Thelypteris inabonensis
(no common name)
Thelypteris verecunda
(no common name)
Thelypteris yaucoensis
(no common name)

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 19) for updated information on *Thelypteris inabonensis, Thelypteris verecunda,* and *Thelypteris yaucoensis*. The new signature page is included on page 29. What precedes this new information (pp. 2-17) is the 5-year review announced in September 27, 2006 (71 FR 556545) and completed and signed in 2015.

5-YEAR REVIEW

***Thelypteris inabonensis* (no common name)**
***Thelypteris verecunda* (no common name)**
***Thelypteris yaucoensis* (no common name)**

I. GENERAL INFORMATION

A. Methodology used to complete the review

On September 27, 2006, the U.S. Fish and Wildlife Service (USFWS) published a notice in the *Federal Register* (71 FR 56545) announcing the 5-year review of the ferns - *Thelypteris inabonensis, Thelypteris verecunda,* and *Thelypteris yaucoensis,* and requesting new information concerning the biology and status of these species. A 60-day comment period was also opened. No comments were received from the public during this period.

This 5-year review was prepared by the lead Service recovery biologists for these species and summarizes the information that the Service has gathered on these species since the ferns were listed in1993 (58 FR 35887). The sources of information used for this review included the listing rule and recovery plan for these species, peer-reviewed literature, personal communications with qualified biologists and experts on these species.

We did not seek additional peer review on this 5-year review since Service biologist Omar Monsegur is the leading expert on these ferns and other plants that share habitat with *Thelypteris inabonensis, Thelypteris verecunda* and *Thelypteris yaucoensis*. Therefore, we believe we have gathered the best available information on these species for this review. No part of this review was contracted to an outside party.

B. Reviewers:

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C. Background

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

2. **Species Status:** Unknown. The status and distribution of *T. inabonensis, T. verecunda and T. yaucoensis* have not been re-evaluated since 1995 (USFWS 1995). In fact, little information regarding abundance and distribution of the three species was known at the time the recovery plan was signed in 1995. *Thelypteris inabonensis* was known from 46 individuals in two localities in the Toro Negro Commonwealth Forest (Proctor 1991, USFWS 1995). *Thelypteris verecunda* was known to occur in three privately owned lands in the municipalities of Hatillo, Quebradillas and San Sebastián. In 1991, Proctor reported about 20 plants in Bayaney Ward in the municipality of Hatillo (Proctor 1991). However, individuals at Charcas Ward in Quebradillas and Cidral Ward in San Sebastián are known from collections, and no current data on these populations is available (USFWS 1995). *Thelypteris yaucoensis* was known to occur in two localities in the municipality of Yauco and in Los Tres Picachos in the municipality of Ciales. Approximately 65 individuals have been estimated from these three sites (Proctor 1991).

The natural populations of the three species have been poorly monitored; therefore, their current status is unknown since 1995.

3. **Recovery Achieved:** 1 (1 = 0-25% species recovery objectives achieved for each of the three *Thelypteris sp*).

4. **Listing History**

Original Listing
FR notice: 58 FR 35887
Date listed: July 2, 1993
Entity listed: species
Classification: endangered

5. **Associated rulemakings:** None.

6. **Review History:**

The Final Rule (58 FR 35887) determining *T. inabonensis, T. verecunda, and T. yaucoensis* as endangered under the Endangered Species Act (Act) of 1973, as amended (ESA), was published in 1993. The Recovery Plan, including seven endemic fern species (*Adiantum vivesii, Elaphoglossum serpens, Polystichum calderonense, Tectaria estremerana, Thelypteris inabonensis, Thelypteris verecunda*, and *Thelypteris yaucoensis*), was signed January 17, 1995 (USFWS 1995). These documents are the most comprehensive analyses of the

species status, and were used as the reference point documents for this 5-year review.

Thelypteris inabonensis is known from two localities, both in wet montane forests at high elevations in the Toro Negro Commonwealth Forest. The species was described in 1985 from specimens collected at the headwaters of the Río Inabón in the municipality of Ponce (Proctor 1989), and the summit of Cerro Rosa in the municipality of Ciales (Proctor 1991). *Thelypteris inabonensis* was described as a small terrestrial fern with erect arching fronds reaching approximately 24 in (60 cm) in length. It differs from all other Puerto Rican *Thelypteridae* fern species on the presence of scales and acicular hairs on the rachis (Proctor 1989). *Thelypteris inabonensis* grows along stream banks in sierra palm (*Prestoea montana*) forests, and mossy forests with sierra palms in deeply-shaded humus near the summit area (3,674.5-4,121 ft (1,120-1,250 m) within the lower montane forest life zone (Ewel and Whitmore 1973). Only 46 plants of *T. inabonensis* have been documented in the Toro Negro Commonwealth Forest (Proctor 1991).

