

Crescentia portoricensis
(Higüero de sierra)

**5-Year Review:
Summary and Evaluation**

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



Photo by Omar Monsegur (USFWS)

5-YEAR REVIEW

Crescentia portoricensis

I. GENERAL INFORMATION

A. Methodology used to complete the review: On September 21, 2007, the U.S. Fish and Wildlife Service (USFWS) published a notice in the *Federal Register* (72 FR 54061) announcing the 5-year review for *Crescentia portoricensis* (higüero de sierra) and requesting new information concerning the biology and status of the species. A 60-day comment period was opened; however, no information on *C. portoricensis* was received from the public.

This 5-year review was prepared by a Service biologist and summarizes information that the USFWS has gathered in the species file since it was listed on December 4, 1987 (52 FR 46085). Since this review was completed by one of the few known experts of this plant, and because it includes the information from the latest research and assessment (Cancel 2010) of the species, we did not seek additional peer review.

B. Reviewers

Lead Region: Kelly Bibb (review completed by Erin Rivenbark on detail), Southeast Region, Atlanta. (404) 679-7132.

Lead Field Office: Omar A. Monsegur, Caribbean Ecological Services Field Office (CESFO), Boquerón, Puerto Rico. (787) 851-7297, extension 217.

C. Background

1. FR Notice citation announcing initiation of this review: September 21, 2007; 72 FR 54061.

2. Species Status:

The overall status of *C. portoricensis* is generally improving. Based on the information gathered during this review, several new populations have been found and the number of known individuals has increased to more than 500. Moreover, the core of the suitable habitat is managed for conservation. Furthermore, the Puerto Rico Department of Natural and Environmental Resources (PRDNER) and the NGO Para “La Naturaleza” are successfully propagating the species. Despite the apparent improving status, this species is still facing threats that hinder its recovery. Threats like rat predation of fruits, the complete absence of recruitment, and low genetic diversity compromise its survival and sustainability.

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

4. Listing History

Original Listing

FR notice: 52 FR 46085

Date listed: December 4, 1987

Entity listed: Species

Classification: Endangered

5. Associated rulemakings: None.

6. Review History: The final rule to list this plant, *C. portoricensis*, as an endangered species on the Federal List of Endangered and Threatened Plant species was published on December 4, 1987 (52 FR 46085, USFWS 1987). The Recovery Plan (hereafter the plan) developed for this species was approved and signed on September 23, 1991 (USFWS 1991). These two documents are the most comprehensive analyses of the status of the species, and were used as the reference point documents for this 5-year review.

Crescentia portoricensis is a vine-like shrub or small tree (up to about 7 meters height) endemic to evergreen, semi-evergreen, and deciduous forests on serpentine soils in the lower Cordillera region of southwestern Puerto Rico. It was listed as endangered due to its extremely low population size and by indirect effects of deforestation (e.g., erosion and landslides caused by accelerated runoff and flash flooding). At the time of listing, a total of 42 plants were known from six sites in the Maricao and Susúa Commonwealth Forests. The species was restricted to sites along permanent or intermittent watercourses. Critical habitat was not designated because of the risk of vandalism and possibility of over-collection (USFWS 1987). The plan reported approximately 100 individuals occurring in three populations (7 localities or sites): 36 mature trees in 5 sites in Quebrada Piedras and Río Seco in the Maricao Commonwealth Forest, and approximately 66 individuals located in 2 sites along Quebrada Peces in the Susúa Commonwealth Forest. The plan specifies that all populations are threatened with increased erosion by deforestation and poor management practices occurring upstream outside the forest. The individuals in the Susúa Commonwealth Forest are also threatened by their proximity to the access road to the Forest (USFWS 1991).

Each year, the Service reviews and updates listed species information to benefit the required Recovery Report to Congress. Through 2013, we did a recovery data call that included showing status recommendations, such as “Stable” or “Improving” for this plant. We continue to show that species status recommendation as part in our 5-year reviews. The most recent evaluation for this plant was completed in 2016.

The Service conducted a five-year review for *Crescentia portoricensis* in 1991(56 FR 56882). In this review, the status of many species was simultaneously evaluated with no in-depth assessment of the five factors or threats as they pertain to the 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 *C. portoricensis* listing classification was found to be appropriate.

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

8. Recovery Plan:

Name of plan: *Crescentia portoricensis* Recovery Plan.

Date issued: September 23, 1991.

II. Review Analysis

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

1. Is the species under review listed as a DPS? No.

The Act defines species to include any distinct population segment of any species of vertebrate wildlife. This definition limits listings as distinct population segments (DPS) only to vertebrate species of fish and wildlife. Because DPS policy is not applicable to this 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. *Crescentia portoricensis* has an approved recovery plan establishing downlisting as the recovery objective. The plan provides criteria for reclassification from endangered to threatened, and considers the protection of recently discovered natural populations as a priority. However; it does not specify criteria for delisting the species, and indicates these should be determined once research needs are addressed.

2. Adequacy of recovery criteria

a. Do the recovery criteria reflect the best available (most up-to-date) information on the biology of the species and its habitat? No. At the time the plan was approved, up-to-date information regarding species' biology, distribution, habitat requirements and life history was not available.

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and there is no new information to consider regarding existing or new threats)? Yes. All listing factors that were considered threats at the time of listing are addressed in recovery criteria.

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. For threats-related recovery criteria, please note which of the 5 listing factors are addressed by that criterion. If any of the 5-listing factors are not relevant to this species, please note that here.

The plan establishes that *C. portoricensis* could be considered for reclassification from endangered to threatened when the following criteria are met:

1. At least four new populations capable of self-perpetuation have been established within suitable protected areas such as Commonwealth forests. The plan specifies that these four populations should be considered a minimum requirement, and should be expanded upon if the regenerative or propagative potential of natural and *ex situ* populations proves to be insufficient.
2. The plan also specifies that if new populations of the species are discovered, it may be preferable to place greater emphasis on protection, rather than on propagation, to achieve a minimum number of plants.

Criterion 1 has been partially met. The species has been cultivated from seeds since 1992 by the University of Puerto Rico, Mayagüez Campus, the Botanical Garden in Río Piedras, and by the PRDNER nursery at the Cambalache and Susúa Commonwealth Forests. Preliminary experiments suggest a high seed viability and germination rates. In addition, an undetermined number of individuals have been planted within the Maricao and Susúa Commonwealth forests. Nonetheless, these reintroduction efforts are characterized by lack of long term monitoring of planted individuals. Further studies are needed to determine how many individuals should be planted to establish a self-sustainable population. As observed in the wild, the species appears to be facing problems of natural recruitment as suggested by the absence of seedlings. Thus, any reintroduction effort needs to include a comprehensive monitoring program to determine if individuals establish successfully and if long term recruitment occurs.

Criterion 2 has been partially met. The Service provided funding to the University of Puerto Rico, Mayagüez Campus, to conduct studies on the species from 1991 to 1995. Breckon and Kolterman 1994 reported an estimate of 334 individuals of *C. portoricensis* occurring in six populations at 11 localities. A further study by Cancel (2010) showed the species remains endemic to serpentine soils within and around the Susúa and Maricao Commonwealth Forests, but more abundant than previously thought. The current number of known individuals has increased to over 500 plants within these Commonwealth forests. More recently, José Sustache (2015; PRDNER botanist) reported about 15 individuals within a previously unreported area adjacent to *Cabañas del Monte del Estado* in Maricao. According to the above information, the majority of known populations occur within protected Commonwealth conservation areas.

