

***Peperomia wheeleri* Britton
(Wheeler's peperomia)**



Photo by: Carlos Pacheco, USFWS Biologist

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

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

**Please see Addendum I (page 22) for updated information on this plant that we have gained while conducting our new 5-year review initiated in 2019 (84 FR 28850). Our new signature page is included on page 27. What precedes this new information (pp. 2- 21) is the 5-year review announced in September 27, 2006 (71 FR 56545) and completed and signed in 2014.*

5-YEAR REVIEW
Peperomia wheeleri
(Wheeler's peperomia)

I. GENERAL INFORMATION

A. Methodology used to complete the review: On September 27, 2006, the U.S. Fish and Wildlife Service (Service) published a notice in the *Federal Register* (71 FR 56545) to announce the 5-year review of the plant *Peperomia wheeleri*, and requested new information concerning the biology and status of this species. A 60-day comment period was opened. No comments were received from the public during this period.

When *Peperomia wheeleri* was originally listed, it was given no common name. However, Wheeler's peperomia seems to be well accepted by the scientific community as its common name (Please refer to the "taxonomy" section in this document for more details). Therefore, we intend to use Wheeler's peperomia as the common name for *Peperomia wheeleri* in this document and from this point forward.

This 5-year review was prepared by the lead Service recovery biologist and summarizes information that the Service has gathered in the Wheeler's peperomia file since the plant was listed on January 14, 1987. The sources of information used for this review included the original final listing rule for the species, the recovery plan for the species, peer-reviewed literature, personal communications with qualified biologists and experts on the species, and unpublished reports from field visits and recovery activities conducted by Service biologists.

We sent this document for peer review to experts at the University of Puerto Rico (Mayagüez and Río Piedras Campuses), and the Puerto Rico Department of Natural and Environmental Resources (PRDNER). Comments and recommendations received were evaluated and incorporated in the 5-year review accordingly. Therefore, we believe to have included the best available information on this species in this review.

B. Reviewers:

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C. Background

1. Federal Register Notice citation announcing initiation of this review: September 27, 2006; 71 FR 56545

2. Species Status: Improving. When the recovery plan for this species was signed, it was known to occur only in one locality in Culebra Island, with an estimated population of several hundred individuals. In 1995, Santiago-Valentín and Vives-Helyger (1997) visited a new population of the species in the municipality of Isabela in northern Puerto Rico, and estimated around 50 plants in that population. On February 2007, Service biologist Carlos

Pacheco conducted a rapid assessment of the species' populations in Puerto Rico, providing the more up-to-date information on its status. Pacheco estimated about 1,387 individuals on Culebra Island, and approximately 154 individuals in an area known as El Costillar in Isabela (C. Pacheco, USFWS unpublished data, 2007 a, b). Since 2007, the Service has propagated approximately 140 individuals of Wheeler's peperomia, introducing the species in three localities in Puerto Rico, including both private and public lands managed for conservation (Table 1; USFWS, unpublished data, 2013). Based on the new information, we believe that Wheeler's peperomia abundance and distribution has increased, particularly because no significant changes to its current habitat have occurred in Culebra Island and Isabela. Therefore, we considered the overall species status as improving.

3. Recovery Achieved: 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: None.

6. Review History:

The January 14, 1987 Final Rule (52 FR 1459), and the *Peperomia wheeleri* Recovery Plan (hereafter the "recovery plan") approved on November 26, 1990, provide the most recent comprehensive analyses of the species and are used as the reference point documents for this 5-year review.

The plant Wheeler's peperomia (Family Piperaceae) was discovered and collected in 1906 by Nathaniel L. Britton and William M. Wheeler at Signal Hill, a non determinate location on Culebra Island, Puerto Rico (Sastre and Santiago-Valentín 1996). The species was found again by Roy Woodburry and Luis F. Martorell in 1969 to the south of Playa Resaca (PRDNER, unpubl. data 1969). In 1981, Jose L. Vivaldi and Roy Woodbury conducted the first status survey on the species (Vivaldi and Woodbury 1981). In their report, the authors mentioned two populations of the Wheeler's peperomia on Culebra Island; one located close to the Radio tower on Monte Resaca, and another at the Helipad hill in Punta Flamenco (Figure 1; USFWS 1990).

In the final listing rule for this plant, the Service identified Factor A (present or threatened destruction, modification, or curtailment of its habitat or range), Factor C (disease or predation), and Factor D (inadequacy of existing regulatory mechanism) as the main threats to the species. The recovery plan was signed on November 26, 1990 (USFWS 1990), and included a description of the species, and information on the species' distribution, habitat characteristics, reproductive biology, and conservation. The information included in the recovery plan will not be repeated in this review.

A species' review was conducted for Wheeler's peperomia 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 the Wheeler's peperomia 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 Wheeler's peperomia was completed in 2013. Recovery Data Call: 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012 and 2013.



Figure 1. Historical distribution of Wheeler's peperomia (*Peperomia wheeleri*) in Culebra Island (Vivaldi and Woodbury 1981).

7. Species' Recovery Priority Number at start of review: 5. At the time of listing, Wheeler's peperomia was recognized as a species with high degree of threat and low recovery potential.

8. Recovery Plan:

Name of plan: *Peperomia wheeleri* Recovery Plan

Date issued: November 26, 1990

II. REVIEW ANALYSIS

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

The Endangered Species Act (ESA or Act) defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing DPS to only vertebrate species of fish and wildlife. Because the species under review is a plant, the DPS policy is not applicable.

B. Recovery Criteria

1. Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes. Wheeler's peperomia has an approved recovery plan (USFWS 1990) establishing reclassification from endangered to threatened status as the recovery objective: Wheeler's peperomia can be considered for reclassification to a threatened species when the existing population is adequately protected and two additional populations are established within the Culebra National Wildlife Refuge or other protected areas in Culebra. The recovery plan also contains measurable recovery criteria to reclassify the species from endangered to threatened.

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, protect the current species' habitat, conduct research on the life history of the species, evaluate methods of propagation, search for reintroduction sites, and enhance existing populations by propagating and producing additional individuals.

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? No. The recovery criteria for Wheeler's peperomia do not reflect the most up-to-date information. When the recovery plan was signed, very little information on the species' abundance and distribution was available.