Thelypteris verecunda is a terrestrial fern found at three localities in privately owned lands in the municipalities of Quebradillas, Hatillo, and San Sebastián. The species was described in 1985 from specimens collected from Charcas Ward in the municipality of Quebradillas (Proctor 1989), Bayaney Ward in Hatillo, and Cidral Ward in SanSebastián. *Thelypteris verecunda* has creeping, 0.079-0.118 in (2-3 mm) thick rhizomes with fertile linear blades, 5.12-5.91 in (13-15 cm) long and truncated at the base (Proctor 1989). *Thelypteris verecunda* grows in moist, shaded, limestone ledges at middle elevations (65.17 ft) (200 m) within the semi evergreen forests of the subtropical moist forest life zone (Ewel and Whitmore 1973). About 20 plants are known from the Bayaney Ward (Proctor 1991). However, the number of plants at Cidral Ward is not known.

Thelypteris yaucoensis is a terrestrial fern known from high elevations at Los Tres Picachos in the municipality of Ciales and two localities in the municipality of Yauco. The species was described in 1985 from specimens collected at Rubias Ward in Yauco (Proctor 1989), but it is also known from Los Tres Picachos, Toro Negro Ward in Ciales, and the summit area of Pico Rodadero, Sierra Alta Ward, in Yauco. *Thelypteris yaucoensis* has creeping, 0.02 in (0.05 mm) thick rhizomes with oblong blades, 9.8 – 12.2 in (25 – 31 cm) long and truncate at the base (Proctor 1989). *Thelypteris yaucoensis* grows in humus on steep, shaded, rocky banks and ledges at high elevations (2,624.7 to 3,937 ft) (800 to 1,200 m)) within the subtropical moist

forest life zone (Ewel and Whitmore 1973). Proctor (1991) estimated about 65 plants at these three sites.

Every year the Service reviews the status of listed species and updates species information in the Recovery Data Call (RDC). The RDC for *T. inabonensis*, *T. verecunda*, and *T. yaucoensis* was completed in 2014. No surveys have been conducted to verify the status of the tree species (i.e., presence, abundance, and distribution) since 1995.

Recovery Data Call: 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013 and 2014.

7. Species' Recovery Priority Number at start of review (48 FR 43098): 5. At the time of listing, *T. inabonensis*, *T. verecunda*, and *T. yaucoensis* were recognized as species with a high degree of threat and a low recovery potential.

8. Recovery Plan:
Name of plan: Puerto Rican Endangered Ferns Recovery Plan
Date issued January 17, 1995.

II. REVIEW ANALYSIS

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

The ESA defines species as including 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 will not be addressed further in this review.

B. Recovery Criteria

1. Does the species have a final, approved recovery plan containing objective, measurable criteria? The multi-species recovery plan which includes *Elaphoglossum serpens*, *Polystichum calderonense*, *Tectaria estremerana*, *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis* established reclassification from endangered to threatened status as the recovery objective. The recovery plan also gives four criteria that must be considered to downlist the seven Puerto Rican endangered ferns. However, one of these criteria is not measurable. The Service does not have sufficient information to determine the number of populations and individuals per population to delist these species. Therefore, these criteria are difficult to meet. Recovery actions identified to help reverse the decline of these ferns include the protection of existing populations and their habitats,

establishment of new populations at other appropriate protected sites and appropriate studies of the life history of these species.

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. Although the plan did include the best available information at the time it was written, that information was general and did not reflect in-depth knowledge of the biology and status of the species. Biological, habitat and spatial distribution studies are needed to better understand the status and habitat requirements of the three fern species.

b. Are all the 5 listing factors that are relevant to the species addressed in the recovery criteria? Yes. When the recovery plan was approved, these species were threatened by Factors A, D, and E. The recovery criteria are relevant to addressing these threats.

