

Elaphoglossum serpens, *Polystichum calderonense*, *Tectaria estremerana*, *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis* Recovery Plan
U.S. Fish and Wildlife Service (USFWS). 1995. *Adiantum vivesii*, *Elaphoglossum serpens*, *Polystichum calderonense*, *Tectaria estremerana*, *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis* Recovery Plan. Atlanta, Georgia. 23pp.

Original Approved: 1995
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AMENDMENT 1

We have identified best available information that indicates the need to amend recovery criteria for *Elaphoglossum serpens*, *Polystichum calderonense*, *Tectaria estremerana*, *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis* since their recovery plan was completed in 1995. In this modification, we synthesize the currently available information, show amended recovery criteria, and provide the rationale supporting the recovery plan modification. The modification is shown as an addendum that supplements the recovery plan for *Elaphoglossum serpens*, *Polystichum calderonense*, *Tectaria estremerana*, *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis* superseding only Part II A. page 11. Recovery plans are a non-regulatory document that provides guidance on how best to help recover the species.

For
U.S. Fish and Wildlife Service
Atlanta, Georgia

Approved: Franklin J. Arnold
Acting Regional Director, U.S. Fish and Wildlife Service

Date: 9/24/19

METHODOLOGY USED TO COMPLETE THE RECOVERY PLAN AMENDMENT

The amendments to the recovery criteria are based on recent studies with the species and the information contained in the 2010 5-year status review for *Elaphoglossum serpens*, *Polystichum calderonense*, *Tectaria estremerana*, and in the 2015 5-year status review for *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis*. This information was analyzed by U.S. Fish and Wildlife Service (Service) biologists and managers in the Caribbean Ecological Services Field Office in order to develop the delisting criteria for *Elaphoglossum serpens*, *Polystichum calderonense*, *Tectaria estremerana*, *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis*.

ADEQUACY OF RECOVERY CRITERIA

Section 4(f)(1)(B)(ii) of the Endangered Species Act (Act) requires that each recovery plan shall incorporate, to the maximum extent practicable, “objective, measurable criteria which, when met, would result in a determination...that the species be removed from the list.” Legal challenges to recovery plans (see *Fund for Animals v. Babbitt*, 903 F. Supp. 96 (D.D.C. 1995)) and a Government Accountability Audit (GAO 2006) also have affirmed the need to frame recovery criteria in terms of threats assessed under the five listing factors.

Recovery Criteria

See previous version of criteria in [Elaphoglossum serpens, Polystichum calderonense, Tectaria estremerana, Thelypteris inabonensis, Thelypteris verecunda, and Thelypteris yaucoensis Recovery Plan](#) on page 11.

Synthesis

For *Elaphoglossum serpens*, *Polystichum calderonense*, and *Tectaria estremerana*, a 5-year status review was finalized and signed by the Service on January 1, 2010 and a second 5-year status review was completed for these species on July 7, 2017 (USFWS 2010, 2017). Both documents summarized the information gathered since these ferns were listed. For *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis*, the most recent 5-year status review was finalized and signed by the Service on May 12, 2015, and it summarized the information that was gathered since these plants were listed (USFWS 2015).

The epiphytic fern *E. serpens* is historically known from only two sites on the highest peaks of the Puerto Rico’s Central Mountain Range: Cerro Punta (elevation 4,390 ft (1,340 m)), and Monte Jayuya (elevation 4,314 ft (1,315 m)) (Proctor 1991). These peaks are located within the Toro Negro Commonwealth Forest (Proctor 1991) (USFWS 1995). Specific number of individuals for the population at Monte Jayuya has never been determined nor has it been visited since Proctor in 1991. For Cerro Punta, Proctor (1991) reported a population estimate of at least 22 individuals. Nevertheless, despite recent efforts in 2016 and 2017 by staff from the Fairchild Tropical Botanic Garden (Fairchild) and the Service, the species has not been found in Cerro Punta or Monte Jayuya (Possley and Lange 2016, 2017). It appears that activities related to the construction and maintenance of communication towers on these peaks has impacted the species’ habitat, abundance, and distribution (USFWS 2010, Monsegur-Rivera 2018, pers. comm.).