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. From 1991 to 1995, the University of Puerto Rico, Mayagüez Campus, conducted surveys and research on *C. portoricensis* under Cooperative Agreements with the Service (Breckon et al. 1992; Breckon and Kolterman 1993; Breckon and Kolterman 1994; and Breckon and Kolterman 1996). They reported about 334 individuals in the Susúa and Maricao Commonwealth Forests, with individuals that extend outside the boundaries of these forests. Between 2006 and 2008, José Cancel (former Graduate Student from the University of Puerto Rico, Mayagüez Campus) studied the population structure, reproductive ecology and conservation status of *C. portoricensis*. During his research, Cancel (2010) reported at least 532 individuals of *C. portoricensis* within eleven populations (Table 1). However, it is important to highlight that further populations may exist within these forests as there is plenty of habitat that remains not surveyed. Breckon et al. (1992) referenced verbal information from personnel from PRDNER reporting individuals of *C. portoricensis* (number not specified) in other areas of the Maricao Commonwealth Forest. Due to the steep topography of both forests (Maricao and Susúa), and the cryptic growth of the species, it is likely that further populations occur on areas that have been poorly monitored due to inaccessibility. For example, as stated earlier, José Sustache (pers. comm.) recently found about 15 individuals of *C. portoricensis* in an area not previously surveyed in the Maricao Commonwealth Forest. As of this review, all surveys have found no evidence of natural seedling establishment which indicates that the species is apparently depending on asexual reproduction (Breckon et al. 1992; Breckon and Kolterman 1993; Breckon and Kolterman 1994; and Breckon and Kolterman 1996; Cancel 2010). Based on the above, we currently estimate at least 547 individuals of *C. portoricensis* in the wild (including individuals located by Jose Sustache).

Table 1. Population size estimate of *C. portoricensis* in the Susúa and Maricao Commonwealth Forests (Breckon et al. 1992; Breckon and Kolterman 1993; Breckon and Kolterman 1994; and Cancel 2010).

Population	Population size (1993)	Population size (1994)	Population size (2010)
Susúa Forest	231	232	369
Quebrada Grande	34	34	39
Río Loco	134	134	160
Quebrada Peces	63	64	170
Maricao Forest	42	102	163
Quebrada Seca	8	8	5
Río Maricao	34	84	38
Río Lajas	-	10	9
Quebrada Piedras	-	-	9
Río Bonelli	-	-	16

Río Cupeyes	-	-	27
Río Postrero	-	-	2
*Quebrada Negra	-	-	57
TOTAL	273	334	**532

*Quebrada Negra population is a combination of an undetermined number of natural and planted individuals (Cancel 2010).

** Does not include the 15 individuals of *C. portoricensis* recently recorded within the Maricao Commonwealth Forest by the PRDNER botanist José Sustache. The current estimate including Sustache record is 547 individuals.

b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.). Breckon and Kolterman (1993) stated that the species is in danger of hybridization with the introduced *Crescentia cujete*. These authors reported a natural population of *C. linearifolia* (native to Puerto Rico) located along State Road PR 116 in the Lajas Valley that was apparently hybridizing with *C. cujete*. They mentioned that trees that appear to be “pure” *C. linearifolia* are infrequent in the population; the majority of the trees are apparently hybrids. *Crescentia cujete* is probably native to Mexico and north Central America. Cancel (2010) recorded individuals of *C. cujete* within the Susúa Commonwealth forests in the proximity of a population of *C. portoricensis*. Nonetheless, Cancel (2010) did not find evidence of hybridization in any of the wild *C. portoricensis* populations he studied. However, he recorded evidence of hybridization in several ex situ collections of *C. portoricensis* (i.e., Quebradillas and Caguas Botanical Garden). This finding highlights the importance of avoiding moving the species out of its range, where it may hybridize with other *Crescentia* species.

Cancel (2010) also suggested the risk of genetic bottleneck on the species as a result of the widespread deforestation that had occurred in Puerto Rico by the 1930s, which probably contributed to the fragmentation and depletion of *C. portoricensis* natural populations. He also suggests that the current reliance on asexual reproduction may contribute to a genetic bottleneck of the species.

c. Taxonomic classification or changes in nomenclature. Breckon and Kolterman (1993) reported a personal communication with the genus expert A. Gentry, who postulated that *C. portoricensis* may be better placed in the allied genus, *Amphitecna*, which also includes *A. latifolia* (native to Puerto Rico). However, the latest floristic treatments of the Puerto Rican flora (Axelrod 2011, and Acevedo-Rodríguez and Strong 2012) kept *C. portoricensis* as the accepted name.

d. Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g., corrections to the historical range, change in distribution of the species within its historic range, etc.).

At the time of listing, *C. portoricensis* was known to occur in few localities within the Maricao and Susúa Commonwealth Forests (Table 1). The available information (i.e., herbarium specimens) and the latest surveys concur with the species’ historical

distribution, but expanded our knowledge on the number of localities of the species and its distribution within these forests. As of this review, *C. portoricensis* remains endemic to remnants of native vegetation overlaying serpentine rock outcrops in southwestern Puerto Rico.

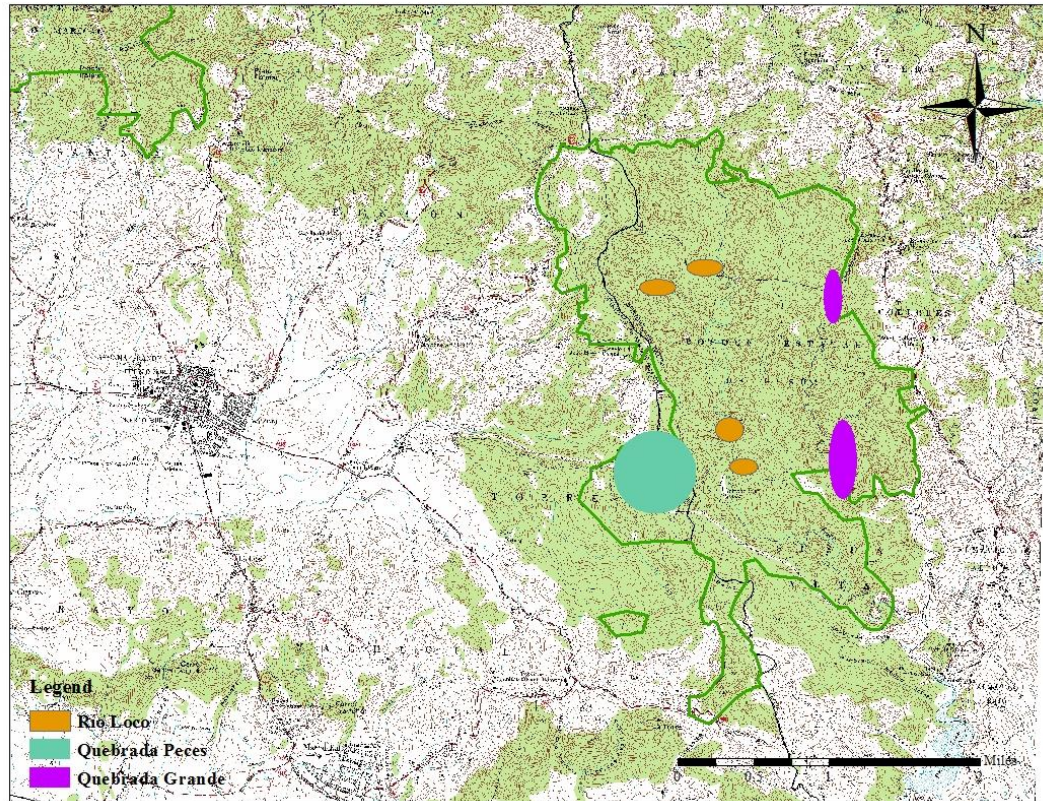


Figure 1. Approximate locality of currently known populations and subpopulations of *Crescentia portoricensis* at the Susúa Commonwealth Forest. (Note that populations are named based on watersheds and drainages.)