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

The recovery plan for *T. inabonensis*, *T. verecunda*, and *T. yaucoensis* indicates that the three ferns could be considered for reclassification from endangered to threatened status when the following criteria are met:

1. The known populations are placed under protective status;
2. An agreement between the Service and the Puerto Rico Department of Natural Resources (PRDNER) concerning the protection of the three fern species in Commonwealth Forests has been developed and implemented; and
3. New populations (the number of which should be determined by appropriate studies) capable of self-perpetuation have been established within protected areas.

Criterion 1 has been partially met. The PRDNER has acquired part of the acres within Los Tres Picachos. However, it is not known if the population of *T. yaucoensis* falls within the already-protected area of Los Tres Picachos (J. Sustache, PRDNER, pers. comm., 2008). As for *T. inabonensis*, this species is only known from two localities within the Toro Negro Commonwealth Forest, and the available information for *T. verecunda* indicates this species still found in privately owned lands.

Criterion 2 has been partially met. Although a specific plan for protection of these Puerto Rican endangered ferns within the Commonwealth Forests does not exist, other mechanisms to protect and recover the species in Toro Negro Commonwealth Forest and Los Tres Picachos are currently in place. These Commonwealth Forests are managed by the PRDNER for conservation of fish and wildlife resources, including federally listed species (PRDNER 1976, Commonwealth of Puerto Rico executive order OE-199-10 February 16, 1999). The PRDNER listed these ferns as endangered (PRDNER 2004), and included them in their list of critical elements. This is a special designation for species of concern for the PRDNER. The PRDNER scrutinizes in more detail those proposed actions that may adversely affect listed species and critical elements and their habitat within Commonwealth Forests and elsewhere they occur. Additionally, a Section 6 Cooperative Agreement under the ESA between the Service and PRDNER has been in place since 1983 to establish and implement an endangered species program in the Commonwealth of Puerto Rico.

Criterion 3 has not been initiated. At present, propagation of these ferns have not been attempted. These species have not been surveyed since 1991, except for one visit a Service biologists conducted in 2009 to Pico Rodadero to search for *T. yaucoensis*, which was not found. Additionally, there is no information about the minimum number of individuals needed per population, species' habitat requirement, and phenology. Therefore, until population dynamics of these species are studied and we have enough information to determine what constitutes a viable population, this criterion will not be met.

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. There is no new information currently available on population trends and demographic features for any of the three species.

b. Genetics, genetic variation, or trends in genetic variation (*e.g.*, loss of genetic variation, genetic drift, inbreeding, etc.). No information on the genetic variability within these species was found during this review, but the restricted range and limited number of individuals reported at the time of listing would suggest a low level of genetic variation. Overall, the genetics, genetic variation, and trends of *T. inabonensis*, *T. verecunda* and *T. yaucoensis* are poorly known and no information on loss of genetic variation, genetic drift, etc., is currently available.

c. Taxonomic classification or changes in nomenclature. No new information regarding taxonomic classification or changes in nomenclature was found during this review.

d. Spatial distribution, trends in spatial distribution, or historic range. No new information regarding spatial distribution, trends in spatial distribution or historic range of these species was found during this review.

e. Habitat or ecosystem conditions . On January 30, 2009, Service biologists Omar Monsegur, Jorge Saliva, Carlos Pacheco and Carlos Díaz visited Pico Rodadero, one of the historically sites for *T. yaucoensis* to conduct a rapid assessment on the species. During this assessment, only the west side of the limestone outcrop was sampled and the species was not found. The east area of Pico Rodadero is more inaccessible and is covered by a closed forest. Based on the dominant vegetation at the top of the mountain, Service biologists believe that the east area is a potential habitat for *T. yaucoensis* and that the presence of this species is possible. (O. Monsegur, USFWS unpublished data 2009).

2. Five Factor Analysis

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

The Final Rule (58 FR 35887) and Recovery Plan (Service 1995) listed destruction and modification of habitat as the most significant factor that may affect the number and distribution of *T. inabonensis*, *T. verecunda*, and *T. yaucoensis*. *Thelypteris inabonensis* is only known to occur within the Toro Negro Commonwealth Forest, managed by PRDNER for conservation (PRDNER 1976). Given that the habitat on which this species depends is consider protected, human activities that may affect the species and its habitat have less probability to occur. Currently, Commonwealth laws and regulations are in place that extend protection to the species in and outside the forest boundary (See Factor D). When *T. inabonensis* was listed, forest management practices were identified as a threat to the species. However, based on the information gathered during this review, we do not believe destruction and modification of habitat is a threat to *T. inabonensis.*

