

**Diablito de Tres Cuernos or Vahl's Boxwood  
(*Buxus vahlii*)**

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

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



**Photos by Frank Suárez (UPRM)**

**5-YEAR REVIEW**  
**Diablito de tres cuernos or Vahl's boxwood (*Buxus vahlii*)**

**I. GENERAL INFORMATION**

- A. Methodology used to complete the review:** On April 9, 2010, the Service published a notice in the *Federal Register* (75 FR 18232) announcing the 5-year review of Vahl's boxwood or diablito de tres cuernos (*Buxus vahlii*) and requested new information concerning the biology and status of the species. A 60-day comment period was opened; however, no information on Vahl's boxwood was received from the public during the comment period.

A cooperative agreement between the Service and the University of Puerto Rico, Mayagüez campus (UPRM), was signed to gather and summarize new information on Vahl's boxwood. The UPRM reviewed available literature, consulted with specialists, and examined herbarium data, including specimens from University of Puerto Rico at Mayagüez (MAPR), Río Piedras Botanical Garden (UPR), University of Puerto Rico at Río Piedras (UPRRP), Department of Natural and Environmental Resources of Puerto Rico (SJ), New York Botanical Garden (NY), US National Herbarium (US), and University of Illinois (ILL). In addition, they visited Vahl's boxwood populations in the municipalities of Rincón, and Isabela on December 18 and 26, 2010, respectively. Under this agreement, Dr. Duane A. Kolterman and Dr. Jesús D. China experts on plants including Vahl's boxwood prepared a draft review. Service biologists then completed the 5-year review and assessed and determined the appropriate status recommendation for the species.

**B. Reviewers**

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

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

**C. Background**

- 1. Federal Register Notice citation announcing initiation of this review:** April 9, 2010; 75 FR 18232.
- 2. Species Status:** Stable. No changes in the species' status have been reported in the past year.

3. **Recovery Achieved** 1 (1=0-25% of species' recovery objectives achieved).

4. **Listing History**

Original Listing

FR notice: 50 FR 32572

Date listed: August 13, 1985

Entity listed: species

Classification: endangered

5. **Associated rulemakings:** Not Applicable.

6. **Review History:**

A species' review was conducted for Vahl's boxwood 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 Vahl's boxwood listing classification was found to be appropriate.

The August 13, 1985 final rule (50 FR 32572) and the Vahl's Boxwood Recovery Plan, approved and signed on April 28, 1987 (US Fish and Wildlife Service 1987), are the most comprehensive analyses of the species' status and are used as the reference point documents for this 5-year review.

Recovery Data Call: 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, and 2012.

7. **Species' Recovery Priority Number at start of review (48 FR 43098):** 11.

At the time of listing, Vahl's boxwood was recognized as a species with a moderate degree of threat and a low recovery potential.

8. **Recovery Plan:**

Name of plan: Vahl's Boxwood (*Buxus vahlii*) Recovery Plan

Date issued: April 28, 1987

## II. Review Analysis

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

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 the DPS policy is not applicable to plant species, it is not addressed further in this review.

### B. Recovery Criteria

1. **Does the species have a final, approved recovery plan containing objective, measurable criteria?** Yes, the species has an approved recovery plan (USFWS 1987). However, the plan establishes downlisting as the recovery objective and does not contain measurable recovery criteria for delisting. In addition, it does not define the number of individuals needed for a sustainable population.
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. The plan does not include up-to-date information about the species' distribution. At the time of listing, the species was considered endemic to Puerto Rico but it is now also known from St. Croix. Knowledge about its distribution and *ex-situ* individuals has expanded.
  - 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 threat)?** Not completely. The plan does not consider the historical and currently known distribution of the species. The distribution of the species is currently known to extend to the southern coast of Puerto Rico (Ponce) and to the USVI (St. Croix). Therefore, the full genetic diversity of the species is not accounted for as part of the recovery plan. Natural populations from those areas must be protected and this task should be included as part of a revised recovery plan.
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 Plan specifies that Vahl's boxwood could be considered for reclassification to a threatened species when:

1. the two known populations at Hato Tejas (Bayamon) and Punta Higüero (Rincon) are placed under protective status, and
2. at least three new populations capable of self-perpetuation have been established within protected units of the Commonwealth Forest System in the karst region (e.g., Vega or Cambalache forests).