Within the Susúa Forest, Breckon et al. (1992) reported three main populations comprised by 10 localities along three water bodies (Quebrada Grande, Río Loco and Quebrada Peces), all tributaries of the Río Loco drainage. In 2010, José Cancel updated the status of these populations (Figure 1). These authors characterized the species localities as follows:

1. Quebrada Grande - Breckon et al. (1992) reported 34 individuals in fifteen small, scattered groups (subpopulations), ranging in size from a single individual to six individuals per group. The population extends for nearly one and a half kilometers along both sides of the stream in a narrow belt approximately 1-2 m above the river bank. The portion of the stream in which the plants occur runs in a general northwest-to-southeast direction. The elevation varies from 210 m (689 ft) in the north to 150 m (492 ft) in the south. Vegetative reproduction was observed in 50 %

of the individuals. Only four individuals were found with flower or fruit during two visits in February 1992, number of fruits ranged between 1 and 9 per plant (Breckon et al. 1992). The number of known individuals at this population increased to 39 plants as reported by Cancel (2010). Cancel (2010) found five additional individuals as part of his research, including four plants that are part of a small subpopulation not previously reported.

2. Río Loco - The Río Loco population is divided in five subpopulations. Four of the subpopulations are along tributaries of the river (Breckon et al. 1992). This population was reported originally as consisting of 134 individuals in 4 subpopulations (referenced as groups by the authors; Breckon et al. 1992). Cancel (2010) reported an additional subpopulation located just along the main Río Loco and increased the number on known individuals in that area to 160. These individuals are scattered in groups within each sub-population.
 - a. Group 1 or Sub-population 1. Six individuals were known to occur in a canyon (known as Quebrada Calliandra) along the west branch of the Río Loco, at about 190 m (623 ft) in elevation. The canyon has a general northwest-southeast orientation, and may be dry during part of the year. No small plants (seedlings) were observed in this area, and only one fruit was observed on October, 1991 (Breckon et al., 1992). The number of known individuals increased to 14 plants as reported by Cancel (2010). Cancel located these plants in three groups of 1, 6 and 7 individuals, respectively, and stated that he was able to located only two tagged individuals from the previous studies by Breckon et al. (1992).
 - b. Group 2 or Sub-population 2. Twenty-two individuals occur in an unnamed and intermittent stream on the west side of the Río Loco (following Camino al Río), approximately 0.7 km (2296 ft) downriver from Quebrada Calliandra, to the north of the end of the road. These individuals occur between 200 m (656 ft) and 250 m (820 ft) in elevation (Breckon et al., 1992). The number of individuals at this site expanded to 41 according to Cancel (2010). He was able to find sixteen individuals previously tagged by Breckon and Kolterman in 1992.
 - c. Group 3 or Sub-population 3. According to Breckon et al. (1992), ten individuals occur in a canyon adjacent to, but more to the south than where Group 2 is located. This canyon has an east-west orientation, and the plants occur between 200 and 250 m (656 ft-820 ft) in elevation. The number of individuals at this site almost doubled to 19 plants according to Cancel (2010).
 - d. Arroyo del Tanque Group or Sub-population. This canyon takes its name from the old water tank that is located half way up the canyon. The Arroyo del Tanque drains directly into the Río Loco. This sub-population was reported to consist of 96 individuals, the largest of any group or population of the species within the Susúa forest (Breckon et al., 1992). Eighty-one of the

96 plants occur within 0.5-1 m (1.6-3.3 ft) of the bottom of the stream, and vegetative reproduction was observed in three plants (Breckon et al., 1992). However, Cancel (2010) reported only 71 plants, a decrease of about 26% from the previously known plants at this site. The loss of individuals at this site is likely due to erosion along the river.

- e. Group 5 or Sub-population 5. This appears to be a new site not previously recorded by Breckon et al. in 1992. Cancel (2010) recorded 15 individuals at this new site. The population is located upstream Río Loco, just north of the entrance to Arroyo del Tanque, and is the only population that lies in the Río Loco itself. The individuals were as close as 6.4 m (21 ft) and as far as 10 m (33 ft) from the river's edge (Cancel 2010).
3. Quebrada Peces - The population is located in Barrios Torre and Susúa Alta, on the boundary between the Municipalities of Sabana Grande and Yauco. Breckon et al. (1992) reported sixty-one individuals in three groups or subpopulations along Quebrada Peces. Breckon and Kolterman (1993) located, labeled, and measured two additional individuals growing along Quebrada los Peces for a total of sixty-three individuals. It is noteworthy that Cancel (2010) recorded 170 individuals on these areas.
- a. North Group. Sixteen individuals scattered over a distance of 800 m (2,625 ft) along the stream at 200-250 m (656 ft-820 ft) in elevation, in a segment of Quebrada Peces that runs nearly north-south were originally reported by Breckon et al. (1992). These authors believe that this population may be partially outside the Susúa Commonwealth Forest boundaries, and found no evidence of flowers or fruits in this group. Nonetheless in 2010, Cancel reported 113 individuals within the same general area.
 - b. South Group. This group was reported by Breckon et al. (1992) as to be composed of 8 individuals about 25 m (82 ft) north of where the access road to the forest crosses Quebrada Peces and extending northward along the stream. An additional 39 plants occur on the southernmost group in Quebrada Peces, scattered over a distance of approximately 400 m (1,312 ft). Plants were observed with flowers and fruits, including one plant that had 10 fruits, the largest number of fruits observed on any *C. portoricensis*. Cancel (2010) reported 57 individuals (an increase of 21%) within this area.