The Final Rule further indicates that *T. verecunda* is only known from privately owned lands not managed for conservation in the municipalities of Hatillo, Quebradillas and San Sebastián. These

unprotected areas are more prone to urban development and agricultural practices. The Puerto Rico Planning Board classified Bayaney ward in the municipality of Hatillo and Cidral ward in the municipality of San Sebastián as Districts of General Agriculture (A-G). This classification allows agricultural development such as planting of agricultural products and cattle grazing. On the other hand, the Puerto Rico Planning Board classified Charcas ward in the municipality of Quebradillas as a District of Conservation Resource 1 (CR-1, the most restrictive for development, precluding tourist and residential development activities). This classification though, allows agricultural (e.g. cattle grazing) and rural developments.

Therefore, clearing or development in these areas could have adverse effects on *T. verecunda*. Due to this species extremely restricted geographical distribution and the information gathered during this review, the Service believes that destruction, modification or curtailment of habitat continues to be a threat for *T. verecunda*.

Thelypteris yaucoensis is only known from three localities: (1) Los Tres Picachos; (2) Rubias Ward; and (3) Pico Rodadero within the municipality of Yauco. At the time of listing, these three localities were in privately owned lands. In 1999, the PRDNER designated part of Los Tres Picachos as a Commonwealth Forest under an executive order (Commonwealth of Puerto Rico executive order OE-199-10 February 16, 1999). Thus, the habitat within Los Tres Picachos Commonwealth Forest will provide protection to the species if it is found there and human activities that may affect the species and its habitat have less probability to occur.

Thelypteris yaucoensis is also known to occur in Rubias Ward and the summit area of Pico Rodadero, Sierra Alta Ward in Yauco. Currently, Rubias Ward is known for its agricultural practices, the majority of the private lands located at this Ward have active coffee plantations. Although Pico Rodadero is a privately owned land, people have access to this mountain and often go hiking and drive ATVs throughout the property. Thus, the species can be affected by these practices due to habitat destruction (e.g., cattle grazing, agricultural practices, human induced fire). The low number of known individuals (i.e., 65 individuals within these three locations), and the restricted distribution of the species, makes it more susceptible to habitat modification, which could result in the elimination of the populations.

Based on the information gathered during this review, the Service believes that destruction and modification of habitat is not a current

threat for the population located at Los Tres Picachos and Toro Negro Commonwealth Forests. However, for the populations of Rubias Ward and Pico Rodadero, the Service believes that destruction, modification or curtailment of the species habitat continues to be a threat for *T. yaucoensis.*

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

The Final Rule states that taking for commercial or recreational purposes could become a threat to *T. inabonensis, T. verecunda,* and *T. yaucoensis* because they are attractive fern species that can be perceived as having ornamental value (58 FR 35887). At present, the Service is not aware that overutilization of these three species of fern for commercial or recreational purposes through collection for ornamental trade, has occurred, or is currently occurring. Additionally, Commonwealth regulations prohibit collection of plants and wildlife in forest lands without a permit and prohibits the collection of listed plant species in Commonwealth territory. We do not believe that locations of these species are known by the public. Therefore, based on the above information, we believe that this factor is no longer a threat for these fern species.

(c) Disease or predation:

The Final Rule states that disease and predation have not been documented as factors in the decline of *T. inabonensis, T. verecunda,* and *T. yaucoensis* (58 FR 35887). Based on the best available information, we continue to believe that this factor is not a threat to these ferns.

(d) Inadequacy of existing regulatory mechanisms:

Following listing, *T. inabonensis, T. verecunda,* and *T. yaucoensis* acquired protection under the Endangered Species Act of 1973, as amended. In 1999, the Commonwealth of Puerto Rico approved Law No. 241-1999 known as the *Nueva Ley de Vida Silvestre de Puerto Rico* (New Wildlife Law of Puerto Rico), as amended. The purpose of this law is to protect, conserve, and enhance both native and migratory 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 the Commonwealth of Puerto Rico). *Thelypteris inabonensis*, *T. verecunda*, and *T. yaucoensis* were included in the list of protected species and designated as "critically endangered" under Regulation 6766. This classification describes a species that "faces an extremely high risk of extinction in the immediate future." Article 2.06 of Regulation 6766 prohibits collecting, cutting, removing, among other activities, listed animals and plants within the jurisdiction of Puerto Rico.