Polystichum calderonense is a terrestrial fern that when listed, was known only from the summit of La Silla de Calderon in the Guilarte Commonwealth Forest, and from a private property in Monte Cerrote, in the municipality of Peñuelas (Proctor 1991, USFWS 2010). For these two populations, Proctor (1991) reported 45 and 12 individuals, respectively. However, Jeanine Vélez (University of Puerto Rico, Mayaguez Campus) described a third population at the Summit of Monte Guilarte (pers. comm. as cited in Possley and Lange 2016), the fifth highest peak in Puerto Rico (elevation 3,934 ft (1,199 m)). Nevertheless, Possley and Lange (2017) surveyed the area and were unable to find any individuals. An average of 14 plants and recruitment were reported

at Silla de Calderon between 2014 and 2017 (Possley and Lange 2017). During these surveys, Possley and Lange (2017) along with Service staff noticed invasive plants species encroaching the area, and remnants of human induced fires just neighboring the *P. calderonenses* individuals. On both localities (i.e., Silla Calderon and Monte Guilarte) Possley and Lange (2017) also discovered pockets of suitable habitat for the species. The current status of *P. calderonense* at Monte Cerrote remains unknown. This area has not been surveyed since 1991.

Tectaria estremarana was known from only one population of 23 individuals within the Arecibo Observatory at the time of listing (USFWS 2015). However, no recent surveys have been completed at this site. In 1994, Frank Axelrod (University of Puerto Rico, Río Piedras Campus) reported the species on two other localities within the karst region: Río Abajo Commonwealth Forest in the municipality of Arecibo, and in a sinkhole near an old quarry in the municipality of Florida (USFWS 1995, USFWS 2010). In 2014, Possley and Lange (2016) surveyed the Río Abajo forest and nearby areas, finding 3 individuals near highway PR-10, and 1 individual near Finca Opiola (private property east of the Río Abajo Commonwealth Forest). The *T. estremarana* population from the municipality of Florida has not been visited since Axelrod's report. Axelrod stated this species might be a fertile hybrid between *T. incisa* and *T. cicutaria* (Axelrod 2011). Consistent with Axelrod's statement, material of *T. incisa* and *T. cicutaria* is usually present and abundant in areas where *T. estremarana* occurs (Monsegur-Rivera 2018, pers. comm.). Ferns are usually difficult to differentiate and can be easily confused, especially since many species show extreme morphological variability between individuals depending on habitat conditions (e.g., substrate, humidity and light), and many undergo hybridization (Possley 2016). Therefore, tissue samples of *T. estremarana* have been collected by Fairchild staff and sent for genetic analysis to the University of Florida (Possley and Lange 2017).

Thelypteris verecunda is known to occur on four private properties in the municipalities of Hatillo, Quebradillas, San Sebastian, and Camuy along the northwest karst region of Puerto Rico (USFWS 1995, Possley and Lange 2017). As of the most recent 5-year status review, 20 plants were known from the Bayaney Ward in Hatillo (Proctor 1991), and no estimates were provided for Quebradillas nor San Sebastian (USFWS 2015). Nevertheless, Possley and Lange (2017) visited the latter municipalities finding 4 plants at Charcas Ward in Quebradillas, and 6 plants at Salto Collazo in San Sebastian. Moreover, Possley and Lange (2017) conducted surveys around the perimeter of Sumidero Tres Pueblos in the Camuy Caverns Park, finding 8 individuals of *T. verecunda*. Similarities between *T. verecunda* and *T. reptans* raise questions whether *T. verecunda* is just a variant of *T. reptans* (Possley and Lange 2017). Thus, tissue samples were sent to the University of Vermont for DNA confirmation (Possley and Lange 2017).