The Plan specifies that these must be considered minimum requirements, and should be expanded upon if the regenerative or propagative potential of natural and *ex situ* populations proves to be insufficient. On the other hand, if new populations of the species are discovered, it may be preferable to place greater emphasis on protection, rather than propagation, to achieve a minimum number of plants.

Criterion 1 has not been met. The populations at Punta Higüero and Hato Tejas remain within areas that are not managed for conservation. The ownership of the Hato Tejas population remains unknown despite the fact that it was proposed to be transferred to the Puerto Rico Department of Natural and Environmental Resources by Levitt Homes Puerto Rico (Lebrón and Associates 1992). The Punta Higüero population lies within a land area managed by the Puerto Rico Electric and Power Authority (PREPA). However, they do not manage this area for conservation and the boundaries of this property are not clearly defined.

Criterion 2 has been partially met. Two new populations have been planted, one in the northern karst region (Guajataca Forest) and the other in the south region (El Convento) of Puerto Rico. The new population established in the Guajataca Commonwealth Forest consists of approximately 25 individuals and it was planted in 2009. However, the current status of this population is unknown since monitoring is lacking. The other population was planted in 2011 in El Convento Reserve (a property owned and managed for conservation by the Puerto Rico Conservation Trust) and consists of 22 mature individuals. Although this area was not included in the Recovery Plan as an introduction site, El Convento is part of the currently known range for the species, it has suitable habitat for the species and the area is managed for conservation. Furthermore, the Service has several agreements with the Puerto Rico

Conservation Trust to establish populations of federally listed species, including *B. vahlii*, within their properties. The effort at the El Convento Reserve is part of one of these agreements.

Currently overall, we know of nine populations with over 4000 individuals estimated. This reflects an increase since the time of listing; however, only one population lies within an area managed for conservation. The introduction sites at El Convento and Guajataca (not currently naturally occurring populations) are both on protected areas. Survival seems to be good at these locations but monitoring is needed to document recruitment.

## 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

Carrero (2001) studied the population and reproductive biology of *B. vahlii*. She identified six populations: one in Rincón, one in Isabela, two in Bayamón, Puerto Rico, and two on St. Croix, US Virgin Islands (Table 1; Figure 1.). She provided a rough estimate of the populations size as part of her study: Rincón (700 individuals (ind.), Isabela (1,000 ind.), Bayamon - "Parque de las Ciencias" (21 ind.), St. Croix - "Frederiksted" (1,000 ind.), and St. Croix - "Christiansted" (undetermined or number of individuals unknown). The population at Hato Tejas Ward in the municipality of Bayamon was estimated to be at least 1,280 individuals by Lebrón and Associates (1992). Since then, an additional population was discovered on St. Croix (Rudy O'Reilly, NRCS; pers. comm. 2011; approximately 10 ind.). Also, there is a new site for the species between the municipalities of Peñuelas and Ponce in southern Puerto Rico (former Gasoducto Sur alignment; CSA Group 2007). The estimated number of individuals at this site is about 370 plants of different size classes. Since this study was limited to the area corresponding to a proposed gas pipeline, it is expected that further individuals or populations may occur on adjacent areas. There is further information about a new population composed of at least 100 individuals by Encarnación Ward in the municipality of Peñuelas (José Sustache, PRDNER; pers. comm. 2011.). This population is located within the boundaries of a rock quarry (Cantera Valdivieso). Based on the above information, the estimated number of individuals of *B. vahlii*

is about 4,500 individuals (including seedlings) in nine natural populations (Table 1).