The Commonwealth Forest Law (Law Num. 133-1975, as amended)or *Ley de Bosques de Puerto Rico* and Regulation 6769 , which regulates permits for communication facilities and constructions associated to electric and communication systems within Commonwealth forests, (*Reglamento 6769 d*e *Permisos Especiales para Uso de Comunicaciones y Edificaciones Asociadas a Sistemas Electrónicos de Comunicaciones en los Bosques Estatales*), further establishes criteria for the protection of threatened and endangered species such as the *Thelypteris sp*.

As mentioned above, *T. verecunda* and *T. yaucoensis* extend to private lands outside protected areas. Consequently, are more susceptible to be affected by habitat modification. The enforcement of laws and regulations within private properties continues to be a challenge as accidental damage or extirpation of individuals could occur due to lack of knowledge of the species by private landowners and law enforcement officers. However, at present we are unaware of any damage to any of these ferns on private properties. Therefore, based on the existence of Commonwealth laws and regulations protecting listed species, we believe that inadequacy of existing regulatory mechanisms is no longer a threat to these three species.

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

The Final Rule states that *T. inabonensis*, *T. verecunda*, and *T. yaucoensis* are more susceptible to natural disturbances such as hurricanes or landslides, because of their limited distribution (58 FR 35887).

Limited distribution

Thelypteris inabonensis, *T. verecunda*, and *T. yaucoensis* are vulnerable to extinction due to low population numbers and restricted

distribution (i.e., only 8 populations and 131 individuals historically reported), (Table 1). The low number of individuals and limited geographic range may also exacerbate their vulnerability to natural or anthropogenic events such as hurricanes, landslides, low genetic variation, and habitat modification, compromising the continued existence of the three species (USFWS1995).

Table 1. Summary of number of individuals of *Thelypteris inabonensis, Thelypteris verecunda* and *Thelypteris yaucoensis* per location at the time the recovery plan was approved, and current status per known populations (USFWS 1995).

Species: *Thelypteris inabonensis*			
Location	**# Individuals Known**	**Current Status**	**Source of Information**
Cerro Rosa, Ciales	12	Unknown	Proctor 1991 and USFWS 1995
Toro Negro Commonwealth Forest	34	Unknown	Proctor 1991 and USFWS 1995
Total	**46**		
Species: *Thelypteris verecunda*			
Location	**# Individuals Known**	**Current Status**	**Source of Information**
Bayaney Ward, Hatillo	20	Unknown	Proctor 1991 and USFWS 1995
Charcas Ward, Quebradillas	Known only from specimens collected	Unknown	Proctor 1991 and USFWS 1995
Cidral Ward, San Sebastián	Known only from specimens collected	Unknown	Proctor 1991 and USFWS 1995
Total	**20**		
Species: *Thelypteris yaucoensis*			
Location	**# Individuals Known**	**Current Status**	**Source of Information**
Rubias Ward, Yauco	65 individuals known from these three sites	Unknown	Proctor 1991 and USFWS 1995
Pico Rodadero, Yauco		Unknown	Proctor 1991 and USFWS 1995
Los Tres Picachos		Unknown	Proctor 1991 and

Commonwealth Forest			USFWS 1995
Total	**65**		

Low reproductive capacity

Little is known about the phenology, recruitment, and habitat requirement of *T. inabonensis*, *T. verecunda*, and *T. yaucoensis*. The limited amount of reported individuals and lack of data regarding their potential to naturally recruit (or propagate) are issues that need to be address. In the absence of knowledge on the reproductive capacity and habitat requirement of these species, it is difficult to predict their recovery after natural or anthropogenic events.

Human induced fire

Fire was not considered in the final listing rule as a factor that may affect the continued existence of these fern species. One of the locations of *T. yaucoensis* in Pico Rodadero is susceptible to human-induced fires, which are frequent in this southern portion of Puerto Rico. The rapid growth of exotic grasses after fire events in areas where *T. yaucoensis* occurs, is a threat because of competition. The accumulation of fuel from exotic grasses also increases the impact of fire. Because so few individuals of *T. yaucoensis* are known to occur in a limited area, its risk of extinction is extremely high. Although the Service and Puerto Rico Fire Department implements a fire-prevention and management program during the dry season, human-induced fires are still a problem during the dry season.

Based on the information gathered during this review, the Service believes that human induced fire is not a current threat for *T. inabonensis* and *T. verecunda*. However, for the population of *T. yaucoensis* located at Pico Rodadero, the Service believes that human induced fire continues to be a threat.