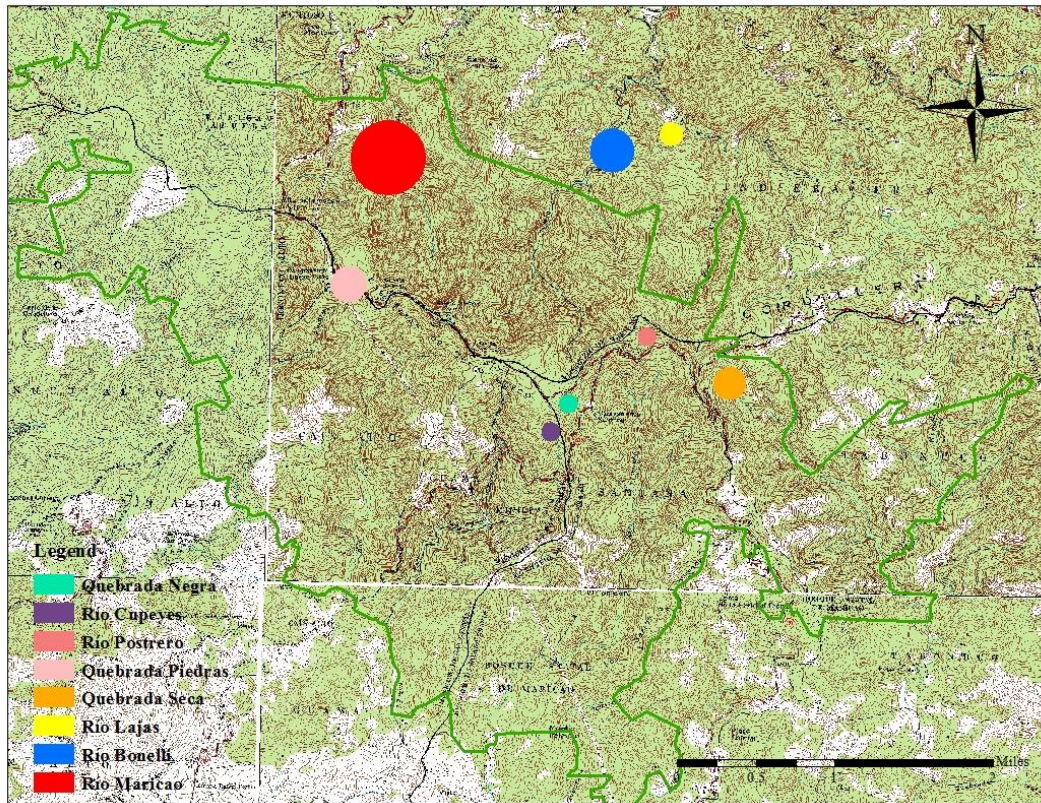


Figure 2. Approximate locality of currently known populations and subpopulations of *Crescentia portoricensis* at the Maricao Commonwealth Forest. (Note that populations are named based on watersheds and drainages).

Breckon and Kolterman (1993) and Breckon and Kolterman (1994) described the three populations within the Maricao Commonwealth Forest. On 2010, Cancel updated the status of these populations (Figure 2). These authors characterized the species localities as follows:

4. Río Maricao - Breckon and Kolterman (1993) identified 34 individuals growing between about 451 m (1,479 ft) and 510 m (1,673 ft) in elevation within the Río Maricao Watershed. The area is located, upriver from the Fish Hatchery to the main fork and then along the eastern fork of the river. Evidence of sexual reproduction was observed in 7 individuals. Eight plants had some evidence of sexual reproduction (i.e., flower buds, flowers or fruits). Breckon and Kolterman (1994) located an additional 50 new individuals along the Río Maricao watershed, all of them were sterile (showed no evidence of reproduction). They also reported that individuals extend to the hills along the watershed, and were not limited to the river margins. This geographic range matches an observation by José Sustache (PRDNER botanist) and Omar Monsegur (USFWS biologist) (2009) that recorded an individual of *C. portoricensis* in a ridge area at the upper watershed of the Maricao River. Nonetheless, Cancel (2010) only recorded 38 individuals along the Maricao River. The decrease in the number of individuals may have one or two reasons; first

individuals along the river were affected by the river overflow and river bank erosion associated to Hurricane Georges in 1998, and second, Cancel (2010) limited his search of individuals to the river margins, and did not explore the hills. Thus, the highest number of individuals recorded within the watershed was 84 plants (Breckon and Kolterman 1992 and 1993), highlighting the importance of this area for the conservation of the species. Moreover, the Maricao River is the type locality for the species (Breckon and Kolterman, 1993).

5. Quebrada Seca - Eight plants were observed by Breckon and Kolterman (1993) along the Quebrada Seca, at an elevation of 620-690 m (2,034-2,263 ft). The Quebrada Seca population occurs along the upper branch of the westernmost tributary of the Río Grande, which is part of the Río Guanajibo drainage. The Quebrada Seca canyon is very steep and has a northwest-southeast orientation. This population is nearly inaccessible and the plants are growing on the slopes on both sides of the river. They were notably more robust, had larger leaves, and were growing in more exposed conditions than those observed in the Susúa Commonwealth Forest. Plants in this population were also observed to root along prostrate branches (branches laying down and in contact with soil), indicating asexual reproduction may be important in the Maricao populations. Cancel conducted an assessment of this population and found only five individuals of *C. portoricensis*.
6. Río Lajas - Approximately 10 individuals along a small tributary of the Río Lajas in the Maricao Forest, below El Salto de Curet (Breckon and Kolterman 1994). Cancel (2010) only recorded nine individuals along Río Lajas.

Breckon, Kolterman and Santiago (1992) referenced verbal information with the forest manager reporting additional populations of *C. portoricensis* in the Maricao Commonwealth Forest, including Río Cruces - Río Potrero, Río Bonelli, and Quebrada Piedras (referenced also in the recovery plan). The following are further populations within the Maricao Commonwealth Forest recorded by Cancel (2010), and not previously described by any author (Figure 2).

7. Quebrada Piedras - The Quebrada Piedras population is located in the boundary between the Hoconuco Alto and Maricao Afuera Wards, in the Municipalities of San German and Maricao, respectively (Cancel 2010). Nine wild plants were found in Quebrada Piedras; two in the southwestern part of the Quebrada Piedras before it crosses State Road PR 120, and another seven individuals in the northeastern part of the quebrada near the telecommunications antennas. Additionally, sixty-four plants were planted by PRDNER personnel in Quebrada Piedras, 21 of these near the forest manager house, and 43 upstream west of the old water tank. Seven of the natural plants in this population were tagged (#231, 273-278) on the first trip made to Quebrada Piedras; another two were left untagged because these were not observed in the first trip made to the quebrada.
8. Río Bonelli - The Río Bonelli population is located on the boundary of the Maricao Afuera and Indiera Fría Wards the Municipality of Maricao. The population can be

reached by following the dirt road at the end of State Road 425, a dirt road that leads to Río Lajas (Salto Curet). The individuals are located just upstream from the second intersection of the dirt road with the river crossing. Sixteen plants were found in the Río Bonelli in two groups of one individual, two groups of two individuals, and one group of ten individuals (Cancel 2010). Eight plants were found demonstrating phases of reproduction: four showed sexual reproduction, and four showed asexual reproduction. Roots were observed along four branches on four different individuals; these branches rested directly on the ground (Cancel 2010). The distribution of the species extent to the upper hills of this watershed, and probably includes several unknown populations. About 15 new individuals were recently located along a creek in the former picnic area about 200 m (656 ft) (Northeast) of the *Cabañas del Monte del Estado* a recreational area managed by the Puerto Rico National Parks Company (J. Sustache PRDNER, 2015, pers. comm.).

9. Río Cupeyes - The Río Cupeyes population is located in the Santana Ward, in the Municipality of Sabana Grande. The Río Cupeyes is part of the Río Guanajibo drainage basin and flows from the north to the southwest. The Río Cupeyes population was reached by walking down old dirt State Road 362 (south of Campamento Santana). Twenty-seven plants were found in this population. Seven plants were found demonstrating phases of reproduction: four showed sexual reproduction, and three showed asexual reproduction. Two plants showed roots at the tip of one branch each; a branch of another individual rested on the ground and roots were observed growing along it (Cancel 2010). There is plenty of habitat along the Río Cupeyes watershed, and it would be expected that further populations may be found in the area.
10. Río Postrero - The Río Postrero population is located in the Indiera Fría Ward, in the Municipality of Maricao. The Río Postrero is part of the Río Grande de Añasco drainage basin; it flows from the southeast to the north, where it joins Río Lajas. The Río Postrero population can be reached by ascending the drainage on the north side of State Road 120 between Km 11.7 and 11.8. Two plants were found demonstrating phases of reproduction; one showed sexual reproduction and the other showed sexual and asexual reproduction.

e. Habitat.

