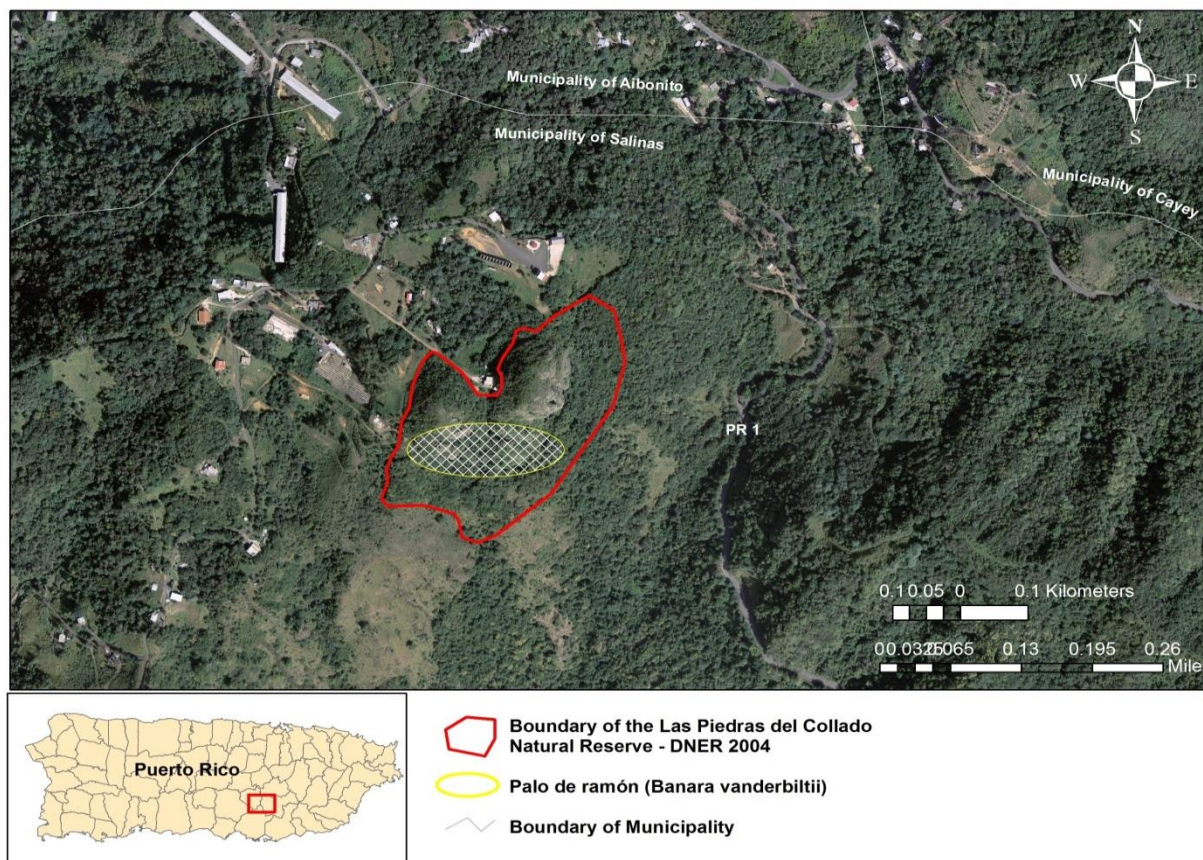
These are minimum requirements and could be expanded upon if the regenerative or propagation potential of natural and *ex-situ* populations prove to be insufficient. Alternatively, if new populations of the species are discovered, it may be preferable to place greater emphasis on protection rather than on propagation in order to achieve the minimum number of plants necessary for recovery.

Criterion 1 is partially completed. On September 1, 2000, The Commonwealth of Puerto Rico signed the Law No. 283, known as "*Ley para designar el área de los montículos de las Piedras del Collado como Reserva Natural*" (Law to designate Las Piedras del Callado as Natural Reserve). The purposes of this law are to control urban and tourism development in the area and to protect and conserve the geological formation of Las Tetas de Cayey and the surrounding forested areas. Under the Law No. 283, the PRDNER designated as natural reserve approximately 19.4 acres (7.86 hectares), including the geological formation and a strip of forest around it (DNER 2004). Fortunately, the Palo de ramón population known to occur in the municipality of Salinas is located within the boundaries of this natural reserve (Figure 1).

However, the population of Palo de Ramón known from Rio Lajas is located in private land and is threatened by urban and commercial development. Therefore, until this population is placed under protective status, this criterion will not be met.

Criterion 2 has not been achieved. Presently, Palo de Ramón has been introduced in eight sites managed for conservation in Puerto Rico (Figure 2). Five of these sites are located in the northern karst region (i.e., Rio Abajo Commonwealth Forest, Cambalache Commonwealth Forest, a conservation area within Fort Buchanan (U.S. Army), Guajataca Commonwealth Forest, and Fundación Luis Muñoz Marín). The other three populations were introduced in the southern face of the central mountain range (i.e., Toa Vaca and Susua Commonwealth Forests) and in the southern karst on Gabia's Farm. Although the Service and PRDNER have successfully propagated and planted Palo de Ramón, no information is available regarding the minimum number of individuals needed for a stable population. Therefore, more information on the population dynamics of the species is needed to determine what constitutes a viable population and to meet this criterion.

Figure 1. Boundary of Las Piedras del Collado Natural Reserve and the area where *Banara vanderbiltii* (Palo de Ramón) is known to occur (DNER 2004).