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria? Yes. When the recovery plan was approved, the species was threatened by Factor A, Factor B and Factor C. Although the recovery plan did not include a 5-listing factor analysis, the recovery criteria are relevant to addressing threats to the species. Therefore, we believe that 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 approved recovery plan for the Wheeler's peperomia has no criteria for delisting. The plan states that the species would be considered for reclassification from endangered to threatened when the following criteria are met:

1. The existing population is adequately protected. [Note: This includes all known occurrences at the time the plan was written.]

2. Two additional populations are established within the Culebra National Wildlife Refuge or on other protected areas on Culebra Island.

The first criterion has been partially met. Currently, two of the four known natural populations of Wheeler's peperomia in Puerto Rico are protected as they are located within lands set aside for conservation (Table 1). On Culebra Island, the populations at the Radio tower and Playa Brava are located within the Culebra National Wildlife Refuge (CNWR), land managed by the Service for the conservation of fish and wildlife resources (USFWS 2012). Additionally, the Comprehensive Conservation Plan (CCP) for the Culebra National Wildlife Refuge includes measures for the protection and recovery of the Wheeler's peperomia within this refuge (USFWS 2012). However, the other two natural populations (i.e., El Costillar and Monte Resaca south; Table 1) are not adequately protected because they occur in privately-owned land subjected to urban development and agricultural practices such as cattle and goat grazing. Since 2009, Wheeler's peperomia has been introduced in private and Commonwealth lands managed for conservation (Table 1). These new populations are considered adequately protected because conservation measures have been taken to avoid or minimize threats to the species at each site.

The second criterion has been partially met. This criterion states that two additional populations of the Wheeler's peperomia should be established within protected areas on Culebra Island. Given that the species has been found in other areas outside Culebra Island, we recommend that this criterion should be reconsidered. Since the recovery plan for this species was approved, two new populations of Wheeler's peperomia have been found in Culebra Island, and another population was discovered at an area known as El Costillar in the municipality of Isabela, in northern Puerto Rico. Additionally, the Wheeler's peperomia has been introduced in three other locations in Puerto Rico (Figure 2). In 2009, the Service and the PRDNER established two populations within the Guajataca Commonwealth Forest, located between the municipalities of Isabela and Quebradillas (Monsegur and Pacheco, USFWS, unpubl. data, 2009). At El Tallonal, a private land in the municipality of Arecibo, the Service established two populations of Wheeler's peperomia in 2010; this property is managed for conservation by the local non-government organization Ciudadanos del Karso (Monsegur and Colón-Merced, USFWS, unpubl. data, 2010). In 2013, the Service and the local Trust Para la Naturaleza planted 40 individuals of Wheeler's peperomia at the Río Encantado Natural Reserve, a private land managed for conservation located between the municipalities of Ciales and Florida (R. Rodríguez, Para la Naturaleza, unpubl. data, 2013). Thus, now there are three populations of this species in the northern karst region of Puerto Rico.

Although the Service has successfully propagated and planted Wheeler's peperomia in three protected areas in Puerto Rico, there is no information regarding the minimum number of individuals needed per population to meet this criterion. Therefore, information on the population dynamics of the species is needed to determine what constitutes a viable population in order to meet this criterion.

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Species' abundance, population trends (e.g. increasing, decreasing, stable), demographic features, or demographic trends.

When the recovery plan was approved, the Wheeler's peperomia abundance was estimated at several hundred plants on Monte Reseca and almost twenty plants at the Helipad hill, both in Culebra Island (USFWS 1990). In 1995, Santiago-Valentín and Vives-Helyger conducted a survey of the species at El Costillar in Isabela, estimating that population on 50 plants (Santiago-Valentín and Vives-Helyger, 1997). In 2007, Carlos Pacheco conducted a rapid assessment of Wheeler's peperomia in Puerto Rico, estimating its population at 2,466 plants (C. Pacheco, USFWS, unpubl. data, 2007 a,b). Since 2007, the Service has propagated the species in their greenhouses at the Cabo Rojo National Wildlife Refuge and the Culebra National Wildlife Refuge, producing over 200 plants. Presently, the species has been introduced in different localities in Puerto Rico, estimating the population of Wheeler's peperomia at 2,595 individuals in Puerto Rico and Culebra Island (Table 1). Therefore, based on our field observations, and new information available on the species, we believe that the Wheeler's peperomia population trend should be considered as increasing.

Table 1. Estimated abundance for Wheeler's peperomia (*Peperomia wheeleri*) population per known localities in Puerto Rico (USFWS unpublished data 2013).

Locations	Species abundance (# of adult plants)	Reference
El Costillar site - Isabela (private land)	154*	C. Pacheco, USFWS, unpubl. data, 2007a
Radio tower site - Culebra NWR	722*	C. Pacheco, USFWS, unpubl. data, 2007b
Playa Brava site - Culebra NWR	511*	C. Pacheco, USFWS, unpubl. data, 2007b
Monte Resaca South - Culebra Island (private land)	1,079*	C. Pacheco, USFWS, unpubl. data, 2007b
Guajataca Commonwealth Forest - Isabela	32**	Monsegur and Pacheco, USFWS, unpubl. data, 2009
Río Encantado Natural Reserve - Ciales, Florida	40**	R. Rodríguez pers. comm. 2013
El Tallonal - Arecibo (private land managed for conservation)	57**	Monsegur and Colón-Merced, USFWS, unpubl. data, 2010
Total	2,595	

*Natural populations

**Introduced populations

No new information about Wheeler's peperomia demographic features or trends was found during this review.

b. Genetics, genetic variation, or trends in genetic variation: No new information on this species' genetics, genetic variation, or trends in genetic variation was found during this review.

c. Taxonomic classification or changes in nomenclature: During this review we have received information that *Peperomia myrtifolia* is frequently misidentified as *P. wheeleri*. *Peperomia myrtifolia* is a highly variable taxon distributed throughout the Lesser Antilles and the Virgin Islands (Axelrod 2011). Presently, some species experts agree that *P. wheeleri* is not a distinctive species from *P. myrtifolia* because the major difference between the two species is the leaf shape and leaf apex (Axelrod 2011, J. Vélez-Gavilan, UPRM, 2014, pers. comm.). Hence, some authors (e.g., Axelrod 2011) treat *P. wheeleri* as a synonym of *P. myrtifolia*. Currently, no genetic studies have been conducted to demonstrate that *P. wheeleri* is not a valid species. Thus, for the purpose of this review we are treating *P. wheeleri* as a valid species. This taxonomic issue should be appropriately assessed in the future.