Crescentia portoricensis is strictly endemic to serpentine soils. Breckon et al. (1992) described the habitat of the species in the Susúa Commonwealth Forest, which is located on the lower slopes of the central mountains in the southwestern portion of Puerto Rico. This forest is characterized by steep mountain slopes separated by narrow valleys. The Susúa Commonwealth Forest occurs within the Subtropical Moist Forest as described by Ewel and Whitmore (1973). The vegetation is more xeric than expected due to the poorly developed soils. The forest is on a large serpentine outcrop and, except for local pockets of alluvial soils in some valley bottoms, the soil is highly mineralized and rocky, and drains rapidly. The Susúa forest has three general areas: ravines or *quebradas* (Quebrada is a common name in Puerto Rico for a small creek or ravine), slopes, and

mountain summits. These ravines are generally mesic and shady, especially along the bottoms. The slopes vary from mesic to xeric, depending on slope angle, exposure, and elevation. The summits are xeric and most similar to the steep upper south- and east-facing slopes (Breckon et al. 1992). *Crescentia portoricensis* occurs in three separate canyons found within the Susúa Commonwealth Forest. The rivers and streams draining these canyons are all part of the Río Loco watershed, a river that flows southward, entering the Caribbean Sea in the Guánica Bay.

Later, Breckon and Kolterman (1993) described the habitat of the species within the Maricao Commonwealth Forest. This forest is located on a large serpentine outcrop in southwestern Puerto Rico, close to the Susúa Commonwealth Forest. The generally higher elevation of the Maricao Forest results in lower temperatures, higher humidity, and greater rainfall than in Susúa. The individuals of *C. portoricensis* labeled by these authors within the Maricao Forest, fall within the Subtropical Wet Forest as described by Ewel and Whitmore (1973).

f. Other relevant information.

Breckon et al. (1992) and Breckon and Kolterman (1993) observed evidence of asexual or vegetative reproduction, which occurred when the terminal portion of the arching branches came in contact with the ground and layering (producing roots). In particular, Breckon and Kolterman (1994) observed that a portion of the plant tagged as #168 in the Susúa Commonwealth Forest, had separated from the parent plant, had rooted, and was in good condition. The observations of asexual reproduction were validated by Cancel (2010), who observed some evidence of asexual reproduction in the majority of the populations during his research. Breckon and Kolterman (1993) further observed evidence of sexual reproduction (flowers and fruits) in *C. portoricensis*. Cancel (2010) found that *C. portoricensis* exhibit few (about 8%) plants with reproductive structures (flowers, fruits, or both) at the time of his assessments. However, Cancel clarified that the timing of visits to the different populations may affect the results and flowering may be variable among populations depending on the prevailing environmental conditions. According to Cancel (2010), the majority of the flower buds were observed from January to March, and flowers lasted about nine days on the plant. Cancel (2010) indicated no flower visitors were observed, but the colors of the flower suggest that they can be pollinated by bats. This author reported an unpleasant odor and a discharge of a transparent fluid from the flower during one of his observations for pollinators. He assumed that this transparent liquid was a reward for pollinators (likely bats). Fruiting was observed at its peaks in April and August (Cancel 2010). However, as of this review, there is no record of seedling or natural recruitment in the wild. On approximately 53 field trips between 1991 and 1995, seedlings were not observed even though seeds of *C. portoricensis* germinate readily in greenhouse conditions (Breckon and Kolterman 1996). Observations in the field suggest that the species is largely dependent on asexual reproduction.

The dispersal mechanism of *C. portoricensis* remains unknown (Breckon et al. 1992). The fruits have a hard rind and contain numerous seeds. These authors suggested that the

fruits are adapted for hydrochory (dispersal by water). Other species of the genus *Crescentia* (e.g., *Crescentia amazonica*) show adaptations to hydrochory, floating fruits showed a maximum duration of buoyancy of 82 days (Kubitzki and Ziburski 1994). Because *C. portoricensis* occurs along the headwaters of at least three different major drainage systems (geographically disrupted from each one), a dual dispersal system should not be discarded. Kubitzki and Ziburski (1994) mentioned that other species of *Crescentia* growing on habitats not associated to rivers had been reported to be dispersed by rodents. It is likely that *C. portoricensis* was dispersed in the past by native mammals such as the extinct rodent, the Puerto Rican hutia (*Isolobodon portoricensis*). The lack of seedlings close to parent trees may suggest that fruits fall, but the pod does not open and may be moved long distances from the parent tree. Breckon et al. (1992) found several fruits of *C. portoricensis* that had been gnawed on, and in some cases the contents had been eaten; presumably by rodents (*Rattus rattus*) (See Factor C.). They believe that, at least in part, predation by rodents may account for the absence of seedlings in all of the populations they have studied. The extent of predation by rodents on fruits requires further investigation.

Breckon, Kolterman, and Santiago (1992) discovered that seeds from full-size green fruits germinate readily in the greenhouse. Seed germination tests were conducted in the Biology Department's greenhouse at the University of Puerto Rico, Mayagüez Campus, under partial shade conditions. Seeds were placed in pots containing a commercial potting medium. The first preliminary test, using seeds from a fruit collected in June of 1991 in the Arroyo del Tanque Area in Susúa, yielded 45% germination. The second test was made using 42 seeds from a fruit collected in late August of 1991 in the Susúa forest, and half (21) of the seeds germinated by the 12th of September. These authors reported that 68% of the seeds germinated during the first month of the experiment, and by February of 1992, 96% of the seeds had germinated. Further germination trials of material from Río Maricao showed over 80% of germination (O. Monsegur, USFWS, unpublished data 2012.). Monsegur (unpublished data) also noted that germinated material may reach a reproductive size (producing flowers) in at least three years under nursery conditions.

Breckon and Kolterman (1993) conducted germination experiments in the greenhouse to determine the effects of different soil moisture regimes (i.e., wet, mesic, and dry) and different light intensities (i.e., shade, partial shade, and sun) on seed germination. Germination was first noted on the tenth day after the seeds were planted, and the experiment was terminated on day 32. Greater soil humidity favors germination, accelerating the process and producing higher germination rates. Lower light intensities appear to have the same effects, but to a lesser degree. The species is shade-tolerant and moisture-limited, but in cultivation, given enough water, it grows in full sun (Breckon et al. 1992).

2. Five Factor Analysis (threats, conservation measures, and regulatory mechanisms)

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

The final rule (USFWS 1987) and the Recovery Plan (USFWS 1991) identified indirect effects of habitat destruction and modification as threats to the species. These effects included increased erosion as a result of deforestation and poor management practices upstream, and flash flooding, which may uproot plants along the river margins. The recovery plan also states that the population located along Quebrada Peces in the Susúa Commonwealth Forest was threatened by its proximity to the access road to the forest. In addition, the plan mentions that the Maricao plants were threatened by small intake dams, trails, and recreational use of the more accessible areas (USFWS 1991).