C. Updated Information and Current Species Status

1. Biology and Habitat

a. Species' abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g. age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends

New information on the Palo de ramón indicates that the overall species' abundance has increased since the time of listing in 1987 (Table 1, Service unpubl. data, 2013). At the time that the recovery plan was approved, Palo de ramón was known from 11 individuals in two populations: one at Rio Lajas ward in Dorado and another at Las Piedras del Collado in Salinas (Service 1991). To date, 201 individuals of Palo de ramón are known from 10 populations (Table 1, Figure2).

At this time, the status of the two natural populations of Palo de ramón (at Rio Lajas ward and Las Piedras del Collado) is uncertain due to the lack of updated information on the species' status, trends, and abundance. When the recovery plan was approved, the population at Rio Lajas ward consisted of 6 young individuals that range from 1.5 to 4 m (5 to 13 ft) in height and up to 4 cm (1.5 in) in diameter (Service 1991). In 2008, Victor Rodríguez-Cruz (former biologist from the PRDNER Forest Service Bureau) visited the Nevares' haystack hill located in Rio Lajas ward and found 5 adult trees of around 12 m (40 ft) height and up to 20 cm (7.8 in) in diameter, but found no seedlings or saplings (V. Rodríguez-Cruz, unpubl. data, 2013). Because the exact location of the individuals found at Nevares' haystack hill is not clear, and this site is located in the same area of the species' historical location, for the purpose of this review we considered the two localities (Rio Lajas and Nevares' haystack hill) to be one population.

In Las Piedras del Collado, the population of Palo de ramón at the time of the recovery plan consisted of approximately 5 individuals (Service 1991). The population has not been monitored since its discovery in 1986. The PRDNER has indicated that the species occurs within Las Piedras del Collado Natural Reserve; however, it does not mention the number of individuals found in the area (PRDNER 2004).

The species was also known to occur in the municipalities of Cataño and San Juan; however, these populations are believed to be extirpated due to urban development (D. Kolterman and J. China, UPRM, unpubl. data, 2013).

The Botanical Research and Herbarium Management System (BRAHMS) database includes a total of seven specimens of Palo de ramón (<http://herbaria.plants.ox.ac.uk>). BRAHMS is a flexible database management system for botanical researchers and herbaria that provide wide-ranging and innovative functionality to gather, edit, analyze and publish botanical data, optimizing its use for widest possible range of curation service and research output. Based on the BRAHMS database, five vouchers of Palo de ramón were collected between 1899 and 1963 along the north coast between San Juan and Bayamón. Two more recent collections are from the municipality of Dorado (1985) and the Tetas de Cayey in the municipality of Salinas (1993). Unfortunately, the herbarium vouchers provided no information on the status of the population at the time the samples were collected.

Since the early 1990's, the Service and PRDNER have established a protocol to propagate Palo de ramón in the greenhouse at the Cambalache Commonwealth Forest, producing over 190 individuals (Service 1991, PRDNER 2006). These individuals have been planted in 8 sites managed for conservation in Puerto Rico (Table 1). At Gabias' Farm and Cambalache Commonwealth Forest, the planted individuals have been established successfully, evidenced by their successful developing, flowering, and fruiting (C. Pacheco, Service, pers. obs., 2013). The status of the other introduced populations is unknown. Overall, planted individuals have been poorly monitored and no updated information on their status is available.

In general, the populations of Palo de ramón have been poorly monitored. However, based on the new information regarding the introduction of new populations throughout Puerto Rico, and the increased number of individuals, we believe that species' population trend may have increased.

Table 1. Number of individuals of *Banara vanderbiltii* known by population in Puerto Rico (Service, unpubl. data, 2013).

Location	Current Species abundance (# of adult plants)	Source of Information
Rio Lajas, Dorado	6*	Service 1991
Las Piedras del Collado, Salinas	5*	Service 1991
Cambalache Commonwealth Forest	8**	DNER 2006
Fort Buchanan, Guaynabo	5**	Victor Rodriguez-Cruz, unpubl. data, 2013
Toa Vaca Commonwealth Forest, Villalba	90**	Juan Casanova, PRDNER, pers. com., 2013
Gabia's Farm, Coamo	60**	Juan Casanova, PRDNER, pers. com., 2013
Guajataca Commonwealth Forest, Isabela	17**	René Roman, PRDNER, pers. comm. 2013
Susua Commonwealth Forest, Sabana Grande	5**	Eduardo Cintrón, PRDNER, pers. comm., 2013
Rio Abajo Commonwealth Forest, Utuado	2**	Quique Casanova, PRDNER, persn. comm., 2013
Fundación Luis Muñoz Marín, Rio Piedras	3**	Alberto Areces, unpubl. data., 2013
Total:	201	

*Natural populations. Number based on historical records, no information of current population status available.

**Introduced populations. Number based on number of individuals originally planted in the area.

b. Genetics, genetic variation, or trends in genetic variation (e.g. loss of genetic variation, genetic drift, inbreeding, etc.)