Table 1. Known natural populations of Vahl's boxwood

<b>Vahl's boxwood populations</b>	<b>Number of individuals*</b>	<b>Reference</b>
Bayamón 1 (Hato Tejas)	1280	Carrero 2001; Lebrón & Associates 1992
Bayamón 2 (Parque de las Ciencias)	21	Carrero 2001
Isabela (Guajataca Forest)	1000	Carrero 2001
Peñuelas (Cantera Valdivieso)	100	Jose Sustache, PRDNER, pers. comm. 2011
Peñuelas-Ponce (Gasoducto del Sur)	370	CSA Group 2007
Rincón	700	Carrero 2011
St. Croix 1 (Christiansted)	Undetermined	Carrero 2011
St. Croix 2 (Frederiksted)	1000	Carrero 2011
St. Croix 3 (Undisclosed)	10	Rudy O'Reilly, NRCS, pers. comm. 2011
Total	4,481	

\* Includes seedlings

On December 18, 2010, the botanists from UPRM, and Service biologist Omar Monsegur visited the population of *B. vahlii* in the municipality of Rincón to assess its status and to look for individuals that had been tagged and measured between March 1992 and March 1993. At that time, Breckon and Kolterman (1993) reported 644 adult and juvenile plants (not including seedlings).

During the visit on December 18, 2010, UPRM botanists and the Service biologist observed that the area appeared to be less severely disturbed by direct human impacts and recent fire damage than it was nearly two decades ago. Plants of *B. vahlii* ranged from seedlings (plants < 10 cm in height) to plants over 3 m, but none reached 4 m. The plants, and particularly the seedlings, were often more or less clumped or clustered. In a visit of several hours, they counted a total of 331 adult and juvenile plants (over half the number of individuals that were tagged and measured on seven trips in 1992-1993) plus 43 seedlings. One plant was observed with

fruits. We also observed some plants that were partly or wholly dead, some whose trunks were split longitudinally partway, and some that were “reclining” (not erect). This may indicate damage due to hurricanes, human activities, or other causes (see threat analysis under Factor E.). In general, the Rincón population seems to be stable.

Most of the individuals observed on December 18, 2010 were untagged. Possible explanations include death of some plants and growth or regrowth of others, death of branches that bore the tags, and/or loss of the aluminum tags due to rusted wire as this population of *B. vahlii* is located on a slope facing the sea.

For 13 individuals of *B. vahlii* that were found with tags from 2002-2003, UPRM botanists estimated the height (m) and measured the stem basal diameter (cm) in order to determine the stem basal area (BA)(cm<sup>2</sup>) [ $BA = \pi (\frac{1}{2} d)^2$  for a cylindrical stem]. About half of the stems were more or less oval in cross section (cf. Castellanos (2008) who studied the architecture of plants from Rincón and Isabela), so two measurements were taken to determine the basal area:  $BA = \pi (\frac{1}{2} d_1) (\frac{1}{2} d_2)$ . Two of the individuals had two stems from the base, but for one of those plants only one of the stems was living; the other was dead (see below).

The height and basal area of these 13 individuals of *B. vahlii* fluctuated between 1992-1993 and 2010. In 1992-1993, the height ranged from 0.9 to 4 m (mean = 2.1 m, s.d. = 0.93); in 2010 the height ranged from 1.5 to 3.5 m (mean = 2.1 m, s.d. = 0.53). Seven individuals showed an increase in height and six individuals showed a decrease in height. However, there was no statistical difference in height over the past two decades ( $P = 0.977$ ). Similarly, in 1992-1993 the basal area ranged from 2.0 to 26.4 cm<sup>2</sup> (mean = 6.7 cm<sup>2</sup>, s.d. = 6.61), and in 2010, the basal area ranged from 1.2 to 9.7 cm<sup>2</sup> (mean = 4.4 cm<sup>2</sup>, s.d. = 2.16). Six individuals showed an increase in basal area and seven individuals showed a decrease in basal area. This difference might be due to an individual whose large main stem was found dead, and therefore, was not used to calculate the basal area in 2010. Still, neither was statistically different in basal area over the past two decades ( $P = 0.292$ ).

These data suggest that for *B. vahlii*, particularly the Rincón population, there is a considerable fluctuation in size and condition of plants at the individual level, but substantial overall stability at the population level.

On December 26, 2010, Dr. Duane Kolterman (UPRM) visited the Guajataca Commonwealth Forest in Isabela to reconfirm the existence of a population of *B. vahlii*. He found the population located just off one of the trails to the south of the forest and even found several tagged trees. This rather inaccessible area appears to be subject to very little human impact.