When the recovery plan for *P. wheeleri* was approved in 1990, no common name was recognized for the species. Presently, the name Wheeler's peperomia seems to be widely accepted. This common name has been adopted by the USDA PLANTS database, the Integrate Taxonomic Information System (ITIS) and the IUCN Red List. Therefore, the Service intends to use this common name for this federally listed plant.

d. Spatial distribution, trends in spatial distribution or historic range (e.g., corrections to the historical range:

At time of listing, the distribution of the Wheeler's peperomia was restricted to Culebra Island in Puerto Rico. After reviewing the most recent information available on the species, we found that the current distribution of the species now includes the main island of Puerto Rico, the Virgin Islands and Dutch West Indies (Figure 2). According to the voucher from the Herbarium of the University of South Florida (USF) in Tampa, the plant was collected by R.P. Sauleda & D.K. Sauleda on September 27, 1982, at Oyster Pond in St. Maarten (Dutch West Indies) (USF #012871 unpublished data 1982). In 1986, George Proctor collected the plant in Gorda Peak National Park, Virgin Gorda, British Virgin Islands (BVI) (DNER (SJ 007746) unpublished data 1986). Later, in 2012 Carlos Pacheco visited the population of Gorda Peak in Virgin Gorda reporting it as a healthy population (C. Pacheco, USFWS, unpubl. data, 2012). These records for the species should be considered as new information for this review, expanding its current range to Puerto Rico, St. Maarten and Virgin Gorda Islands.

In Puerto Rico, the Wheeler's peperomia is not restricted only to two populations in Culebra Island as previously thought. When the recovery plan was approved, the species was known from the radio tower area in Monte Resaca and the helipad hill in Punta Flamenco. Presently, three natural populations of Wheeler's peperomia are found in Culebra Island; one at the Radio Tower area, one at Playa Brava, and the other at Monte Resaca South (Figure 3; C. Pacheco, USFWS unpublished data 2007b).

In 1991, George Proctor collected the species at El Costillar in the municipality of Isabela (DNER (SJ 004752) unpublished data 1991; Santiago-Valentín and Vives-Helyger 1997). This population of Wheeler’s peperomia was found in the northwest face of El Costillar. The historical site at the Helipad hill apparently no longer exists. Efforts to locate the species in this area have been conducted with no success. In addition, the species has been introduced in three localities in Puerto Rico (Figure 2). Since 2009, the Service has established one population within the Guajataca Commonwealth Forest in the municipality of Isabela (Monsegur and Pacheco, USFWS, unpubl. data, 2009), one population at El Tallonal in the municipality of Arecibo (Monsegur and Colón-Merced, USFWS, unpubl. data, 2010), and one population at the Río Encantado Natural Reserve in northern Puerto Rico (Figure 2; R. Rodríguez pers. Comm. 2013). Thus, the species is presently known from seven localities. All these populations are new, expanding the species’ distribution in Puerto Rico.

Even though the overall distribution of Wheeler’s peperomia has expanded in twenty years, the plant has very limited spatial distribution at known localities (Table 2). When the recovery plan was approved, the area of occupancy of the species in Puerto Rico was estimated at about 0.5 acres (0.2 hectare) (USFWS 1990). In February 2007, Service biologist Carlos Pacheco conducted an assessment on the status of the species in Puerto Rico. Based on his observations, the species has a clumped distribution pattern. The total area currently occupied by natural populations of the species is approximately 1 acre (0.4 ha) (Table 2; C. Pacheco, USFWS unpublished data 2007a,b). The total area currently occupied by the re-introduced populations is unknown.



Figure 2. Current distribution of *Peperomia wheeleri* in Puerto Rico, US Virgin Islands and British Islands (USFWS, unpubl. data, 2013).



Figure 3. Current distribution of *Peperomia wheeleri* in Culebra Island (Pacheco, USFW, unpubl. data, 2007a).

Table 2. The area currently occupied by the Wheeler’s peperomia (*Peperomia wheeleri*) and distribution pattern at each locality in Puerto Rico (USFWS unpublished data 2013).

Location	Area surveyed	Number of clumps	Reference
El Costillar site - Isabela (Proctor 1991)	0.089 acre / 0.036 hectare	15	USFWS 2007a
Radio tower site - Culebra Island (USFWS 1990)	0.163 acre / 0.066 hectare	30	USFWS 2007b
Playa Brava site - Culebra Island	0.491 acre / 0.198 hectare	15	USFWS 2007b
Monte Resaca South - Culebra Island (USFWS 2007)	0.211 acre / 0.085 hectare	24	USFWS 2007b
Guajataca Commonwealth Forest - Isabela	unknown	32	USFWS 2009
Río Encantado Natural Reserve - Ciales and Florida	unknown	40	R. Rodríguez pers. comm. 2013
El Tallonal - Arecibo	unknown	57	USFWS 2010

e. Habitat or ecosystem conditions: At the time of listing, the Wheeler’s peperomia was only found in a particular habitat type on Culebra Island. The species was described

as growing in humus accumulated on granodiorite boulders within a semi-evergreen seasonal open forest (Ewel and Whitmore 1973). In 1995, Santiago-Valentín and Vives-Helyger found the species growing in humus accumulated on limestone boulders in subtropical wet forest (Ewel and Whitmore 1973) at El Costillar Hill in Isabela (Santiago-Valentín and Vives-Helyger 1997). This new habitat was not considered before as suitable for the species. The species still persists in both habitats (USFWS unpublished data 2007a,b). Based on the current distribution of Wheeler's peperomia, we believe that there is more habitat available to and appropriate for the species than previously thought when the species was listed in 1987.