Thelypteris yaucoensis is known from Los Tres Picachos in the municipality of Ciales, and from two other private properties in the municipality of Yauco: Pico Rodadero, Sierra Alta and at Rubias Wards. Current population estimates for each location is unclear, however, Proctor (1991) reported 65 individuals for all three sites. Nonetheless, Possley and Lange (2016) re-discovered the species at Pico Rodadero and documented about 59 plants of what seemed to be *T. yaucoensis*. Morphological similarities with *T. sclerophylla* pose taxonomical questions on the identity of *T. yaucoensis* (Possley and Lange 2016, 2017). Currently, tissue samples are being analyzed at the University of Florida (Possley and Lange 2017). The other two localities, Los Tres Picachos and Rubias Ward, have not been visited since 1991 and, therefore, their current

status remains unknown. Furthermore, it is unclear if the population of *T. yauconensis* at Los Tres Picachos lies within the boundaries of the area managed for conservation by the Puerto Rico Department of Natural and Environmental Resources. *Thelypteris inabonensis* is only known from two localities within the Toro Negro Commonwealth Forest: headwaters of Río Inabón, and Cerro Rosa, where 34 and 12 plants were reported by Proctor (1991), respectively (USFWS 2010). Neither of these populations have been visited since 1991 and, therefore, their current status is unknown.

These ferns are known to occur on medium to high elevation mountains (USFWS 2010, USFWS 2015) mostly on sites that exhibit mature vegetation with dense or closed canopies, which often promotes specific microhabitat conditions that are essential for their establishment (e.g., shaded conditions, moisture, humus and mossy substrate, high humidity level and moderate temperatures (USFWS 2010, USFWS 2015)). Therefore, habitat destruction or modification is one of the most conspicuous threats that these fern species may face, not only by individuals directly impacted, but often by changes in microhabitat, which also may favor establishment of exotic plant species.

Factor A (destruction, modification or curtailment of their habitat) and Factor E (other natural and manmade factors) (USFWS 2010) are current threats to these species. Although Factor B (overutilization for commercial, recreational, scientific or educational purposes) has been considered a possible threat to some of these fern species, due to their popularity among collectors, particularly *E. serpens* (Possley and Lange 2017), Factor B has been ruled out due to lack of evidence of collection, existing regulations preventing collection, and lack of knowledge by the public on species current location. Some populations occurring on private lands are threatened by development (i.e., *T. estremerama* and *T. yaucoensis*) and deforestation. Even populations occurring on protected land (e.g., Toro Negro, Guilarte, and Río Abajo Commonwealth Forests, and Camuy Caverns Park) face threats due to habitat modification activities such as unplanned forest management, trampling and terrain disturbance by hikers and all-terrain vehicle use or, in the particular case of *E. serpens*, maintenance of communication towers (Possley and Lange 2016). In fact, the Service has recorded evidence of impacts due to maintenance of communication towers, and the associated habitat intrusion by invasive exotic plants and human induced fires (USFWS 2012). Moreover, highly disturbed areas promote the colonization of exotic plant species (e.g., invasive ferns and weeds), which not only compete for resources, but also serve as fuel for fires. This is a concern especially at Pico Rodadero, and Toro Negro and Guilarte Commonwealth Forests, where human induced fire has been observed (USFWS 2010, USFWS 2015).

In addition to habitat modification, other natural or manmade factors (Factor E) such as hurricanes and landslides, possible low genetic diversity, and risks of hybridization are considered a potential threat to each of these species. Specifically, small population size and restricted distribution intensifies threats associated with stochastic or catastrophic events such as hurricanes. The effects of these threats are exacerbated by the fact that current status of many of these populations is unknown and there is no information to determine what constitutes a viable population.