Cancel (2010) found evidence of plants being cut within the Maricao Commonwealth Forest (i.e., at Quebrada Negra) and the Susúa Commonwealth Forest (i.e., at Arroyo del Tanque). With respect to the Quebrada Negra population, its proximity to the forest office makes this population more vulnerable to impacts because of the regular maintenance, which includes cutting of vegetation of the area by forest personnel. Cancel, additionally reported cut individuals within the populations of Río Lajas (Municipality of Maricao), and Quebrada Peces (Municipality of Sabana Grande), both on private lands.

In 1996, forest vegetation was affected by improvements to State Road PR 362 from Maricao to San German. The improvement of this road was initiated but the project was abandoned due to opposition of the academia and community. Although some impacts due to vegetation clearing and landslides associated to this project are still visible in that area, the forest vegetation is slowly recovering. There is no evidence of direct impacts to individuals of *C. portoricensis* due to this project and, in fact, at that time there was no evidence of plants along the project area. It was not until recently that Cancel (2010) reported at least 27 individuals along a tributary of Río Cupeyes, a watershed that was affected by the mentioned project. The MCF is managed for conservation and the re-establishment of State Road PR-362 throughout the forest is not anticipated. In 2014, a Candidate Conservation Agreement between the Service, the PRDNER and U.S. Forest Service was established to protect the elfin-woods warbler a species whose habitat overlaps the habitat of *C. portoricensis*. Furthermore, the MCF has been identified as the third wild population site for the Puerto Rican parrot, and Service staff working on this project is assisting on habitat surveys and the monitoring of the natural populations of *C. portoricensis*. These recent conservation and management practices provide additional protection to several federally listed plants that occur within the MCF (i.e., *C. portoricensis*, *Varronia bellonis* and *Gesneria pauciflora*).

As previously mentioned, impacts to the species due to forest management practices in certain areas of the Maricao and Susúa forests were documented in 2010, and continue due to accidental vegetation clearing. Service Biologist O. Monsegur (2016) observed pruning of edge vegetation as part of the maintenance of recreational areas adjacent to individuals of *C. portoricensis* not previously recorded in the Maricao Commonwealth Forest. Impacts even to a single individual of *C. portoricensis* are considerably adverse

due to the species current dependence on asexual reproduction, as there is no evidence of new individuals (seedlings) been recruited at the natural populations. However, since the majority of the prime habitat for the species is already protected as Commonwealth forests managed by PRDNER where impacts caused by forest management do not occur on a regular basis, and are limited to maintenance of existing trails and recreational areas, we consider the threat by this factor as low and non-imminent.

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

Overutilization for commercial, recreational, scientific, or educational purposes was not identified as a threat to the species in the final listing rule. Although *C. portoricensis* is attractive and might have some cultivation potential, we have no evidence that it is currently threatened by this factor. Therefore, we believe that overutilization for commercial, recreational or educational purposes is not a current threat to the species.

(c) Disease or predation;

At the time of listing, disease and predation were not documented as threats to *C. portoricensis*. However, Breckon et al. (1992) found several fruits of *C. portoricensis* that had been gnawed on, and in some cases the contents had been eaten; presumably by the introduced rat, *Rattus rattus*. Breckon et al. (1992) recommended further studies to determine if rat predation of fruits accounted for the absence of seedlings in the wild. Cancel (2010) also found evidence of rat predation in the *C. portoricensis* population at Quebrada Peces, Susúa Commonwealth Forest. The predated fruit found by Cancel was green and was still hanging on the plant at the time of his observation. Evidence of predation was also observed in 2010 by Service biologist O. Monsegur, along the headwaters of Río Maricao (Maricao Commonwealth Forest). A ripe fruit was found submerged in the river with clear rodent teeth marks around the pericarp, with intact seed material that was set for germination and showed 80% germination. Although other *Crescentia* spp. have been reported to be dispersed by rodents (Kubitzki and Ziburski 1994), the existing evidence of predation and the lack of natural recruitment of the species, lead us to concur with Breckon et al. (1992), who suggested that exotic rats (*Rattus rattus*) might be negatively impacting *C. portoricensis*. It is likely that the majority of the fruits are eaten before the seed material has fully developed and any seed (embryo) left by rodents might be immature and not able to germinate. The Service is currently collaborating with the University of Puerto Rico to monitor rat predation and to conduct research on the factors affecting the species natural recruitment.

In addition, Cabrera and Segarra (2008) described *Holopothrips tabebuia*, a gall-inducing species that is mainly specific to Bignoniaceae, and particularly to species of *Tebebuia*. *Holopothrips tabebuia* has been collected in Florida, Puerto Rico, and Hispaniola, mainly from Bignonaceae (Cabrera and Segarra 2008). The *H. tabebuia* is present in almost all populations of *T. heterophylla* in Puerto Rico. However, the infected populations of *T. heterophylla* continue producing flower multiple times in a year and there are no signs of mortality associated to this pest (Jenkins 2013). Evidence of *H. tabebuia* has been observed by O. Monsegur (USFWS biologist) on individuals of *Tabebuia haemantha*

within the Maricao Commonwealth Forest, and on individuals of *Crescentia cujete* at the nursery of the CRNWR. Although there is no current evidence of this pest affecting natural populations of *C. portoricensis*, there is a chance that it will eventually reach the populations of *C. portoricensis* as it continues to spread and affect the more common and widespread *T. haemantha*.

As indicated above, there is evidence strongly suggesting that natural recruitment of *C. portoricensis* is being adversely affected by rat predation. This information is extremely important because the lack of recruitment will compromise the long term survival of the species. Although *C. portoricensis* has the capability of reproducing asexually, this mechanism is only occurring under limited circumstances (e.g., a broken branch touches the ground and sprouts). Moreover, individuals that result from this asexual reproduction are clones of the parental tree, leading to a reduction of genetic variability of the species (see Factor E).

Although the number of known populations of *C. portoricensis* has increased, it does not necessarily mean these are new individuals or that populations are expanding, they just happened to be found as a result of increased efforts to find the species. Hence, we consider rat predation on seeds of *C. portoricensis* can have a detrimental effect on the natural recruitment and long-term survival of the species.

(d) Inadequacy of existing regulatory mechanisms;

At the time of listing (1987), the inadequacy of regulatory mechanism was considered as a threat to *C. portoricensis*. Following listing, *C. portoricensis* received protection under the Endangered Species Act (ESA) of 1973, as amended. One of the mechanisms of protection for federally listed species is the consultation process under section 7 of the ESA for projects with a Federal nexus.

The Maricao and Susúa Commonwealth Forests are protected by Law No.133 (12 L.P.R.A. sec. 191) of 1975, as amended, known as *Ley de Bosques de Puerto Rico* (Puerto Rico's Forest Law), as amended in 2000. Section 8 (A) of Law No. 133 prohibits cutting, killing, destroying, uprooting, extracting, or in any way hurting any tree or vegetation within a Commonwealth forest without authorization of the PRDNER Secretary. These forests are also designated as Critical Wildlife Areas (CWAs) by PRDNER. The CWA designation constitutes a special recognition by the Commonwealth of Puerto Rico with the purpose of providing information to Commonwealth and Federal agencies about the conservation needs of these areas and assisting permitting agencies in precluding negative impacts as a result of permit approvals or endorsements (PRDNER 2005).