2. Five Factor Analysis

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

When the Wheeler's peperomia was listed as endangered in 1987, the Service identified Factor A (modification and destruction of habitat) as one of the most important threats to the species (USFWS 1987). The recovery plan states that the species' habitat in Culebra Island has been largely modified or destroyed through deforestation, grazing by cattle and goats, and foraging by domestic fowl, thus eliminating the species throughout most of its former range (USFWS 1990). In Culebra Island, the Wheeler's peperomia occurs in mesic forested drainages within the semi-evergreen seasonal open forest. Presently, this type of forest in Culebra Island is being affected by deforestation and modification for residential and tourist development. Some of these projects have resulted in the elimination of potential habitat for the species. Additionally, areas in Culebra Island have been deforested as a result of cattle and goat grazing. Exotic mammals such as white-tailed deer (*Odocoileus virginianus*) are found throughout the range of Wheeler's peperomia on Culebra Island. It is expected that, due to their abundance, the exotic mammals are modifying the forest structure through overgrazing or altered habitat conditions. Land clearing activities for urban development and removal of forested vegetation for cattle grazing have resulted in a more xeric environment and erosion in some areas which are still forested (Vivaldi and Woodbury 1981, Lugo 2005). At present, one of the Culebra populations is located within an area under development pressure for residential lots and adjacent (less than 100 meters) to a privately-owned land subjected to agricultural practices such as cattle and goat rising. At El Costillar, evidence of grazing by cattle or goats has not been documented. However, the population of the Wheeler's peperomia in Isabela occurs along an un-frequently used trail that provides access to the top of El Costillar hill. Some wood harvesting still occurs in this area, and it is visited for scientific purposes. An increase in use or visitors may result in habitat modification such as removal of vegetation for additional trails and increased soil erosion.

Based on the above information, the Wheeler's peperomia is threatened by urban development, land clearing and wild domestic mammals. Therefore, we consider this factor as a threat. We consider the magnitude of this threat as high due to the limited distribution of the species, but non-imminent because five of the seven known populations occur in lands protected for conservation.

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

There is no information documenting over-utilization of the plant Wheeler's peperomia for commercial, recreational, scientific or educational purposes as a present threat to the species.

(c) Disease or predation.

Disease and predation have been documented as factors in the decline of the species in Culebra Island (USFWS 1990). The white-tailed deer, and other mammals such as feral goats (*Capra aegagrus hircus*), and domestic fowls (*Gallus gallus domesticus*) are found throughout the range of Wheeler's peperomia in Culebra Island (Carlos Pacheco, USFWS, 2007, pers.obs.). In 2007, Service biologist Carlos Pacheco documented the presence of trails and sheltering sites used by these introduced animals resulting in habitat degradation, soil erosion and possible elimination of individual plants (C. Pacheco, USFWS, unpubl. data, 2007b). Although it is likely that some grazing or browsing of plants has occurred, the effect of depredation over the species is not well documented and understood. Therefore, the possible impact of predation to Wheeler's peperomia by exotic and wild domestic animals remains speculative as long term monitoring is needed.

(d) Inadequacy of existing regulatory mechanisms.

In 1999, the Commonwealth of Puerto Rico approved Law No. 241, known as the "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 property of Puerto Rico all wildlife species within its jurisdiction, regulate permits, regulate hunting activities, and regulate 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). The plant Wheeler's peperomia (*Peperomia wheeleri*) was included in the list of protected species and designated as endangered in this regulation. Under Article 2.06, Regulation 6766 prohibits collecting, cutting, or removing, among other activities, listed plant individuals within the jurisdiction of Puerto Rico.

The habitat on which the plant depends on the north slope of Monte Resaca in Culebra Island is a National Wildlife Refuge protected by the U.S. Fish and Wildlife. The Culebra Island National Wildlife Refuge was declared as a National Wildlife Refuge by the Department of Interior and managed for conservation by the Service since 1975. The protection and management of this area as a National Wildlife Refuge are ensured by Federal and Commonwealth statutes. Within the CNWR, Wheeler's peperomia is protected by the National Wildlife Refuge Act of 1966, as amended in 1997 (16 U.S.C. 668dd) (Pub. L. 89-669, Oct. 15, 1966, 80 Stat. 927) where all plants existing on a National Wildlife Refuge System are protected from collection (50 CFR 27.51). Additionally, the Comprehensive Conservation Plan (CCP) for the Culebra National

Wildlife Refuge was published in May 2012. The CCP include measures for the protection and recovery of threatened and endangered, including Wheeler's peperomia, within this refuge (USFWS 2012).

Based on the presence of local and federal laws and regulations protecting this species and its habitat, and the absence of evidence proving otherwise, we believe that inadequacy of existing regulatory mechanisms should no longer be considered a threat.

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

One of the most important factors affecting the continued existence of the Wheeler's peperomia is its limited distribution. In the Caribbean, native plant species, particularly endemic with limited distribution and highly specialized ecological requirements, may be vulnerable to natural or anthropogenic events such as hurricanes, human induced fire and genetic variation. The Wheeler's peperomia is more susceptible to natural disturbance such hurricanes or fire, because it is confined to small geographic areas (Carlos Pacheco, USFWS, 2007, pers.obs.).

Limited distribution and highly specialized ecological requirements.

Wheeler's peperomia is vulnerable to extinction due to its limited distribution and highly specialized ecological requirements. The species is only found growing on organic matter (humus) accumulated in forested drainages of Culebra Island or on limestone boulders in the municipality of Isabela. Little is known about the phenology, natural recruitment, and habitat requirements of the species. The low number of individuals per population and its spatial distribution may suggest that the species has highly specialized ecological requirements to grow (Carlos Pacheco, USFWS, 2013, pers. obs.). The low population number and restricted distribution (i.e., only 4 natural populations reported), coupled with habitat alteration or loss may also exacerbate its vulnerability to natural or anthropogenic events such as hurricanes and fire, compromising the continued existence of this species (C. Pacheco, USFWS, unpubl. data, 2007a,b). 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 or anthropogenic events such as hurricanes, human induced fires and climate change, compromising the continued existence of the species.

Genetic Variation.

Given the extremely limited geographic distribution of Wheeler's peperomia, it is highly likely that its genetic variability is very low. This would result in a loss of alleles by random genetic drift, which would limit the species' ability to respond to changes in the environment (Honnay and Jacquemyn, 2007). In order to safeguard the remaining genetic diversity, the protection and monitoring of known adult individuals should be considered as a high priority for the conservation of the species. Based on the above, we consider the potential lack of genetic variation as a possible threat to the species.