No information on the genetic variability within the species was found during this review, but the restricted range and limited number of individuals reported to date may suggest a low level of genetic variation. Overall, the genetics, genetic variation, and trends of Palo de ramón are poorly known and no information on loss of genetic variation, genetic drift, etc., is currently available. However, it would be reasonable to expect some genetic differentiation between the populations in northern and south central Puerto Rico, given their separation and the notable differences in elevation, substrate, and rainfall between the two areas.

c. Taxonomic classification or changes in nomenclature

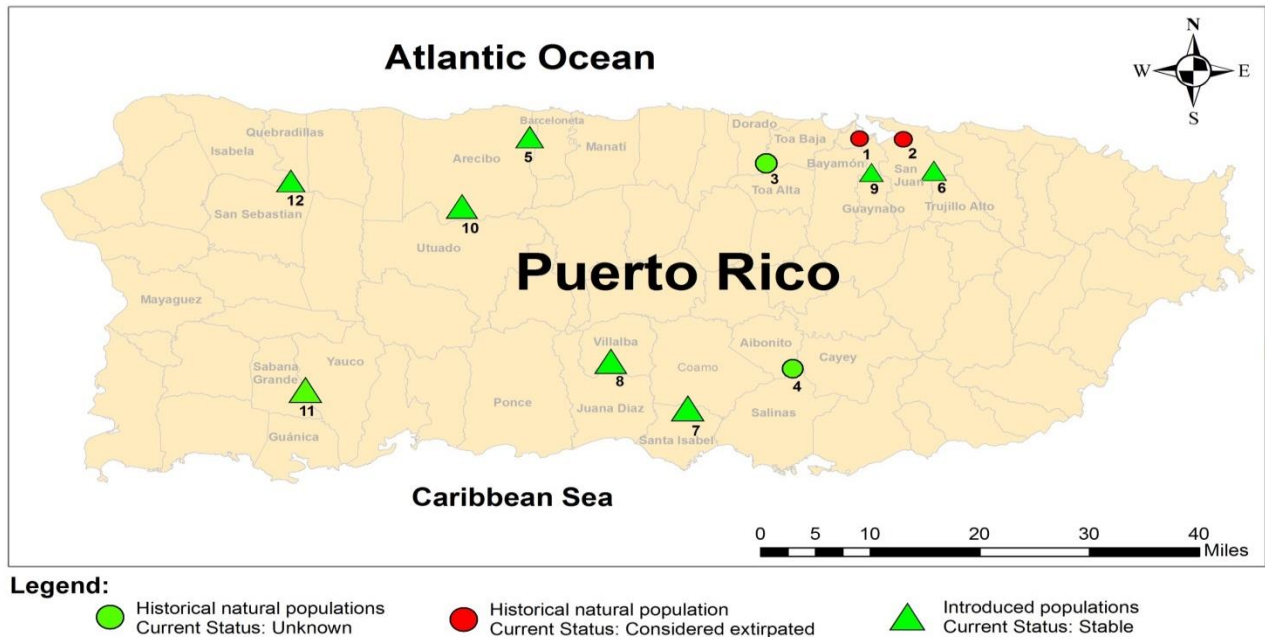
No recent taxonomic or nomenclatural changes are known for the species. Palo de ramón (*Banara vanderbiltii*) is the name accepted in the recent checklists for Puerto Rico (Axelrod, 2011) and the West Indies (Acevedo-Rodríguez and Strong, 2012). However, the family Flacourtiaceae, to which it was formerly assigned, has been dismantled and the genus *Banara* has been transferred to the Salicaceae family (D. Kolterman and J. Chinae, UPRM, unpubl. data, 2013).

d. Spatial distribution, trends in spatial distribution, or historic range

Palo de ramón is endemic to northern and south central Puerto Rico (D. Kolterman and J. Chinae, UPRM, unpubl. data, 2013). This species has a limited geographic range that may reflect a remnant population of the a species whose habitat has been altered or lost due to agricultural practices, such as cultivation of yam, sugar cane, cotton, and coffee (Service 1991). At the time of listing, Palo de ramón was known only from two natural populations (Service 1991). The species is believed to no longer persist in Cataño and San Juan due to the urban expansion in the metropolitan area (D. Kolterman and J. Chinae, UPRM, unpubl. data, 2013). The species has not been found in St. Thomas since 1980 despite search efforts. However, after reviewing the information available on the species, we have found that the current distribution of the species has increased due to recovery efforts conducted by the Service and PRDNER. Presently, the species has been introduced in 8 localities managed for conservation (Table 1 and Figure 2).

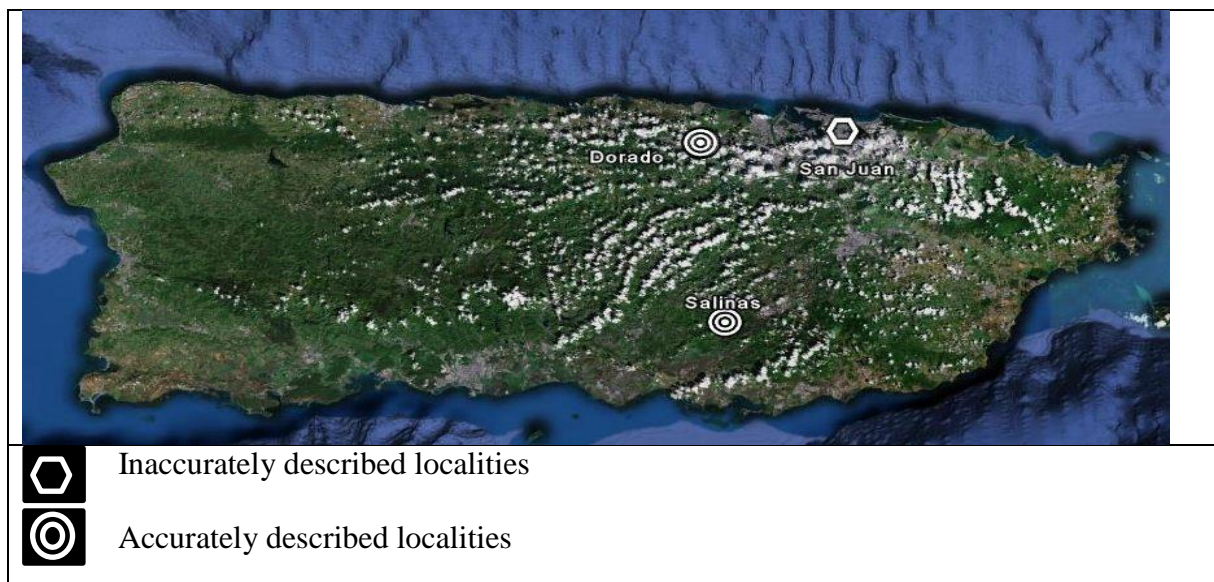
Palo de ramón has a very limited spatial distribution within its localities (Figure 3). Drs. Kolterman and Chinae (UPRM) evaluated seven specimens deposited in herbaria between 1899 and 1993 and mapped their collection sites using the information provided in the labels (D. Kolterman and J. Chinae, UPRM, unpubl. data, 2013). They used the point-circle method (Chapman and Wieczorek 2006) that assigns coordinates for the location of the collection as well as an estimate of the uncertainty (in meters) based on the locality descriptions obtained from the specimen labels of such localities.