AMENDED RECOVERY CRITERIA

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 short-leaved rosemary, Avon Park harebells, Garrett's mint, scrub mint, snakeroot, Highlands scrub hypericum, scrub blazing star, Lewton's polygala, wireweed, sandlace, Carter's mustard, and Florida ziziphus may be delisted. Delisting is the removal of a species from the Federal Lists of Endangered and Threatened Wildlife and Plants. Downlisting is the reclassification of a species from an endangered species to a threatened species. The term "endangered species" means any species (species, sub-species, or DPS) which is in danger of extinction throughout all or a significant portion of its range. The term "threatened species" means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Revisions to the Lists, including delisting or downlisting a species, must reflect determinations made in accordance with sections 4(a)(1) and 4(b) of the Act. Section 4(a)(1) requires that the Secretary determine whether a species is an endangered species or threatened species (or not) because of threats to the species. Section 4(b) of the Act requires that the determination be made "solely on the basis of the best scientific and commercial data available." Thus, while recovery plans provide important guidance to the Service, States, and other partners on methods of minimizing threats to listed species and measurable objectives against which to measure progress towards recovery, they are guidance and not regulatory documents.

Recovery criteria should help indicate when we would anticipate that an analysis of the species' status under section 4(a)(1) would result in a determination that the species is no longer an endangered species or threatened species. A decision to revise the status of or remove a species from the Federal Lists of Endangered and Threatened Wildlife and Plants, however, is ultimately based on an analysis of the best scientific and commercial data then available, regardless of whether that information differs from the recovery plan, which triggers rulemaking. When changing the status of a species, we first propose the action in the *Federal Register* to seek public comment and peer review, followed by a final decision announced in the *Federal Register*.

Amended Delisting Recovery Criteria:

The amended delisting criteria for *Elaphoglossum serpens*, *Polystichum calderonense*, *Tectaria estremarana*, *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis* are as follows:

1. Existing populations (number populations in parentheses) of *E. Serpens* (2), *P. calderonenses* (3), *T. estremarana* (3), *T. verecunda* (3), *T.inabonensis* (2) and *T. yaucoensis* (2) show a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected via a conservation mechanism (addresses Factor A and Factor E).
2. Establish or discover new populations (number of populations in parentheses) within the historical range of *E. serpens* (3), *T. inabonensis* (3), *T. yaucoensis* (3), *P calderonense*

- (2), *T. estremerana* (2), and *T. verecunda* (2) that show a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected via a conservation mechanism (addresses Factor A and
3. Threat reduction and management activities have been implemented to a degree that the species is viable for the foreseeable future (addresses Factor A and E).

Justification

Justification for criterion 1: All of these fern species occur in areas with specific habitat characteristics such as high humidity and moderate temperatures. Therefore, habitat protection either from development (private lands) or from ground disturbance (maintenance work or trampling from hiking on public land) is critical for their survival. Engaging with private landowners on conservation mechanisms will ensure the protection of high quality habitat for the species, and coupling this with Best Management Practices at public lands, the threat of habitat loss would be reduced to a point where it is no longer considered a threat. The protection of these natural populations is expected to result in an increase in the populations of *E. serpens*, *P. calderonense*, *T. estremerana*, *T. verecunda*, *T. inabonensis*, *T. yauconensis* and, therefore, this would result in an increase to their resiliency and representation, enabling them to withstand and rebound from stochastic and catastrophic events. Habitat and species population enhancement will be accomplished through agreements with landowners and with a monitoring plan to document recovery of the species. Progress towards meeting this criterion will be measured through a stable or increasing population trend, evidenced by natural recruitment and multiple age classes.

Justification for criterion 2: The second recovery criterion focuses on increasing the number of populations for each species, aiming to improve their representation and redundancy. In order to expand the species' distribution, these new populations will be established on suitable habitat similar to where natural population occurs and within their geographic range, and if necessary will represent populations that are currently on the verge of disappearing (small populations). Increasing the number of populations and broadening the species' distribution will enhance their ability to withstand catastrophic and stochastic events. This strategy will be met by implementing the germination and propagation protocols developed by the Fairchild staff.