Human induced fire

Fire was not considered in the listing rule as a factor that may affect the continued existence of the species. The plant is only found growing on humus accumulation under the canopy of deciduous trees, in particular *Bursera simaruba*. Humus accumulation and heavy leaf fall of the deciduous vegetation during the dry season could represent an increase in fuel that may exacerbate the impact of fire. Although the population in Isabela is located in moist forest, during the dry season human-induced fires may occur. On Culebra Island, the species is located in dry areas surrounded by grasslands used for cattle grazing. Even though wildfires or human-induced fires are not frequently reported in the species' area, the potential is there. Hence, this factor should be considered as a low to moderate threat.

Hurricanes

Hurricanes or tropical storms may also affect the continued existence of Wheeler's peperomia. Hurricanes contribute to shaping vegetation and ecosystem processes, and determining the structure and composition of biotic communities in the Caribbean forests (Walker et al 1991, Lugo 2000). As a species endemic to the Lesser Antillean, the Wheeler's peperomia should be adapted to hurricanes, but its occurrence on natural drainages or ravines on Culebra Island, where significant water discharge through those drainages during heavy rain events, may place it at increased risk, especially as climate change is predicted to increase the frequency and strength of hurricanes. High rainfall associated with tropical storms and hurricanes, sometimes about 24 inches (2 feet) of rain in a single storm event, can cause floods and interacting with topography and substrate may induce mass wasting events (e.g., land, mud and debris slides; Lugo 2000). A mass wasting event in the area where Wheeler's peperomia grows would not only take out adult plants and their young offspring, but their seed bank and substrate as well. Hurricane winds often lead to tree defoliation, loss of small and large branches, and uprooted resulting in damage to adjacent trees and understory plants when trees or branches fall, and ultraviolet damage to leaves of understory juveniles exposed to high light levels creating a less favorable xeric environment (Walker et al. 1991).

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 well have an adverse impact on the species.

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 populations, we consider this threat as high in magnitude; but not imminent.

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 examine the potential consequences to species and their habitats that arise from changes in environmental conditions associated with various aspects of

climate change. Vulnerability to climate change impacts 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 the climate change is the increase in intensity of hurricanes and tropical storm, followed by extended period of drought (IPCC 2012). This climate change may alter (modify) the microclimate and the surrounding vegetation around the populations of the Wheeler's peperomia. Hurricane effects followed by extended period 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. *Megathyrsus maximus*) may spread and colonized the Wheeler's peperomia habitat, and it could alter fire regimen, microclimate, and nutrient cycling of the habitat that the species depend.

Due to its limited distribution and number of natural populations, we consider the cumulative effects by hurricanes, genetic variation, and exotic and invasive species (plants and animals) as detrimental to the Wheeler's peperomia as a whole. The population dynamics of the species is poorly known (e.g., depressed genetic variability and its competitive abilities), there are only few known natural populations, and there is a lack of information to determine what constitutes a viable population. Therefore, we consider the above mentioned threats as high in magnitude because the species has only few known populations; but not imminent because threats like climate change are not likely to occur in near future.

3. Synthesis

At the time of listing, Wheeler's peperomia was known from only one location in Culebra Island, Puerto Rico. The species is now known from nine localities: seven localities in Puerto Rico, one locality at St. Maarten (Dutch West Indies), and one locality at Virgen Gorda (BVI). The number of individuals known in Puerto Rico is approximately 2,600. The area currently occupied by the species is unknown, but we do know that the species appears to have a clumped distribution. The species is found in both semi-evergreen seasonal open forest (Culebra) and subtropical wet forest (Isabela).

Based on our analysis, Wheeler's peperomia 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). The species is threatened by habitat modification for urban and tourist development in Culebra. Additionally, habitat modification and degradation caused by small herbivorous animals such as goats and deers were documented by the Service in Culebra. Human-induced fires, physical damage caused by human trampling, hurricanes and storms are also considered as threats to this species. We considered the magnitude of Factor A and Factor E as high because of the species' limited spatial distribution and low number of populations, but non-imminent because most known population occurs within protected land. Overutilization for commercial, recreational, scientific, or educational purposes, the inadequacy of existing regulatory mechanisms and disease/predation are not current threats to the species.

The Endangered Species Act defines an endangered species as any species which is in danger of extinction throughout all or a significant portion of its range. Based on the information gathered during this review, we believe that Wheeler's peperomia continues to meet the definition of endangered particularly because of its low number of populations and its limited spatial distribution.

The species *Peperomia wheeleri* and *Peperomia myrtifolia* are closely related. Both species have been frequently confused in herbarium collections as well as in the field. Presently some species experts consider *P. wheeleri* as not a distinctive species from *P. myrtifolia*, treating *P. wheeleri* as a synonym of *P. myrtifolia*. Systematic studies, including a genetic study, should be conducted to demonstrate that *P. wheeleri* is not a valid species.

Presently, Wheeler's peperomia has been reported in seven localities in Puerto Rico occupying more than one acre of land. Additional surveys are needed in the limestone hills of northern Puerto Rico to determine if the species is more widely-distributed than presently reported. Propagation efforts should continue to expand the area occupied by the species, particularly within the Culebra National Wildlife Refuge.

III. RESULTS

A. Recommended Classification:

 X No change is needed.

Although the Wheeler's peperomia populations have increased due to its introduction within its historical range, these populations have been poorly monitored to see if they are self-sustainable. Therefore, at this time we do not recommend a change in classification potential.

B. New Recovery Priority Number: 8 The Service recommends a change on the species' Recovery Priority Number (RPN). At the time of listing the RPN for Wheeler's peperomia was 5. This plant was recognized as a species with high degree of threat and low recovery potential. We believe that the new information gathered during this review supports a change in RPN from 5 to 8, recognizing Wheeler's peperomia as a species with moderate degree of threat and high recovery potential.