Figure 2. Distribution of Palo de ramón (*Banara vanderbiltii*) in Puerto Rico (USFWS, unpubl. data, 2012).



Localities: 1- Caño Martín Peña; 2- Cataño; 3- Río Lajas; 4- Las Piedras del Collado; 5- Cambalache Commonwealth Forest; 6- Fundación Luis Muñoz Marín; 7- Gabia's Farm; 8- Toa Vaca Commonwealth Forest; 9- Fort Buchanan; 10- Río Abajo Commonwealth Forest; 11- Susúa Commonwealth Forest; 12 - Guajataca Commonwealth Forest.

Figure 3. Available specimen localities for the Palo de ramón (*Banara vanderbiltii*) in Puerto Rico. Accurate specimen localities were those with uncertainties smaller than 300 meters. The Cataño and San Juan localities were partially covered by the San Juan area. The Salinas area is a cluster of two specimens of low uncertainty (D. Kolterman and J. D. Chinae, UPRM, unpubl. data, 2013).



e. New information addressing habitat or ecosystem condition (e.g. amount, distribution, and suitability of the habitat or ecosystem)

Very little is known about Palo de ramón habitat requirements. It is known from only a few small populations in northern and south central Puerto Rico, at elevations of 10 to 840 m (33 to 2,756 ft) (Axelrod 2011). In Rio Lajas ward and in the municipality of Salinas, the species occurs within the subtropical moist forest life zone, where rainfall ranges from 1,100 to 2,200 mm (44-88 in) per year (Ewel and Whitmore 1973). This life zone (as defined by the Holdridge life zone system) included areas that were extensively deforested for agriculture. Areas in which agricultural activities have been abandoned and reforestation has occurred may provide possible sites for the establishment of new populations of Palo de ramón. The species has been planted in Gabia's Farm in Coamo and in the Susua Commonwealth Forest in Sabana Grande. These two locations fall within the subtropical dry forest life zone, where rainfall ranges from 600 to 1,100 mm (23.6 to 43.3 in) per year (Ewel and Whitmore, 1973).

The species appears to occur on both limestone and volcanic substrates. The soils at the Rio Lajas ward in Dorado are derived from limestone and belong to the Tanama clay series. At the Salinas area, the soil survey category is rock land, however, the most recent geological map indicates that the bedrock at this site, Robles formation, is "a sequence of volcanic sandstone and siltstone that contains minor pillowed lava and limestone" (PRDNER 2004). Currently, the populations occur at elevations from 20 to 90 m (66 to 295 ft) at the Dorado area, and 840 m (2,756 ft) at the Salinas area (D. Kolterman and J. China, UPRM, unpubl. data, 2013).

f. Other relevant information

At the time of listing, little was known about the species' phenology, recruitment, and habitat requirements. The recovery plan (Service 1991) cited that the species had been propagated successfully by cuttings and seeds. In 2006, PRDNER reported on their success in germinating seeds of Palo de ramón and their intention to introduce these individuals in areas managed for conservation. The recovery plan also mentioned that the Fairchild Tropical Garden (FTG) in Florida, had planted over 16 individuals in FTG's conservation collection and held more individuals (an undetermined amount) in containers in their nursery. The FTG reported that planted individuals were growing, flowering and fruiting on the limestone soils of South Florida. Additionally, FTG distributed plants of Palo de ramón to the horticultural community to assess their desirability as an ornamental and as part of their backup of their collection. However, we have no information regarding the species' ornamental potential.

A new pest affecting the Palo de ramón has been identified. The lobate lac scale (*Paratachardina pseudolobata*) has been reported infecting individuals of Palo de ramón in the populations at the Susúa and Guajataca Commonwealth Forests (Christian Torres, USDA Forest Service, unpubl. data. 2013). The lobate lac scale is an insect in the family Kerriidae. It infests the woody portion of twigs and small branches and less frequently main stems of usually <2 cm in diameter, but usually not branches or mainstems >2cm in diameter. On a highly susceptible host, the scale insects are crowded, forming a contiguous mass that appears as a dark, lumpy crust. Dense infestations are associated with branch dieback of some plant species, and in severe

cases highly infested shrub and small trees have died. Some plant species appear to tolerate dense infestation, but this is speculative as the long term effects of such infestation are not yet known.