Neither the Service nor the UPRM staff visited the populations in Bayamón, Peñuelas-Ponce, or St. Croix. On August 25, 2011, Michael J. Morgan (pers. comm.) of the University of the Virgin Islands reported on the status of the St. Croix populations. He considers that *B. vahlii* might be more common and numerous on St. Croix than what people expect. He also indicated that the habitat has not been adequately surveyed.

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

Breckon and Kolterman (1993) documented some morphological differences between the Rincón and Isabela (Guajataca) populations, which they suggest may reflect genetic variation and/or environmental factors. However, there is no further information on genetics, genetic variation, or trends in genetic variation on the species.

**c. Taxonomic classification or changes in nomenclature.**

No recent taxonomic or nomenclatural changes are known for the species.

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

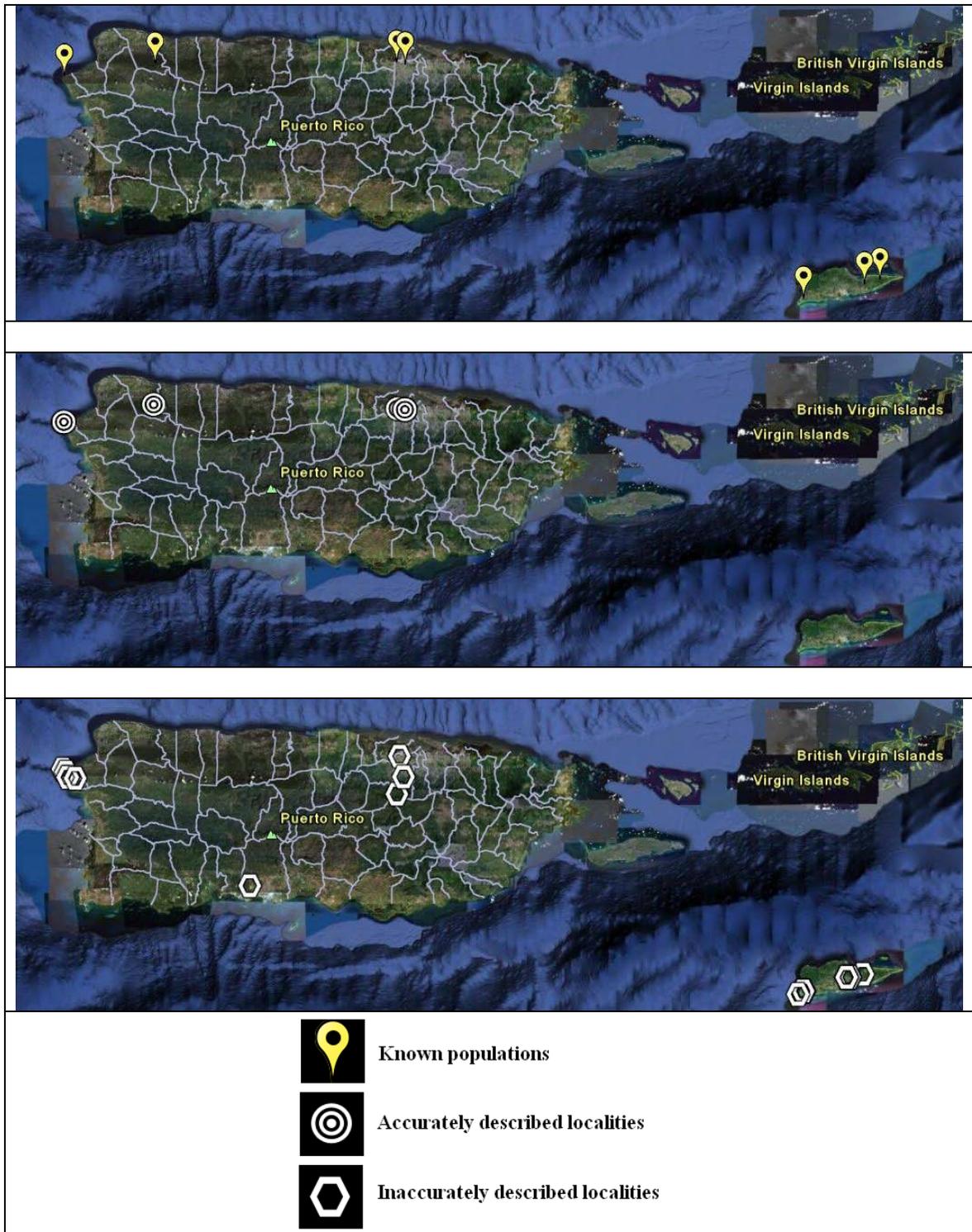
Vahl's boxwood is endemic to the islands of Puerto Rico and St. Croix, US Virgin Islands (Breckon and Kolterman, 1993). The first collection of this species is not known; it was first described by Baillon in 1859 (Vivaldi and Woodbury, 1981). Different specimens were collected by Eggers, Sintenis and Borgesen in Rincón, Puerto Rico, and St. Croix during the nineteenth century. In the early twentieth century, Haussen (1901) and Heller (1902) collected different specimens in St. Croix and Ponce, Puerto Rico, respectively (UPRM). Additional collections have been made during the twentieth century and new populations have been discovered in recent years at Ponce and Peñuelas (Gasoducto Sur