As stated above, Wheeler's peperomia was originally known from only two populations in Culebra Island. Today, the species is found in four localities both in Culebra and Puerto Rico with more than 2,000 individuals, as well as in USVI and BVI. Additionally, the species has been propagated successfully in green houses. This evidence suggests that the Wheeler's peperomia does not have a low recovery potential. Furthermore, the recovery criteria for reclassifying the species to threatened has been almost met. Most populations are in protected areas, and we have established 3 additional populations, 1 more than required by Recovery Criterion 2.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- Conduct genetic studies to verify if *Peperomia wheeleri* is a valid species or a synonym of *Peperomia myrtifolia*.
- Develop measurable objective criteria for delisting the species.
- Conduct studies on the biology and ecology of the Wheeler's peperomia.
- Continue a propagation program for the species and establish new populations in protected areas or increase / augment existing populations.
- Continue working with landowners to enhance existing populations or establish new ones within protected areas that ensure their long-term protection.
- Incorporate the private landowners in habitat conservation programs (e.g., Partners for Fish and Wildlife, Coastal Program, PRDNER-Bosque Auxiliar).
- Evaluate the abundance and distribution of the species through surveys within traditional and non-traditional sites, using the best available plant survey methodology to determine current population numbers and number of viable populations necessary to protect and stabilize Wheeler's peperomia populations (wild, naturally-reproducing populations large enough to maintain sufficient genetic variation and evolve and respond to natural habitat changes).
- Appropriate government agencies should continue evaluating and implementing conservation measures to minimize possible adverse effects on natural drainages on Culebra Island.
- Quantify predation pressure on the species and determine if predation is a limiting factor for its recovery.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Wheeler's peperomia (*Peperomia wheeleri*)

Current Classification: Endangered.

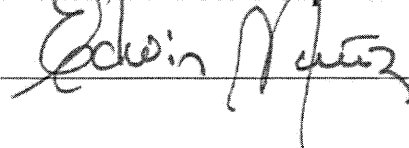
Recommendation resulting from the 5-Year Review:

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

Review Conducted By: Carlos G. Pacheco, Caribbean Ecological Services Field Office.

FIELD OFFICE APPROVAL:

Edwin E. Muñiz, Lead Field Supervisor, Fish and Wildlife Service

Approve  Date March 10, 2014

REGIONAL OFFICE APPROVAL:

for
Lead Regional Director, Fish and Wildlife Service

Approve  Date 3-12-14

Appendix A

Summary of peer review for the 5-year review of the *Peperomia wheeleri* (Wheeler's peperomia).

José Cruz-Burgos, CESFO Endangered Species Program Coordinator, reviewed this 5-year review and provided editorial and technical comments that were included in the document. Additionally, we sent the document to four outside peer reviewers (see below) via electronic mail. Reviewers were selected based on their qualifications and knowledge of the species. We indicated our interest in all comments the reviewers may have about the Wheeler's peperomia, particularly any new additional information on the status and current threats to the species. Comments and recommendations received by the peer reviewers were incorporated into the document and cited accordingly.

List of Peer Reviewers

Dr. Duane Kolterman
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No comments received.

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Comments on Section C(1)(c) **Taxonomic classification or changes in nomenclature:**
According to Frank Axelrod (2011) and Gary J. Breckon (UPRM, perns comm, 2014), *Peperomia wheeleri* is not a distinctive species from *Peperomia myrtifolia*. G. Breckon agrees with F. Axelrod, in fact they had discussed it at length. G. Breckon strongly suspect that at least some of the *Peperomia* species are apomictic races, which is what I think (without much evidence) is going on between *P. myrtifolia* and *P. wheeleri*. The major difference between them is leaf shape and primarily the leaf apex. The questions are: first, is that enough to segregate out *P. wheeleri* as a distinct species or even a distinct variety?, and second, is apomixis involved? Good for a Master's thesis.

Citing Axelrod (2011): Notes: *Peperomia myrtifolia* is a highly variable taxon throughout the Lesser Antilles and the Virgin Islands. I have thus far been unable to discriminate between exsiccate of it and of what, in Puerto Rico, has been called *Peperomia wheeleri*. Until such time

as marked differences among populations of *Peperomia myrtifolia* are demonstrated, I am treating *Peperomia wheeleri* as encompassed within it. *Peperomia wheeleri* is on the U. S. Fish & Wildlife Service list of threatened and endangered plants. Axelrod, F. 2011. A Systematic Vademecum to the Vascular Plants of Puerto Rico. Botanical Research Institute of Texas Press, Fort Worth. The vademecum can be accessed through the UPRRP Herbarium Webpage.

No comments on rest of document. All is carefully prepared.

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No comments received.

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No comments received.

U.S. FISH AND WILDLIFE SERVICE
5 – YEAR STATUS REVIEW OF *Peperomia wheeleri*

Addendum I. Summary of new information gathered since the 2014 *Peperomia wheeleri* 5-Year Status Review

I. GENERAL INFORMATION

On June 20, 2019, the U.S. Fish and Wildlife Service (Service) published a notice in the Federal Register (84 FR 28850) announcing the five-year status review of *Peperomia wheeleri* (Wheeler’s peperomia). It requested new information and comments from species experts and biologists familiar with this endangered plant concerning its biology and status. No comments were received from the public.

This addendum was prepared by a Service biologist and summarizes information that the Service has compiled from other state partners for the plant since the last *Peperomia wheeleri* 5-year status review approved on March 12, 2014.

II. UPDATED INFORMATION

By 2014, Wheeler’s peperomia was known from approximately 2,595 individuals in 7 areas in Puerto Rico (USFWS 2014). On the mainland Puerto Rico, the current populations are located at Isabela (El Costillar; C. Pacheco, USFWS, unpubl. data 2007a), Ciales-Florida (Río Encantado Natural Reserve; R. Rodríguez pers. comm. 2013), Arecibo (El Tallonal; Monsegur and Colón-Merced, USFWS, unpubl. data 2010), and Guajataca State Forest (Monsegur and Pacheco, USFWS, unpubl. data 2009; and Trejo, unpubl. data 2018). In addition, there are three populations in Culebra Island (Radio tower site, Playa Brava site, Monte Resaca South, C. Pacheco, USFWS, unpubl. data 2007a). These populations are comprised by both natural and planted individuals. Also, an undetermined number of individuals were known from U.S. Virgin Islands, and British Virgin Islands.