The Commonwealth of Puerto Rico also approved Law No. 241 in 1999, known as *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 the property of Puerto Rico all wildlife species within its jurisdiction, regulate permits, hunting activities, and exotic species, among other activities. This law

also has provisions to protect habitat for all wildlife species, including plants. In 2004, the PRDNER approved Regulation 6766, *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 the Commonwealth of Puerto Rico). Article 2.06 of this regulation prohibits collecting, cutting, and removing, among other activities, listed plant individuals within the jurisdiction of Puerto Rico. *Crescentia portoricensis* was listed under Regulation 6766 as critically endangered.

Suitable habitat may extend to private properties. The enforcement of laws and regulations on private lands continues to be a challenge as accidental damage or extirpation of individuals has occurred with *C. portoricensis* and other federally listed species due to lack of knowledge of the species by private landowners. However, the majority of the populations and suitable habitat of *C. portoricensis* occur on Commonwealth Forests (Susúa and Maricao). Therefore, based on the presence of Commonwealth laws and regulations protecting the species, the inadequacy of existing regulatory mechanisms is not a current threat to this species.

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

Hurricanes and Landslides

The final listing rule of *C. portoricensis* states that although the species is probably adapted to disturbances related to natural weather events, such as flooding and landslides during storms, the effects of these natural events may be exacerbated by anthropogenic actions discussed under Factor A. According to Cancel (2010), erosion may explain why the numbers of individuals in the Río Lajas and Quebrada Seca in Maricao, and Arroyo del Tanque in Susúa have decreased as compared to the data provided by Breckon and Kolterman from 1991 to 1995. Moreover, the loss of individuals in the Río Maricao could be explained by the construction of a small dam in the river and the effect of hurricanes. Based on the monitoring of this population by Breckon and Kolterman (1992), and by Cancel (2010), there was a decline in number of individuals likely due to river overflow and erosion of the river bank during hurricanes events (i.e., Hurricane Georges in 1998). Despite documentation of additional populations, loss of individuals due to erosion along river margins and landslides may have a major detrimental effect on the species, particularly since recruitment is not documented on these populations.

Genetic diversity and Hybridization

An issue with rare species is the low genetic diversity (Falk 1992, Fiedler and Ahouse 1992, Rieseberg, 1991). Along with a small population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007), which may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). This may be due to the founder effect or a genetic bottleneck during the history of the species. This might well be the case of *C. portoricensis* following the massive deforestation island wide in Puerto

Rico, and that reached its peak prior to the designation of the Maricao and Susúa forests as conservation areas (Cancel 2010). Species with low fruit set and no evidence of natural recruitment as the case of *C. portoricensis* were likely adversely affected by this deforestation. Thus, another factor that would be expected to contribute to a low genetic diversity in *C. portoricensis* is its apparent reliance on asexual reproduction. A preponderance of asexual reproduction on this species would be expected to be reflected in genetic differences of individuals among different river drainages (Cancel 2010). Moreover, in the absence of natural recruitment, where seedlings are a result of crosspollination among adult individuals, the clones produced through asexual reproduction are expected to reduce the genetic variability of the species.

Additionally, it is known that species of the genus *Crescentia* hybridize with related species (Gentry 1980), but Cancel (2010) did not find evidence of hybridization in any of the wild populations he studied. Nonetheless, Cancel (2010) reported plants of *C. portoricensis* with fruits of intermediate size and shape, suggesting hybridization on cultivated material in the municipality of Quebradillas. Hybridization of *C. portoricensis* also has been documented in the nursery of Para La Naturaleza (O. Monsegur, USFWS, pers. obs., 2009). Hybridization with other species of the genus should be avoided both *in situ* and *ex situ*, to safeguard the integrity of this narrow endemic species.

Natural Recruitment.

We believe the absence of natural recruitment of *C. portoricensis* is one of the major threats currently affecting this species. Neither Breckon et al. (1992), Cancel (2010), nor any Service biologist has documented evidence of seedlings in the wild despite the evidence of high germination rates (about 80%) of seed material collected from wild populations when propagated in nursery conditions.

Factors such as the lack of a native seed disperser and/or appropriate microhabitat conditions for germination may explain the absence of natural recruitment in the wild. Nonetheless, the Maricao and Susúa Commonwealth Forests harbor very good stands of native vegetation, including some remnants of pristine forest, suggesting that ecological conditions are suitable. However, available evidence strongly suggests that predation of fruits by rats is a major factor preventing the establishment of seedlings of *C. portoricensis* (see Factor C), and thus compromise the long term recovery of the species.

As indicated above, hurricanes, landslides, low genetic diversity, potential hybridization, and lack of natural recruitment are threats affecting the recovery of *C. portoricensis*. Probably the most important threat right now is the absence of natural recruitment by means of seed germination and seedling establishment. However, certainly all these natural or manmade factors acting in combination worsen the status of the species. Based on the above discussion, the Service considers the threat by hurricanes, landslides, low genetic diversity, potential hybridization, and lack of natural recruitment as high in magnitude and imminent.

3. Synthesis

Crescentia portoricensis is a vine-like shrub or small tree (up to about 7 meters height) endemic to evergreen, semi-evergreen, and deciduous forests on serpentine soils in the lower Cordillera region of southwestern Puerto Rico. It was listed as endangered due to its extremely low population size and by indirect effects of deforestation (such as erosion or landslides caused by accelerated runoff and flash flooding). At the time of listing, a total of 42 plants were known from six sites in the Maricao and Susúa Commonwealth Forests. Later, the recovery plan reported approximately 102 individuals occurring in three populations distributed along 7 localities or sites: 36 mature trees in 5 sites in Quebrada Piedras and Río Seco in the Maricao Commonwealth Forest, and 66 individuals located in 2 sites along Quebrada Peces in the Susúa Commonwealth Forest. The plan specified that all populations were threatened with increased erosion by deforestation and poor management practices occurring upstream outside the forest. The individuals in the Susúa Commonwealth Forest were also threatened by their proximity to the access road to the forest (USFWS 1991).

By 1994, Breckon and Kolterman (UPR, Mayagüez) had expanded the number of known individuals to about 334 individuals in the Susúa and Maricao Commonwealth Forests (these populations include individuals that extend outside the boundaries these forests). Then, Cancel (2010) reported at least 532 individuals of *C. portoricensis* in eleven populations, also in these forests. This data include new populations not previously described (i.e., Quebrada Piedras, Río Bonelli, Río Cupeyes, and Río Postrero). It is likely that further undetected populations or individuals of *C. portoricensis* occur within the Maricao and the Susúa Commonwealth Forests, but their steep topography makes it difficult to search the species. The Service currently estimate at least 547 individuals of *C. portoricensis* in wild populations at Maricao and Susúa Commonwealth Forest (including about 15 individuals recently located by Jose Sustache).

Information available during this status review indicates that *C. portoricensis* remains threatened by some forest management practices. However, the majority of the suitable habitat for the species is protected and managed for conservation, and the impacts by forest management do not occur on a regular basis. Therefore, we consider Factor A as low and non-imminent for *C. portoricensis*. Nonetheless, we identified evidence that strongly suggests predation of fruits by rats as a major threat to this species (Factor C). The predation of fruits could be compromising the recruitment of *C. portoricensis* as evidenced by the absence of seedlings or juveniles on the natural populations that have been monitored since 1992 (Factor C). The absence of recruitment will compromise the long term survival of the species, hence its self-sustainability. Although *C. portoricensis* is capable of reproducing asexually, this strategy does not occur consistently, and furthermore, the resulting clones of the parental tree would not contribute to increase the genetic diversity of the species.