The mature females are about 1.5-2 mm long and about the same width. The body has two pairs of prominent lobes. To the practiced eye, this scale insect's x-shaped appearance is discernible, even without magnification. The testa is extremely hard and brittle, glossy, and of dark reddish brown color, but often appears dull and black due to a coating of sooty-mold. The first instars (development stage of an insect that crawls) are elongate-oval, deep red, and about 0.4 mm long. Since the mature females of scale insects are wingless, they play no role in dispersal of populations to occupy new host plants. They rely mostly on passive dispersal of the crawler stage via air currents. Phoresis (being carried by birds and other animals "in the wild") may be of some importance in some species. Undoubtedly, movement of infested host plants from one locality to the next is a key factor in spreading scale insect pests. The lobate lac scale bug has been found mostly on woody dicotyledonous plants. Some plant families, notably Fabaceae, Myrtaceae, and Moraceae are especially well represented by species that serve as hosts, but the families Salicaceae (of which Palo de ramón is a member) and Flacourtiaceae have also been identified as host plants (Howard et al. 2010).

2. Five Factor Analysis-

(a) Present or threatened destruction, modification or curtailment of its habitat or range:

When the species was listed in 1987, the Service identified habitat destruction and modification as important factors affecting the species. The Rio Lajas population occurs on private land located near to the metropolitan area of San Juan. This area is under intense development pressure for industrial and residential expansion. At the time of listing, the species was threatened by habitat loss due to fragmentation, soil erosion, and changes in forest structure. Sources of this habitat loss included agricultural practices, an abandoned dumping site, and maintenance of power lines and their right of way (Service 1991). Currently, some agricultural practices and deforestation for residential, industrial, and commercial projects (i.e., landfills, construction of dwellings and roads, power lines, and limestone quarrying) remain threats to this species, and we believe some of these sources have been responsible for elimination of some mature individuals. Deforestation for urban development and agriculture practices have resulted in habitat degradation through fragmentation, soil erosion, and changes in forest structure at the Rio Lajas ward (C. Pacheco, Service, pers. obs. 2013). However, at present we are not aware of information indicating that any of the activities mentioned above are occurring or will occur within the Palo de ramón habitat in near future.

The Palo de ramón population in Rio Lajas is located a short distance from the right-of-way of a power line that provides energy to an adjacent community (Service 1991). Occasionally, the Puerto Rico Energy and Power Authority (PREPA) conduct maintenance activities such as trimming and removal of vegetation growing under power lines and along their rights-of-way. PREPA usually has a restricted perimeter delimiting the area that can be mowed and trimmed. However, any unintentional expansion or widening of this perimeter during vegetation removal activities may result in harm or elimination of individuals of this population. Clearing of

vegetation may result in direct impacts (cutting of individuals) or indirect impacts (by opening forest gaps that can serve as corridors for invasive plant species) to the species. Since the species' population dynamics are not well known, we understand that the impacts discussed above could be detrimental to the species as a whole. Therefore, we conclude that vegetation management and maintenance of power lines are threats to the Palo de ramón due to changes in microclimate, plant species composition, and direct impact to individuals of Palo de ramón.

During the 1980s, the Puerto Rico National Guard conducted several military training maneuvers and camping on areas where Palo de ramón was found in Las Piedras del Collado in Salinas. These activities may have resulted in loss of individuals and habitat modification through trampling and cutting (Service 1991). No military activities have been conducted in Palo de ramón area within the past 10 years, and the Service is not aware of potential future military activities within or near Las Piedras del Collado area. Therefore, we believe that military training maneuvers are not a current threat to the species.

The species' rarity and restricted distribution make it vulnerable to habitat destruction and deforestation. Sources of habitat destruction and deforestation include some agricultural practices, residential, industrial and commercial development, and vegetation removal along the right-of-way the existing PREPA power lines. Therefore, habitat loss and destruction remain a threat to Palo de ramón. However, the magnitude of this threat is considered to be low and non-imminent because most of the known individuals occur on lands managed for conservation.

(b) Overutilization for commercial, recreational, scientific, or educational purposes:

At the time of listing, overutilization for commercial, recreational, scientific or educational purposes was not considered a threat to the species. Commonwealth Law No. 241 regulates collection of listed plant species (see Factor D evaluation below) through the PRDNER permit process. Because little is known about the population dynamics of Palo de ramón (i.e., abundance, population trends, distribution, habitat requirements, and phenology), any collection of seedlings, saplings, flowers, fruits, or parts of the individual could adversely affect the status of this species. Therefore, before the PRDNER authorizes a permit, the agency's botanist evaluates the request and ensures that the species is not affected. Presently, Palo de ramón is recognized by its rarity and restricted range, making it more attractive to collectors and scientists. Nonetheless, we have no evidence that the species has been sought for such purposes. Therefore, we consider overutilization not to be a threat to the species.

(c) Disease or predation:

At time of listing, disease and predation were not considered to be a threat to the species. New information reveals that Palo de ramón can be infested by the lobate lac scale (Hodges 2013). The effect of the lobate lac scale bugs on the species is not well understood because some individuals appear to tolerate dense infestation and some die by a combination of factors (i.e. humidity, soil, transplant, etc.), not only by the effects of the infestation (Eduardo Cintrón, PRDNER, pers. comm. 2013). Therefore, due to the lack of information on the effect of the lobate lac scale bugs on the Palo de ramón, we conclude that the species is not threatened by disease or predation.