Throughout the years, additional planting efforts have been implemented to augment current population and establish new populations in protected areas. In June 2018, the Service and Envirosurvey, Inc. collected 20 fragments at the Culebra NWR to develop and implement propagation protocols and for the establishment of additional populations in protected areas. Five Wheeler’s peperomia fragments were also collected from another location within the Culebra NWR. These fragments were used for propagation efforts at the Cabo Rojo National Wildlife Refuge (Arrocho-Hernandez 2018). As a result of this propagation effort, on March 1st, 2018, staff from Envirosurvey, Inc. and the Puerto Rico Department of Natural and Environmental Resources (PRDNER) planted 37 individuals in the Guajataca State Forest (Trejo 2019) to increase and augment the current population at the Guajataca State Forest. In addition, on July 31 and September 17, 2019, staff from Envirosurvey, Inc. and the Service planted 50 individuals at Villa de Angel, Lares, Puerto Rico. This last effort addressed establishing a new population on mainland Puerto Rico to address and increase the redundancy of species. This last population was introduced through a conservation agreement with the private landowner as part of the Partners for Fish and Wildlife Program.

Table 1. Estimated abundance for Wheeler’s peperomia population per known localities in Puerto Rico.

Location	Species abundance (number of adults plants)	Reference
El Costillar site-Isabela (private land)	154*	C. Pacheco, USFWS, unpubl. data 2007a
Radio tower site - Culebra NWR	722*	C. Pacheco, USFWS, unpubl. data 2007b
Playa Brava site - Culebra NWR	511*	C. Pacheco, USFWS, unpubl. data 2007b
Monte Resaca South - Culebra Island (private land)	1079*	C. Pacheco, USFWS, unpubl. data 2007b
Guajataca Commonwealth Forest - Isabela	67**	O. Monsegur and C. Pacheco, USFWS, unpubl. data 2009; Envirosurvey 2018)
Río Encantado Natural Reserve - Ciales, Florida	40**	R. Rodríguez pers. comm. 2013
El Tallonal - Arecibo (private land managed for conservation)	57**	O. Monsegur and R. Colón-Merced, USFWS, unpubl. data 2010
Valle del Angel- Lares site (private land managed for conservation)	50**	J. Rios-Cruz and A. Galindo, USFWS, unpubl. data 2019
Total	2,680	

*Natural populations

**Introduced populations

In December 2019, Service biologists visited different sites between St. Thomas and St. John to conduct work on *Zanthoxylum thomasianum* populations. On December 12, 2020, they visited a St. John population of Wheeler’s peperomia and collected samples. This population is located at central road in St. John and appears to be stable and recruiting after Hurricane Irma (O. Monsegur, USFWS pers. comm. 2020). They documented that the species is known at one locality but it might be relatively common at St. John as noted by Pedro Acevedo-Rodriguez in the Flora of St. John published in 1996 (O. Monsegur USFWS pers. comm. 2020).

In January 2020, the population at El Costillar in the Municipality of Isabela was visited post Hurricane Maria, and it seemed to be 3 or 4 times larger in size than when last visited in 2007 (O. Monsegur pers. comm. 2020).

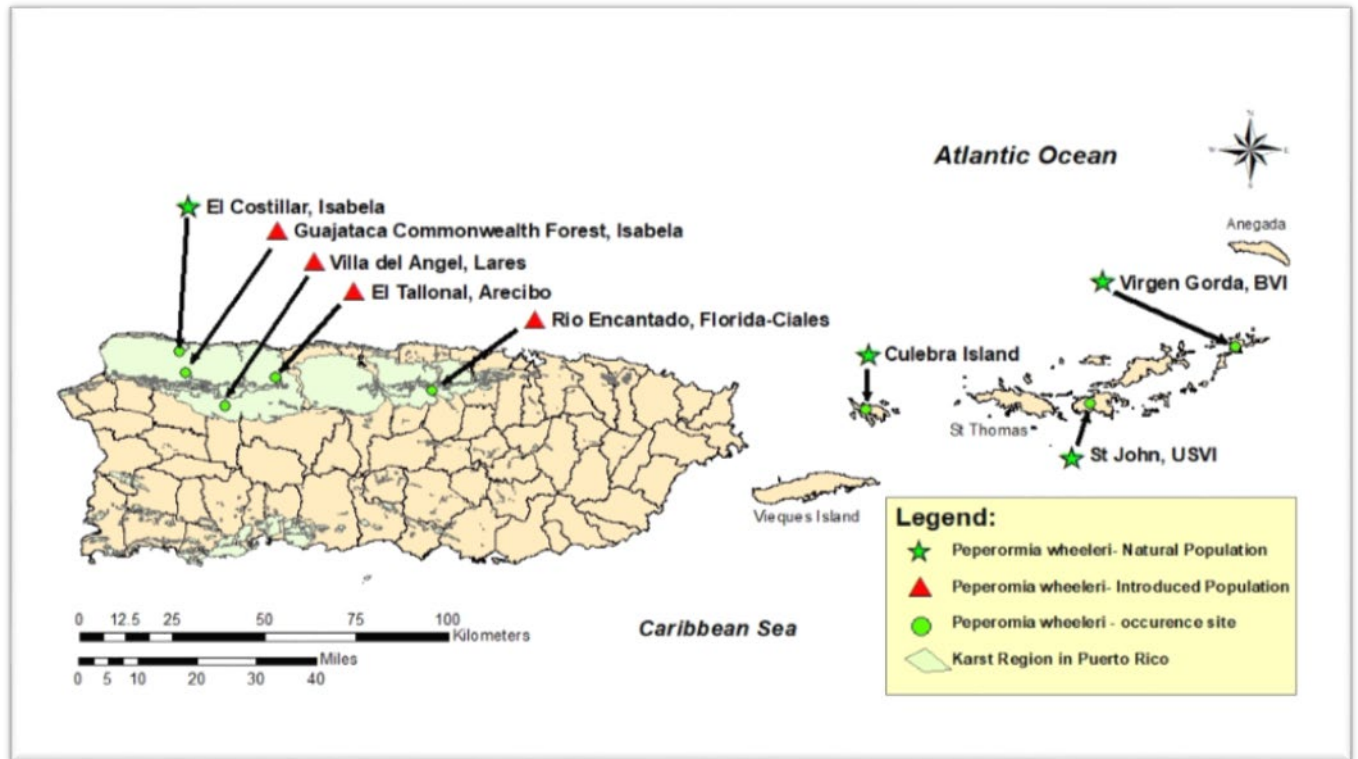


Figure 1. Current populations of Wheeler's peperomia in Puerto Rico, U.S. Virgin Islands, and British Virgin Islands