and Cantera Valdivieso) in Puerto Rico, and St. Croix (undisclosed) (Figure 1).

Plant specimens deposited in herbaria can be mapped using the information provided in their labels. UPRM staff used the point-circle method (Chapman and Wieczorek, 2006) that assigns coordinates for the location of the collection as well as an estimate of their uncertainty (in meters), based on the locality descriptions obtained from the specimen labels of such localities, to allow the creation of an accurate species' distribution map.

Specimens and population sites located with accuracies better than 300 m occur at elevations from 15 to 300 m above sea level on soils of the following series: Limestone outcrop, Tanamá, Colinas, Hesselberg clay, and Victory-Southgate complex; the latter is of volcanic origin while the rest originated from limestone bedrock or from other marine deposits. Other specimen localities with inaccurate locality descriptions (inaccuracies from 400 m to 19 km), were collected within Rincón, Bayamón, St. Croix and Ponce.

Probably as a result of unclear taxonomy, this species was considered as endemic only to the island of Puerto Rico and in only two locations: Rincón and Bayamón (Vivaldi and Woodbury 1981), even though Heller had collected it in Ponce in 1902. Breckon and Kolterman (1993) reported *B. vahlii* at two sites other than the one found in Ponce by Heller (1902): Isabela and St. Croix. Rather than expanding its geographic distribution, the finding by Breckon and Kolterman, and recent new records of the species likely suggest a lack of adequate botanical surveys for this species and the lack of examination of the available material at the herbaria.



**Figure 1. Reported localities for populations and specimens of Vahl's boxwood (*Buxus vahlia*). Accurate specimen localities are those with uncertainties below 300 meters. Map includes only information from herbarium specimens.**

#### **e. Habitat or ecosystem conditions**

The populations of *B. vahlii* in Puerto Rico and St. Croix occur primarily within the subtropical dry forest life zone and to a lesser extent the subtropical moist forest life zone (Ewel and Whitmore, 1973). Rainfall ranges from 600 to 1,100 mm (24-44 in.) per year in the subtropical dry forest and from 1,100 to 2,200 mm (44-88 in.) per year in the subtropical moist forest.

These Holdridge life zones are predominant in Puerto Rico and occupy areas that were extensively deforested for agriculture (Ewel and Whitmore 1973). So far all the known populations are associated with remnants of native vegetation within the subtropical dry forest life zone and subtropical moist forest life zone. This highlights the importance of protecting these types of habitat on areas adjacent to the currently known populations as these areas constitute possible areas for enhancement and reintroduction of the species and they may harbor undetected viable populations of *B. vahlii*.

#### **f. Other relevant information**

*Buxus vahlii* has been successfully propagated by PRDNER biologists at the Guajataca Commonwealth Forest (José René Román, Guajataca Commonwealth Forest manager, PRDNER, pers. comm. 2009). They documented a high germination rate on seed material collected at Rincón. Twenty-five individuals of *B. vahlii* were planted in the Guajataca Forest (PRDNER 2011). According to Duane Kolterman pers. comm. (UPRM 2011), Michael J. Morgan from St. Croix is in the process of setting up germination experiments using different pre-treatments.