(d) Inadequacy of existing regulatory mechanisms:

The inadequacy of existing regulatory mechanisms was not considered to be a threat to the species at the time of listing. Palo de ramón was recognized at that time as endangered under the regulations of the Commonwealth of Puerto Rico. In 1999, the Commonwealth of Puerto Rico approved Law No. 241 (*Nueva Ley de Vida Silvestre de Puerto Rico* (New Wildlife Law of Puerto Rico)). The purpose of this law is to protect, conserve, and enhance both native and migratory wildlife species, declare as property of Puerto Rico all wildlife species within its jurisdiction, regulate permits, hunting activities, and exotic species, among others. In 2004, the PRDNER approved the *Reglamento para Regir el Manejo de las Especies Vulnerables y en Peligro de Extinción en el Estado Libre Asociado de Puerto Rico* (Regulation 6766 to regulate the management of threatened and endangered species in Puerto Rico). Palo de ramón was included in the list of protected species and designated as endangered under Regulation 6766. Under Article 2.06, this regulation prohibits collecting, cutting, and removing, among other activities, listed plant individuals within the jurisdiction of Puerto Rico, including Palo de ramón.

On September 1, 2000, the Commonwealth of Puerto Rico approved Law No. 283 (*Ley para Designar el Area de los Montículos de las Piedras del Collado como Reserva Natural*) (Law to Designate Las Piedras del Callado as Natural Reserve)). The purposes of this law are to control urban and tourism development in this natural area and to protect and conserve the geological formation of Las Tetas de Cayey and the surrounding forested areas. Under Law No. 283, the PRDNER designated as natural reserve approximately 19.4 acres (7.86 hectares) including the geological formation and a strip of forest around it (PRDNER 2004). Therefore, the habitat on which the Palo de ramón depends at Las Piedras del Collado is protected by the Commonwealth of Puerto Rico.

Based on the presence of Commonwealth laws and regulations protecting Palo de ramón, we believe that the inadequacy of existing regulatory mechanisms should be continuing considered as not a threat to this species.

(e) Other natural or manmade factors affecting its continued existence:

One of the most important factors affecting the continued existence of the Palo de ramón is its limited distribution. In the Caribbean, native plant species, particularly endemics with limited distribution, may be vulnerable to natural or anthropogenic events such as hurricanes, human induced fire, landslides, and genetic variation. Palo de ramón is more susceptible to natural disturbances such as hurricanes, wildfire or landslides, because it is confined to geographically small areas (Service 1991).

Limited distribution.

Palo de ramón is vulnerable to extinction due to low population numbers and restricted distribution (i.e., only 10 populations and 201 individuals reported), coupled with habitat loss or alteration (Service unpubl. data, 2013). The low number of individuals and limited geographic range reflects a remnant population of the Palo de ramón whose habitat has been altered or lost

due to agricultural practices, urban development, industries, and commercial projects. The limited distribution of the species may also have exacerbated its vulnerability to natural or anthropogenic events such as hurricanes, wildfire, landslides, and genetic variation, compromising the continued existence of this species.

Hurricanes and Landslides.

Hurricanes and tropical storms frequently affect the islands of the Caribbean. Hurricanes contribute to shaping vegetation and ecosystem processes, factoring in the determination of the structure and composition of biotic communities in the Caribbean forests (Walker et al. 1991, Lugo 2000). As a species endemic to the Greater Antilles, Palo de ramón should be adapted to tropical storms. However, its occurrence in montane elevations, where winds may be stronger, may place the species at increased risk, particularly as climate change is predicted to increase the frequency and strength of tropical storms. Hurricane winds often lead to tree defoliation, loss of small and large branches, and up-rooting, resulting in damage to adjacent trees and understory plants when trees and branches fall, and ultraviolet damage to leaves of understory juveniles exposed to high light levels (Brokaw and Walker 1991). Additionally, high rainfall associated with tropical storms and hurricanes (rainfall can be as high as about 24 in (2 ft) of rain in a single storm event) can cause floods that, in combination with steep topography and highly erosive substrate, may induce mass wasting events (e.g., land, mud, and debris slides; Lugo 2000). A mass wasting event in the area where Palo de ramón grows would not only take out adult plants and their young offspring, but also their seed bank and substrate as well. A small landslide or felling trees may provide gaps in the vegetation that would allow other plants (native or non-native, herbaceous or woody) to become established. Due to the extremely limited range of the species, low number of individuals, and lack of information about its natural recruitment and habitat requirements, we believe that stochastic events such as severe tropical storms or hurricanes may have adverse impacts on the species, particularly in their natural populations in Rio Lajas and Las Piedras del Collado.

In the absence of knowledge on the natural recruitment capacity and habitat requirement of this species, it is difficult to predict its recovery after natural events such as hurricanes and tropical storms. Therefore, since the species has only few known individuals in a limited range, we consider this threat to be high in magnitude but not imminent.

Genetic Variation.

Given the extremely small numbers of individuals in natural populations and the limited geographic distribution of the Palo de ramón, it is highly likely that its genetic variability is very low. This would result in the loss of alleles by random genetic drift, which would limit the species' ability to respond to changes in the environment (Honnay and Jacquemyn 2007). Also, there may well be genetic differences between the populations in northern and south central Puerto Rico, insofar as they are separated by the Cordillera Central (Puerto Rico's central mountain range; D. Kolterman and J. China, UPRM, unpubl. data, 2013). Therefore, the protection and monitoring of known adult individuals should be considered a high priority for the conservation of the species. Until studies of the species' genetic variation have been conducted, an effort should be made to preserve and propagate multiple individuals from all wild

populations to safeguard the remaining genetic diversity. Based on the above information, we consider the lack of genetic variation a threat to the species.