AMENDED RECOVERY CRITERIA

On August 6, 2019, the Service published the amended delisting criteria for the Wheeler's peperomia (84 FR 38284). Recovery criteria serve as objective, measurable guidelines to assist in determining when an endangered species has recovered to the point that it may be downlisted to threatened, or that the protections afforded by the Act are no longer necessary and the species may be delisted. The amended delisting criteria for the Wheeler's peperomia are as follow:

1. Existing populations of *P. wheeleri* in Culebra Island (2 populations) and Puerto Rico (2 populations) exhibit a stable or increasing population trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A, C, and E).
2. Establish or discover two (2) additional populations (as defined in criterion 1) of *P. wheeleri* on lands protected via a conservation mechanism on Culebra Island (Addresses Factors A and E).
3. Establish two (2) additional populations of *P. wheeleri* (as defined in criterion 1) on lands protected via a conservation mechanism on mainland Puerto Rico (Addresses Factors A and E).
4. Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future (addresses Factor C and E).

The new delisting criteria supersede those include in the *Peperomia wheeleri* Recovery Plan approved in 1990 (USFWS 1990). Achieving the prescribed recovery criteria is an indication that

the species is no longer threatened or endangered, but this must be confirmed by a thorough analysis of the factors that may affect the continued existence of the species.

Threats:

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

In the 2014 5-year status review, Wheeler's peperomia was considered threatened by present destruction, modification, or curtailment of its habitat or range. Presently, we believe that this threat continues to apply since new information regarding these threats is not available to the Service, and the environmental conditions of the currently known populations have not changed. In Culebra Island, the known populations of Wheeler's peperomia occur in mesic forest drainages within the semi-evergreen seasonal open forest (USFWS 2014). This type of habitat currently continues to be affected by deforestation and modification for residential and tourist development (e.g., Monte Resaca South population). Additionally, areas where Wheeler's peperomia is present in Culebra Island continue to be subject to deforestation due to cattle and goat grazing. Although there is no current information available regarding the current effects of exotic mammals such as introduced white-tailed deer (*Odocoiles virginianus*) on the species, we continue to believe that the species is being affected by the predation and habitat modification caused by this deer within the current range of Wheeler's peperomia on Culebra Island. (USFWS 2014). Furthermore, at El Costillar, wood harvesting, which was identified as a threat in the 2014 5-year status review, continues to be an occurring threat.

Based on the above information the present or threatened destruction, modification or curtailment of its habitat or range, continues to affect the populations of Wheeler's peperomia.

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. Presently, we have no information that evidence that this factor is threatening the species. Therefore, we are not considering overutilization for commercial, recreational, scientific, or educational purposes as a threat to the species.

Disease or predation:

Disease and predation is a factor that has contributed to the decline of the species in Culebra Island (USFWS 1990). The white-tailed deer, and other mammals such as feral goats (*Capra aegagrus hircus*), and domestic fowl (*Gallus gallus domesticus*) are found throughout the range of Wheeler's peperomia in Culebra Island (USFWS 2014). This has resulted in habitat degradation, soil erosion and possible elimination of individual plants (USFWS 2014). Currently, the magnitude of the problem is still unknown and the information regarding this threat is still speculative

In the 2014 5-year review, this factor was present and to date continues to affect the species in its limited range.

Inadequacy of existing regulatory mechanisms:

In 2014, we concluded that the inadequacy of existing regulatory mechanisms was not a threat to this species (USFWS 2014). Presently, we have no new information or evidence that the inadequacy of existing regulatory mechanisms are threatening the species.

Other natural or manmade factors affecting its continued existence:

In the 2014 5- year status review, the current Wheeler's peperomia populations were still susceptible to natural and manmade factors such as hurricanes (i.e., open canopy within planting quadrant; Trejo unpubl. data [2018]) and human-induced fires, particularly since the known populations are confined to small geographic areas (Carlos Pacheco, USFWS, pers. obs. 2007). The islands of the Caribbean are affected by hurricanes, the most recent, Hurricane Irma and Maria on September 6 and September 20, 2017. Of the existing populations, only a few have been visited post hurricane and currently it is hard to determine the overall status of this species. However, of those populations that have been visited, the post Hurricane Maria population at El Costillar in Isabela was estimated to be 3 or 4 times larger than previous visits (Omar Monsegur pers. comm. 2020). We consider that natural and manmade threats continue and can affect the species because of few areas of species occurrence.

Synthesis

Based on the most recent information, the estimate of number of individuals of Wheeler's peperomia in Puerto Rico and U.S. Virgin Islands has been relatively stable since the 2014 5-year status review. At present, approximately 2,680 individuals are known to occur in 8 sites in Puerto Rico. The current numbers are related to propagation efforts in suitable habitat within the main island of Puerto Rico. More recently, there have been efforts to reintroduce the species in protected (i.e., Guajataca State Forest) and private conservation lands (El Tallonal, El Costillar, Valle del Angel and Monte Resaca). The purpose of these reintroductions is to increase and augment the current populations in areas and to create new areas for redundancy and persistence due to the limited geographic areas of the species. The natural populations of the species continue to be threatened by deforestation, fragmentation and habitat modification; disease, and predation by exotic mammals; and other natural or manmade factors such as human-induced fires and hurricanes. Thus, we believe that Wheeler's peperomia continues to meet the definition of an endangered species.

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U.S. Fish and Wildlife Service (USFWS). 2014. *Peperomia wheeleri* (Wheeler's peperomia) 5-year review: summary and evaluation. US Fish & Wildlife Service Southeast Region Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

FY 2020 APPROVAL*

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

Approved _____ Date _____

In 2014, Southeast Region Field Supervisors have been delegated authority to approve 5-year reviews that do not recommend a status change.

Field Supervisor signature on this document reflects:

1. We have no new information received, no new public comments, and the original five factor analysis remains an accurate reflection of the species current status.
2. We have obtained a small amount of new information that we have summarized in Addendum 1, received no new public comments, and the original five factor analysis remains an accurate reflection of species current status.