Justification for criterion 3: Threat reduction and management activities are key to the successful recovery of each of these species. Competition from invasive plant species and impacts from wildfires are the most conspicuous threat for ferns on public and private lands. Implementing management actions to reduce fire threats to the maximum extent possible will not only reduce direct impact to the species and their habitat, but also will reduce invasive species colonization and associated competition. Hence, the species can spread to other areas as population growth and recruitment increases. On public land specifically, Best Management Practices and site-specific protocols are needed to reduce direct impacts to individuals or its habitats (e.g. proper signage, outreach initiatives, protocols for communication towers maintenance work).

Rationale for Recovery Criteria

The delisting recovery criteria reflect the best available and most up-to-date information on the biology, distribution, and habitat of *E. serpens*, *P. calderonense*, *T. estremerana*, *T. inabonensis*, *T. verecunda*, and *T. yaucoensis*. Each of these species is currently in danger of extinction due to habitat modification activities (Factor A) and other natural or manmade factors (Factor E) (e.g., low number of populations and low number of individuals, hurricanes, landslides, climate change, genetic drift, human induced fires and invasive species) (USFWS 2010, USFWS 2015). Habitat modification activities (Factor A) on privately owned properties (e.g., development and agriculture) and within areas managed for conservation (e.g., construction and maintenance of communication towers, unplanned management practices, trampling from hikers) are a major threat to each of these fern species. As mentioned above, these species have very specific habitat requirements needed to secure their natural recruitment and self-perpetuation. Therefore, we aim to protect those natural populations occurring on privately owned lands by engaging in long-term conservation mechanisms (e.g., land acquisition, conservation easements, and conservation agreements with landowners) and, as needed, replicate and establish new populations within suitable habitat in areas already managed for conservation. For those populations occurring on land managed for conservation, we aim to augment the number of individuals to a level that the species shows viability (resiliency, redundancy and representation), and to reduce or eliminate those threats related to Factor E.

The purpose of having five resilient populations, including natural and newly established, within areas managed for conservation for each of these species is to increase their representation and redundancy, which is hindered by their current low number of populations, small number of individuals, and restricted geographical distribution. For each of these species, we recommend establishing additional populations on protected land to compensate for those that may be lost due to habitat modification on privately owned properties. Site selection for population establishment should be determined based on the species' geographic range, habitat characteristics and species' needs, and similarity in current forest plant communities. Based on the reduced number of populations, low number of individuals, and the particular reproductive biology of ferns (e.g. spore transport, dependence of gametophyte phase to water), we expect a low genetic exchange among current existing populations. Thus, the protection and enhancement of those known localities is critical to maintain the genetic representation of the species. We recommend considering broadening all the species distribution into other nearby Commonwealth Forests or conservation areas, as it would increase their resilience, redundancy, and representation in the midst of a catastrophic or stochastic event (e.g., hurricanes, droughts, fires).

Considering all these factors, we recommend the following:

- The habitat of the two (2) known populations of *E. serpens* occurring on protected land (i.e., Cerro Punta and Monte Jayuya) need to be fully assessed, and populations enhanced to ensure their resiliency. Specifically, Possley and Lange (2017), and Service biologist O. Monsegur-Rivera recommend a more comprehensive survey that covers a wider area and expands away from the summit of Cerro Punta, a currently very disturbed area where the species was once found. Additionally, three (3) new populations of *E. serpens* should be established within the Toro Negro Commonwealth Forest or a similar protected habitat (e.g.,

Monte Guilarte), which genetically represent the known natural populations. Since this is an epiphytic plant, the protection of forest stands that harbor *E. serpens* common host trees, (e.g., *Lyonia Rubiginosa var. stahlii*), is also important in order to ensure the species' viability.