Human Induced Fires.

Human induced fire is a current threat for the species at Salinas. Areas potentially used by the species in the municipalities of Salinas and Cayey have been negatively affected by human induced fires (C. Pacheco, Service, pers. obs. 2013). Fire is not a natural event in the subtropical moist forest of Puerto Rico. Thus, most species found in this type of forest are not fire-adapted. Human-induced fires may lead to destruction of the native vegetation seed bank and may create conditions favorable for the establishment of exotic plant species (e.g., guinea grass [*Megathyrsus maximus*]), which serve as fuel for fires. The populations of Palo de ramón that occur in both northern and south central Puerto Rico may be subject to human induced fires, particularly on private lands where fire could be accidentally or deliberately ignited. Thus, we consider human induced fires as a threat to the species.

Invasive Species

As mentioned under Factor A, habitat modification for vegetation removal along the power lines right-of-way may increase the magnitude of the threat to Palo de ramón due to an increase in invasive species in these areas. Any disturbance of vegetation within the Palo de ramón habitat may create conditions favorable for the establishment of invasive species that may outcompete native plant species, changing the vegetation structure of the species' habitat. Invasive species (e.g., *Leucaena leucocephala* and *Megathyrsus maximus*) may spread and colonize the Palo de ramón habitat, altering fire regimes, microclimate, and nutrient cycling of the habitat the species depends on. However, because we have no information that this has occurred or on the competitive abilities of the Palo de ramón in such situations, the possible impact to the Palo de ramón by invasive species remains speculative.

Climate change

Changes in climate can have a variety of direct and indirect impacts on species, and can exacerbate the effects of other threats. Rather than assessing climate change as a single threat in and of itself, we examined the potential consequences to species and their habitats that arise from changes in environmental conditions associated with various aspects of climate change. Vulnerability to the effects of climate change is a function of sensitivity to those changes, exposure to those changes, and adaptive capacity (IPCC 2007, Glick et al. 2011).

An expected effect of climate change is the increase in intensity of hurricanes and tropical storms, followed by extended period of drought (IPCC 2012). These events may alter the surrounding vegetation around the populations of the Palo de ramón. Hurricanes followed by extended periods of drought may result in changes in soil conditions and microclimate and may allow other plants (native or non-native, herbaceous or woody) adapted to drier conditions to become established (Lugo 2000). Invasive species (e.g. *Leucaena leucocephala* and *Megathyrsus maximus*) may spread and colonize the Palo de ramón habitat, and it could alter fire regime, microclimate, and nutrient cycling of the habitat that the species depends on.

Due to its limited distribution and number of natural populations, we consider the cumulative effects of hurricanes, genetic variation, and exotic and invasive species (plants) as detrimental to the Palo de ramón as a whole. The population dynamics of the species is poorly known (e.g., suspected depressed genetic variability, lack of natural recruitment, and competitive abilities), there are only few known populations, and there is a lack of information to determine what constitutes a viable population. Therefore, we consider these threats to be high in magnitude, because the species has only few known individuals in a limited range if a hurricane makes landfall, but not imminent, because threats like climate change are more long term threats and hurricanes/landslides are heavily dependent on natural factors.

3. Synthesis

Palo de ramón is listed as an endangered species and is currently known from 10 locations; two natural populations and eight introduced. In St. Thomas, the species has not been found since 1980, despite search efforts.

Presently, the overall status of the species in Puerto Rico is not well known. Since 1991, the information regarding the species' status, population trends, phenology, habitat requirements and the status of its habitat is limited. However, despite the little available information, we believe the species still occurs in Rio Lajas and Las Piedras del Collado because its habitat still present in and around historical collection sites. Field surveys on Palo de ramón should be conducted in areas where the species was traditionally found and in non-traditional sites that harbor suitable habitat in order to get a better idea of the species' status. There is a profound lack of information on the species' biology and habitat, which has hampered recovery efforts.

Based on our analysis, Palo de ramón is currently threatened by Factor A (present or threatened destruction, modification, or curtailment of its habitat or range), and Factor E (other natural or manmade factors affecting its continued existence). Habitat modification and degradation caused by urban development and maintenance of the PREPA power lines threaten the Palo de ramón. Hurricanes and tropical storms, and climate change are also considered as threats to this species. We consider the magnitude of Factor A and Factor E as high because of the species' limited distribution and low number of individuals known, but non-imminent. Overutilization for commercial, recreational, scientific, or educational purposes, the inadequacy of existing regulatory mechanisms and disease/predation are not threats to the species.

The Endangered Species Act defines as endangered any species that is in danger of extinction throughout all or a significant portion of its range. Therefore, based on the information gathered during this review, the Palo de ramón meets the definition of endangered.

III. RESULTS

A. Recommended Classification:

 X No, no change is needed.

Rationale: The status of this species is unknown and the information we have on the species is limited.