Other natural or manmade factors such as hurricanes and landslides, possible low genetic diversity, and the possibility of hybridization with other species of *Crescentia* (Factor E)

are also threats to *C. portoricensis*. Although the habitat encompassing most of the range of *C. portoricensis* is under PRDNER jurisdiction and managed for conservation, most of the threats identified as having major adverse effects on the species are not related to habitat conservation and operate independently of the protection of the habitat. Therefore, we believe *C. portoricensis* stills meet the definition of endangered because threats like rat predation of fruits, the absence of recruitment, and low genetic diversity compromise its survival and sustainability.

III. RESULTS

A. Recommended Classification:

- ☐ Yes, downlisting to Threatened.
- ☐ Yes, uplisting to Endangered.
- ☐ Yes, delist.
- ☒ No, no change is needed.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Develop a plan for the long term monitoring of the known populations of *C. portoricensis* in order to establish population trends and to record any evidence of natural recruitment.
2. Conduct further studies to address possible adverse effects of fruit predation by rats (*Rattus rattus*), and to determine if rats provides some mechanism for seed dispersal or if they damage the seed embryo.
4. The populations that are actively producing fruits should be monitored to collect seed material for recovery purposes. Due to the absence of natural recruitment in the wild, enhancement of natural populations with propagated material should be considered a priority for the species.
3. Studies should be conducted to determine the patterns of genetic variation within and among populations in order to develop a plan to preserve the species genetic variability and to manage populations effectively.
4. Further studies should be conducted on the species reproductive biology to address other limiting factors (e.g., lack of pollinators or seed dispersers).

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.

- Booy G., R.J.J. Hendriks, M.J.M. Smulders, J.M. Van Groenendael, and B. Vosman. 2000. Genetic Diversity and the Survival of Populations. *Plant biol.* 2 (2000) 379–395
- Breckon, G.J., D.A. Kolterman, and E. Santiago. 1992. *Crescentia portoricensis* Britton (Bignoniaceae) Final Report under Cooperative Agreement No. 14-16-0004-91-958 between U.S. Department of the Interior Fish and Wildlife Service and Department of Biology, University of Puerto Rico, Mayaguez Campus. Mayaguez, PR. 25pp.
- Breckon, G.J. and D.A. Kolterman. 1993. *Crescentia portoricensis* Britton (Bignoniaceae) Final Report under Cooperative Agreement No. 14-16-0004-92-970 between U.S. Department of the Interior Fish and Wildlife Service and Department of Biology, University of Puerto Rico, Mayaguez Campus. Mayaguez, PR. 21pp.
- Breckon, G.J. and D.A. Kolterman. 1994. *Crescentia portoricensis* Britton (Bignoniaceae) Final Report under Cooperative Agreement No. 14-16-0004-93-973 between U.S. Department of the Interior Fish and Wildlife Service and Department of Biology, University of Puerto Rico, Mayaguez Campus. Mayaguez, PR. 9pp.
- Breckon, G.J. and D.A. Kolterman. 1996. *Crescentia portoricensis* Britton (Bignoniaceae) Final Report under Cooperative Agreement No. 14-16-0004-94-9113 between U.S. Department of the Interior Fish and Wildlife Service and Department of Biology, University of Puerto Rico, Mayaguez Campus. Mayaguez, PR. 3pp.
- Cabrera I. and A. Segarra. 2008. A New Gall-Inducing Species of Holopothrips (Thysanoptera: Phlaeothripinae) from Tabebuia Trumpet Trees in the Caribbean Region. *The Florida Entomologist*. Vol 91(2)232-236.
- Cancel, J. 2010. Studies of the population ecology, reproductive biology and conservation status of *Crescentia portoricensis* (Britton) [Bignoniaceae]. M. S. Thesis, University of Puerto Rico, Mayaguez Campus. 141 pp.
- Ewel, J.L. & J.L. Whitmore. 1973. The ecological life zones of Puerto Rico and the U.S. Virgin Islands. USDA Forest Service. Res. Pap. ITF-18.
- Falk, D. A. 1992. From conservation biology to conservation practice: strategies for protecting plant diversity. In: P. L. Fiedler and S. K. Jain (eds.). *Conservation Biology: The Theory and Practice of Nature Conservation, Preservation and Management*, pp. 397-431. Chapman and Hall, New York. 507 pp.
- Fiedler, P. L., and J. J. Ahouse. 1992. Hierarchies and cause: toward an understanding of rarity in vascular plant species. In: P. L. Fiedler and S. K. Jain (eds.). *Conservation Biology: the Theory and Practice of Nature Conservation, Preservation and Management*, pp. 23-47. Chapman and Hall, New York. 507 pp.

- Honnay, O. and Jacquemyn, H. 2007. Susceptibility of rare and common plant species to the genetic consequence of habitat fragmentation. *Conservation Biology* 21, No.3:823-831.
- Jenkins D. 2013. Holopothrips tabebuiae: A thrips from nowhere! Entomology PR.
<http://entomologylabpr.blogspot.com/2013/01/holopothrips-tabebuiae-thrips-from.html>
- Kubitzki, K. and A. Ziburski. 1994. Seed Dispersal in Flood Plain Forests of Amazonia. *Biotropica* 26 (1): 30-43.
- Little, E.L and F.H. Wadsworth. 1964. Common Trees of Puerto Rico and the Virgin Islands. U.S.D.A., Forest Service. Agriculture Handbook No. 249. 490-491pp.
- Little, E.L.; Woodbury R.O, and F.H. Wadsworth. 1988. Arboles de Puerto Rico y Las Islas Vírgenes. Segundo Volumen. U.S.D.A., Forest Service. Agriculture Handbook No. 449-S. 1020-1023pp.
- Rieseberg, L. H. 1991. Hybridization in rare plants: insights from case studies in *Cercocarpus* and *Helianthus*. In: D. A. Falk and K. E. Holsinger (eds.). Genetics and Conservation of Rare Plants, pp. 170-181. Oxford University Press Inc., New York. 304 pp.
- U.S. Fish and Wildlife Service. 1987. Endangered and Threatened Wildlife and Plants; Determination of endangered status for *Crescentia portoricensis*. *Federal Register* Vol. 52: 46085.
- U.S. Fish and Wildlife Service. 1991. *Crescentia portoricensis* Recovery Plan. Atlanta, Georgia. 20 pp.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *C. portoricensis*

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

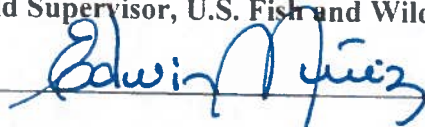
- ☐ Downlist to Threatened
- ☐ Uplist to Endangered
- ☐ Delist
- ☒ No change needed

Review Conducted By: Omar A. Monsegur Rivera, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve



Date

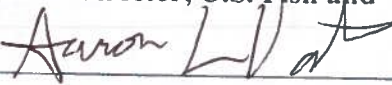
2 March 2017

REGIONAL OFFICE APPROVAL:

for

Lead Regional Director, U.S. Fish and Wildlife Service

Approve



Date

June 16, 2017