- For *P. calderonense*, the two (2) known populations within Guilarte Commonwealth Forest should be monitored and enhanced to ensure their resiliency. Also, the population within the private property at Cerrote de Peñuelas needs to be protected through long-term conservation mechanisms (e.g., conservation easements). In order to achieve five viable populations of *P. calderonenses*, two (2) new populations should be established within the Guilarte Commonwealth Forest or areas with similar habitat characteristics and forest plant species communities (e.g., Toro Negro Commonwealth Forest).
- The two (2) current *Tectarea estremarana* populations within private properties need to be protected through long-term conservation mechanisms. Also, the population found at the Río Abajo Commonwealth Forest should be monitored and enhanced to ensure its resiliency. Additionally, two (2) new populations should be established in properties managed for conservation within the species geographic range.
- *Thelypteris verecunda* occurs only on three (3) private properties within the northwest region of Puerto Rico. Therefore, all three populations need to be protected through long-term conservation mechanisms, and two (2) new genetically representative populations need to be established on protected land within its geographic range on suitable habitat for the species.
- The two (2) known populations of *T. inabonensis* occur within Toro Negro Commonwealth forest. Since this is protected land, we recommend these two populations need to be monitored and enhanced to ensure their resiliency. Additionally, we recommend the establishment of three (3) new populations also on protected land and within its geographic range.
- *Thelypteris yaucoensis* occurs on two (2) private properties within Yauco, and possibly, within protected land at Los Tres Picachos. However, if these two populations are not currently protected, they need to be protected through long-term conservation mechanisms. Additionally, three (3) populations should be established within areas already managed for conservation and within the species geographic range, or sites with similar habitat characteristics and forest plant communities.

An equally important recovery criterion is to eliminate or significantly reduce species threats due to other manmade and natural factors (Factor E), which threatens populations on both private and protected properties (e.g., maintenance work, fires, invasive species). Habitat modification activities within Commonwealth forests (e.g., accidental cutting and habitat alteration caused by maintenance work and ground disturbance by hikers) need to be addressed by educating maintenance workers about the species characteristics and by implementing Best Management Practices on trails and road maintenance activities. Additionally, fires, trampling, and other manmade threats can be addressed through public education (e.g., proper signage), and public outreach activities that increase public knowledge about listed species and their protection.

Furthermore, control or eradication of invasive weed and fern species are deemed essential to reduce resource competition, and to minimize fuels that feed wildfires. Therefore, the implementation of invasive species control protocols is needed to reduce the associated impacts. Moreover, a site-specific protocol should be developed and implemented to avoid or minimize detrimental effects of construction or maintenance work of telecommunication facilities and associated infrastructure on known populations of species within Commonwealth forests (e.g., Toro Negro Commonwealth Forest).

It is important to note that climate change and associated scenarios (e.g., more intense hurricanes, increase in temperature, changes in precipitation) are a concern for species that have specific habitat requirements, such as high humidity and moderate temperatures (Khalyani 2016). It is predicted that precipitation will decrease faster in regions that receive more rain; such as the Puerto Rico's central mountains (Kahlyani 2016). These changes in precipitation and humidity will likely result in a change of life zones, affecting distribution of many plant species (Weaver and Gould 2013, Kahlyani 2016). Such changes also can result in a shift of plant communities, increasing competition and displacement (USFWS 2015). Monitoring the species through time will help understand their population dynamics and status to inform management decisions.

ADDITIONAL SITE SPECIFIC RECOVERY ACTIONS

1. Genetic material from all species should be preserved through long-term spore storage and/or propagation efforts in institutions authorized by the Service. Priority species for this action are *E. serpens*, *P. calderoneneses*, and *T. inabonensis* because their taxonomy is not in question. This recovery action should be added to recovery action 33.
2. Establishing new populations outside the current range needs a monitoring and propagation protocol, and pilot studies to ensure appropriate planting sites. To be added to the recovery action 4 (41).
3. Since most agreements and conservation efforts are associated with other Service branches or partner organizations, careful planning for conservation and management needs to be developed and should include partners' education. To be added to recovery action 1 (14).
4. Implement fire and invasive plant species management and control protocols at disturbed areas. This should be added as a new action in the recovery plan.

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