B. New Recovery Priority Number: N/A. Recovery priority number

IV. RECOMMENDATIONS FOR FUTURE ACTION

1. The recovery of the species should focus both on the protection of the known populations and their habitat in private lands and also on increasing the number and size of the populations of Palo de ramón.
2. Field surveys on Palo de ramón should be conducted within historical sites and in non-traditional sites with suitable habitat to determine the existence and distribution of the species.
3. Studies should be conducted to determine the species' phenology and reproductive biology.
4. Studies should be conducted to determine the patterns of genetic variation, in order to develop a plan to preserve the species' germplasm.
5. Studies should be conducted to determine the effects of the lobate lac scale bugs (*Paratachardina pseudolobata*) on the Palo de ramón.
6. Propagation and reintroduction of the species should be conducted in order to strengthen the existing population. This action should be carefully evaluated by the Service, taking into consideration the effects of seeds and/or seedlings removal effects on the species, existing threats, genetic variations, and considering ways to propagate by cuttings.
7. The populations, both natural and introduced, should be monitored on a regular basis, and additional surveys should be conducted after hurricanes, landslides, fires, or other major disturbances. The natural populations should be monitored on a long term basis to determine the species' trends.
8. The Service should work with partners (e.g., PRDNER, UPRM and USDA) to update the recovery plan as new information becomes available on the species. Such collaboration should lead to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species.

V. REFERENCES:

- Acevedo-Rodríguez, P. and M.T. Strong. 2012. Catalogue of seed plants of the West Indies. Smithsonian Institution Scholarly Press, Washington, DC. 1,192 pp.
- Axelrod, F.S. 2011. A systematic vademecum to the vascular plants of Puerto Rico. BRIT Press, Fort Worth, TX. 428 pp.
- Bawiec, W.J. (ed.). 2001. Geology, geochemistry, geophysics, mineral occurrences and mineral resource assessment for the Commonwealth of Puerto Rico. U.S. Geological Survey Open-File Report 98-38.
- BRAHMS. Botanical Research and Herbarium Management System. <http://herbaria.plants.ox.ac.uk>. Accessed on October 4, 2012
- Brokaw, N. V. L. and L.R. Walker. 1991. Summary of the Effects of Caribbean Hurricanes on Vegetation. Biotropica 23 (4a): 442-447.
- Chakroff, M. 2012. U.S. Virgin Island Forest Resources Assessment and Strategies. VI Department of Agriculture, Forest Division. 107pp.
- Chapman, A.D. and J. Wiczorek (eds). 2006. Guide to best practices for georeferencing. Global Biodiversity Information Facility, Copenhagen.
- DNER. 2011. Informe de progreso del Acuerdo (No. 401817J167) con el Servicio de Pesca y Vida Silvestre de EE.UU. Informe de trabajos realizados 2007-2010. Departamento de Recursos Naturales y Ambientales, Negociado de Servicio Forestal, Sección de Investigación y Monitoria Forestal.
- Ewel, J.J. and J.L. Whitmore. 1973. The ecological life zones of Puerto Rico and the U.S. Virgin Islands. Forest Service Research Paper ITF-8, USDA. 72 pp.
- Hodges, A. 2013. Regional Pest Alert: Lobate Lac Scale (*Paratachardina lobata* (Chamberlin)). <http://www.ncipmc.org/lobatelacscale>. Accessed on September 17, 2013
- Honnay, O. and Jacquemyn, H. 2007. Susceptibility of rare and common plant species to the genetic consequence of habitat fragmentation. Conservation Biology 21:824-831.
- Howard, F.W.; A. Hamon; G.S. Hodges; B. Steinberg; C.M. Mannion; D. McLean; J. Cooper. 2010. Lobate lac scale, *Paratachardina pseudolobata* (Kndo & Gullan). [Http://entnemdept.ifas.ufl.edu/creatures/orn/scales/lobate_lac.htm](http://entnemdept.ifas.ufl.edu/creatures/orn/scales/lobate_lac.htm) (September 25, 2013).
- [IPCC] Intergovernmental Panel on Climate Change, 2007a: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment

- Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland. 104 pp.
- Kolterman, D and J.D. Chinea. 2012. Status and Evaluation of Thomas' Lidflower. UPRM. Cooperative Agreement F10AC00495. 9 pp.
- Liogier, H.A. 1994. Descriptive flora of Puerto Rico and adjacent islands. Spermatophyta. Volume III. Cyrillaceae to Myrtaceae. Editorial de la Universidad de Puerto Rico, Río Piedras. PR. 461 pp.
- Little, E.L., Jr., R.O. Woodbury, and F.H. Wadsworth. 1974. Trees of Puerto Rico and the Virgin Islands. Second volume. Agriculture Handbook No. 449. USDA Forest Service, Washington, DC. 1,024 pp.
- Lugo, A. 2000. Effects and outcomes of Caribbean hurricanes in a climate change scenario. The Science of the Total Environment 262: 243-251
- U.S. Fish and Wildlife Service. 1991. *Banara vanderbiltii* recovery plan. U.S. Department of the Interior, Fish and Wildlife Service, Southeast Region, Atlanta, GA. 22 pp.

US FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Banara vanderbiltii* (Palo de Ramon)

Current Classification: Endangered

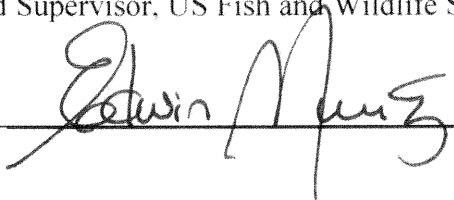
Recommendation resulting from the 5-Year Review:

X No change needed

Review Conducted By: Carlos Pacheco, Caribbean Ecological Service Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, US Fish and Wildlife Service

Approve:  Date: Nov 13, 2013

REGIONAL OFFICE APPROVAL:

for
Lead Regional Director, US Fish and Wildlife Service

Approve:  Date: 1-10-14