The U.S. Fish and Wildlife Service have an ongoing agreement with the Puerto Rico Conservation Trust for the reintroduction of this species at El Convento property in Peñuelas. About 22 mature individuals of *B. vahlii* were planted in January 2011 at El Convento. So far all individuals have survived and at least one of the plants had fruits by early July 2011 (Omar Monsegur, Service, pers. obs. 2011.). The material used on this project was part of the original material propagated by José René Román (Guajataca Commonwealth Forest manager).

## 2. Five Factor Analysis

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

The population of *B. vahlii* at the Guajataca Commonwealth Forest and one of the populations in St. Croix occur in public lands that are managed for conservation under Puerto Rico and Federal jurisdiction, respectively. The Rincón population is located on land owned by PREPA (a public corporation) adjacent to the long defunct BONUS nuclear reactor. However, there is no evidence that PREPA manages the area in any way. There is no fence or other access limitations. Breckon and Kolterman (1993) documented damage to this area and to plants of *B. vahlii* due to the apparent incursion of undocumented aliens and to presumably anthropogenic fires. In the case of Rincón, the boundaries of the property are not clearly defined and it is not possible to determine if part of the population lies within private land. The properties adjacent to this population have a great potential for urban and tourism development, which could result in further encroachment of the population and the modification of suitable habitat for the expansion of the population.

For the Peñuelas-Ponce area the greatest threat is urban development (residential housing and hotels). All the populations within this area lie within private lands with no protection; the same applies to two of the St. Croix populations. The native forest that harbors one of the populations at Ponce has been severely fragmented for housing lots (Omar Monsegur, Service, pers. obs. 2011). Furthermore, the general area that harbors suitable habitat for the species between Ponce and Peñuelas has been proposed for the construction of several infrastructure projects (Gasoducto del Sur and Vía Verde Gas Pipeline). In fact, one of the populations at Peñuelas lies within the boundaries of a rock quarry (Cantera Valdivieso; José Sustache, PRDNER, per. comm. 2011).

Despite attempts to study its reproductive biology (cf. Carrero, 2001), the pollination and fruit dispersal mechanisms of the species have not been clearly documented. Therefore, the partial or complete extirpation of a population or habitat fragmentation due to urban development could have a serious impact upon the species' existence. Accordingly, we consider that *B. vahlii* is threatened by habitat destruction, modification, and fragmentation.

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

Taking for these purposes was not documented as a factor in the decline of the species in the final listing rule. The species may be affected by its cultivation potential (bearing in mind the extraordinarily widespread cultivation of innumerable cultivars of *Buxus sempervirens*). We have no evidence that *B. vahlii* has been used for such purposes. Furthermore, there is no evidence that it has been affected by overutilization for scientific, recreational, or educational purposes. Therefore, we continue to consider that the species is not threatened by this factor.

**(c) Disease or predation:**

At the time of listing, disease or predation was not considered a threat to the species. Based on the best available information, we continue to consider that the species is not threatened by this factor.

**(d) Inadequacy of existing regulatory mechanisms:**

The Commonwealth of Puerto Rico approved Law No. 241 in 1999, known as “Nueva Ley de Vida Silvestre de Puerto Rico” (New Wildlife Law of Puerto Rico, includes all listed species, including plants). 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 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). Vahl’s boxwood has been included in the list of protected species and designated as endangered under Regulation 6766. Under Article 2.06, this regulation prohibits collecting, cutting, removing, among other activities, listed plant individuals within the jurisdiction of Puerto Rico. This regulation extends to private lands as well, but enforcement on private lands continues to be a challenge. Furthermore, the Territory of the U.S. Virgin Islands considers *B. vahlii* to be endangered under the Virgin Islands Indigenous and Endangered Species Act (V.I. Code, Title 12, Chapter ), and has amended an existing regulation (Bill 18 – 0403) to provide for protection of endangered and threatened wildlife and plants by prohibiting the take, injury or possession of endangered plants.

Based on the presence of Commonwealth and State laws and regulations protecting *B. vahlii*, we believe that inadequacy of existing regulatory mechanisms should no longer be considered a threat to this species. However, it is important to note that enforcement on private lands continues to be a challenge as accidental damage or extirpation of individuals of endangered plants has occurred due to lack of knowledge of the species by private land owners. This is highlighted because *B. vahlii* is difficult to identify unless it is in fruit or the person (private land owner, law enforcement officers or biologist) have expertise on the species.

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

In the Caribbean, native plant species, particularly endemics with limited distribution, may be vulnerable to natural or anthropogenic events such as hurricanes and human-induced fires.

Human-Induced Fires. Fire is not a natural event in subtropical dry or moist forest in Puerto Rico and Virgin Islands. Thus, most species found in this type of forest are not fire-adapted. Human induced fires may lead to destruction of the native vegetation seed bank and may create conditions favorable for the establishment of exotic plant species (e.g., *Leucaena leucocephala* and *Megathyrus maximus*) that may outcompete *B. vahlii*. The *B. vahlii* populations that occur in Rincón, Peñuelas-Ponce, and St. Croix may be susceptible to forest fires, particularly on private lands where fire could be accidentally or deliberately ignited. Such damage has been observed in the Rincón population (Breckon and Kolterman 1993). Evidence of recent fires in the habitat and adjacent to known populations have been observed recently at Ponce (Omar A. Monsegur, Service, pers. obs. 2011). Thus, we consider human induced fires as a threat to the species. However, there is no direct evidence of fires affecting a population.

Hurricanes and Climate Change. Hurricanes and tropical storms frequently affect the islands of the Caribbean. The plants that were observed partly or wholly dead at Rincón had trunks that were split longitudinally partway, or were “reclining” (not erect), which suggest damage caused by hurricanes. As a species endemic to the central Caribbean, and with a rather widespread distribution in Puerto Rico and the U.S. Virgin Islands, *B. vahlii* should be well adapted to tropical storms, but observations in Rincón might suggest otherwise. Hence, cumulative effects of severe tropical

storms may jeopardize the Rincón population. Vahl's boxwood may be further threatened by climate change, which is predicted to increase the frequency and strength of tropical storms, which could possibly impact the Rincón and Sandy Point "St. Croix" populations. The cumulative effect of coastal erosion due to severe hurricanes, plus the habitat modifications for urban and tourism development can further diminish the availability of suitable habitat, and therefore, limit the population expansion and colonization of new areas at Rincón and St. Croix. In addition, the possibility of severe droughts may contribute to an increase in the quantity and frequency of fires on the Island. We have observed unusual shifts on dry and rainy seasons. In some cases these events have produced an overload of fuel (primary by exotic grasses) that when burned during the next dry season or drought produces severe damage to the native vegetation and seed bank.

The population dynamics of this species are poorly known and while we do not have enough information to determine what constitutes a viable population, we believe that the impacts discussed above could be detrimental to the species as a whole. Based on current information, we consider fires, hurricanes and climate change as a low and non imminent threat to the species.

### **3. Synthesis**

Vahl's boxwood is a federally listed, endangered species. Based on the information gathered, an estimated number of individuals for *B. vahlii* is about 4,500 individuals in nine natural populations in Puerto Rico and St. Croix, USVI. In addition, there have been two reintroductions of the species; in the north karst- Guajataca Commonwealth Forest and in the south area of Puerto Rico at El Convento (property owned by the Puerto Rico Conservation Trust).

Although the species has expanded its range and the number of natural individuals within the islands of Puerto Rico and the USVI, the species remains threatened by urban and tourist development. Despite the increase in the number of populations and the natural recruitment that is apparent in all of the populations, the reproductive biology of the species poses a limiting factor to the recovery of the species. *Buxus vahlii* have capsules with tiny seeds that depend on mechanical dispersal (explosion). Therefore, despite the number of populations and individuals, the recovery of the species remains uncertain as colonization and expansion of the populations to new areas is limited by its dispersal mechanism and the availability of suitable habitat.

In order to secure the recovery of the species, the Service needs to ensure that populations within the Ponce, Rincón and Bayamón area are protected from possible habitat destruction from urban development, and that the adjacent habitat to this plant receives protection (e.g., permanent conservation easement). This will safeguard the genetic pool of the species. Additionally, this effort should be accompanied by population enhancement that takes into consideration the genetics of the species. Once these actions are implemented along with other actions identified in the recovery plan, the species could be considered for reclassification to threatened status.

At this time, we believe that Vahl's boxwood continues to meet the definition of an endangered species. The species remains threatened by habitat destruction or modification because there are several proposed developments in the areas where the species occurs (tourism and urban development), which could result in further encroachment of populations and the modification of suitable habitat, limiting the expansion of those populations. Furthermore, we believe that natural and human induced factors including fires, hurricanes, and climate change may affect the continued existence of the species.

### III. RESULTS

**A. Recommended Classification:**

  X   No, no change is needed.

**B. New Recovery Priority Number:   5  .**

**Rationale:** The original recovery priority number identified a moderate degree of threat and a low recovery potential. However, the recently discovered populations within the southern coast of Puerto Rico and at St. Croix lie within private properties subject to high pressure for urban development. We consider that the forest and the prime habitat for the species may remain unprotected. These areas are subject to urban development and the inability to protect these areas may compromise the recovery potential of the species. Furthermore, these natural areas were not originally considered as part of the recovery plan for the species and they may account for an important part of the genetic diversity of the species.

Furthermore, this change is based on observations that there is almost no seed dispersal of the species within most of the known populations (seedling under parent trees). The reproductive biology of the species

poses a limiting factor as the species depends on mechanical dispersal (capsule explosion) of the seeds. Despite the evidence of recruitment and different size classes' further studies and monitoring are needed to determine if these constitute self-sustainable populations. Therefore, we now believe that a Recovery Priority Number of 5 (a high degree of threat and low recovery potential) is appropriate.

#### **IV. RECOMMENDATIONS FOR FUTURE ACTION**

1. The recovery of the species should focus on the protection of the known populations and its habitat. Conservation Agreements should be signed between the Service and private landowners to protect natural populations.
2. The land on which the Rincón population of *B. vahlii* occurs should be transferred from PREPA either to PRDNER or to the Puerto Rico Conservation Trust. Then, a management plan for the conservation of the species should be developed and implemented. The Service will start to advise PREPA on the benefits for the ecosystem and for the species by protecting this natural area.
3. The populations that are actively reproducing need to be identified and monitored to collect seed material for propagation purposes. A protocol to collect seed should be created and implemented to avoid altering the natural recruitment of the species.
4. The efforts by José R. Roman and Michael Morgan to germinate and to propagate the species need to be coordinated toward the recovery (ensuring that propagated material is used for the establishment and enhancement of populations) of the species.
5. The Bayamón, Peñuelas-Ponce, and St. Croix populations should be visited, and monitored on a regular basis; additional visits should be made after hurricanes, fires, or other major disturbances to determine their impacts on the populations.
6. The recovery plan should be revised to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species.
7. 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 germplasm.
8. Rincón has one of the most active “environmentalist” communities in Puerto Rico, which might well be recruited to assist in the species' conservation. In

fact, *B. vahlii* may well be the only endangered plant species with a major population located at Rincón, so it may be proposed as an iconic species for environmental education among school children and the general public at a local level.

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**U.S. FISH AND WILDLIFE SERVICE**  
**5-YEAR REVIEW of Diablito de tres cuernos or Vahl's boxwood (*Buxus vahlii*)**

Current Classification: Endangered

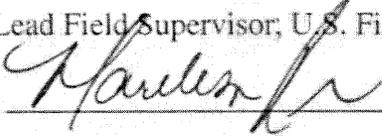
Recommendation resulting from the 5-Year Review:

  X   No change is needed

Review Conducted By: Omar A. Monsegur, Caribbean Ecological Service Field Office,  
Boqueron, Puerto Rico

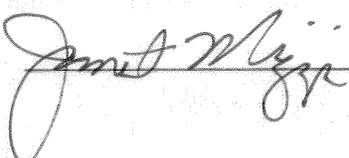
**FIELD OFFICE APPROVAL:**

Edwin E. Muñoz, Lead Field Supervisor, U.S. Fish and Wildlife Service

fi Approve:  Date: 12/13/2012

**REGIONAL OFFICE APPROVAL:**

Lead Regional Director, Fish and Wildlife Service

APZ Approve:  Date: 4/19/13