Genetic Variation

Given the limited geographic distribution of *T. inabonensis*, *T. verecunda*, and *T. yaucoensis*, it is highly likely that their genetic variability is low. In rare species like these ferns, genetic variation is very important because the loss of genetic variation can reduce the ability of these species to adapt to environmental changes. In addition, it may increase the susceptibility to diseases and pests. This is highlighted by the fact that these three species show a low number of populations with a low number of individuals. In order to

safeguard the remaining genetic diversity, the protection and monitoring of known adult individuals should be considered a high priority for the conservation of these species. Based on the above, we consider the potential lack of genetic variation as a possible threat to these species.

Hurricanes, Landslides and *Climate Change*

Hurricanes and tropical storms are atmospheric systems that frequently affect the islands of the Caribbean. Hurricanes contribute to shaping vegetation and ecosystem processes, being an important factor determining the structure and composition of biotic communities in Caribbean forests (Walker et al. 1991, Lugo 2000). As species endemic to the Caribbean, *T. inabonensis*, *T. verecunda*, and *T. yaucoensis* should be well adapted to tropical disturbance. However, as stated in the final rule, the low number of populations and individuals pose a threat to the species by making them susceptible to stochastic events such as hurricanes.

Additionally, heavy rains associated with tropical storms and hurricanes in the mountains of Puerto Rico often lead to landslides, which are part of the forest dynamics. A massive landslide in areas where these species grow would not only take out the adult ferns and their offsprings, but their habitats as well. Even a small landslide would provide an opening in the vegetation that would allow other plants (native or non-native, herbaceous or woody) to become established. Moreover, the frequency and severity is expected to increase due to climate change (Hopkinson et al. 2008).

Vulnerability to climate change impacts is a function of sensitivity and exposure to those changes, and the adaptive capacity of the species (IPCC 2007, Glick et al. 2011). Therefore, shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Numerous plant species in Puerto Rico survived the deforestation that occurred in the Island during the early 1930s. Some species, however, survived that deforestation and are now restricted to forests remnants. Climate change may alter or modify the microclimatic conditions of those remnants where *T. inabonensis*, *T. verecunda*, and *T. yaucoensis* occur. Under this scenario, these populations may be displaced or outcompeted by native or exotic species with wider environmental plasticity.

Due to the low number of populations and individuals of *T.inabonensis*, *T. verecunda*, and *T. yaucoensis*, the Service considers hurricanes, landslides, and climate change as threats to these species,

despite climate change is occurring gradually and the frequency of severe hurricanes in Puerto Rico is low.

D. Synthesis

Thelypteris is a group of ferns that consists of more than 100 species in the Caribbean. *Thelypteris inabonensis*, *T. verecunda*, and *T. yaucoensis* are endemic terrestrial ferns that were described in 1985 by G. Proctor. The available information indicates they are restricted to two or three localities in the central mountains and karst region of Puerto Rico at medium or high elevations (Table 1). Although other *Thelypteris* species are found in Puerto Rico, most have a wider distribution. The information available for these three species indicates they mainly occur in privately-owned lands, except for *T. inabonensis*, which has a small population in the Toro Negro Commonwealth Forest (municipality of Ponce), and *T. yaucoensis*, which has a small population in Los Tres Picachos (municipality of Ciales).

We believe that destruction and modification of habitat may threaten the survival and recovery of *T. verecunda*, and *T. yaucoensis* in private lands. There is no evidence that over-utilization for commercial, recreational, scientific, or educational purposes threatens these ferns. Similarly, disease and predation have not been documented as factors that pose a threat to these species. We believe that the inadequacy of existing regulatory mechanisms is no longer a threat to these three species. Evidence supporting lack of enforcement of regulations to protect these species, or governmental measures to prevent destruction of their habitat is absent. Although, we recognize that enforcement of laws and regulations within private properties continues to be a challenge as accidental damage or extirpation of individuals may occur due to lack of knowledge of the species by private landowners and law enforcement officers. Natural factors such as hurricanes, landslides or climate change, represent a threat to the three ferns. However, the Service considers them as moderate and non-imminent.

Based on the information gathered during this review, the Service believes that T. *inabonensis*, *T. verecunda*, and *T. yaucoensis* continue to be endangered.

III. RESULTS

A. Recommended Classification:

__X__ No change is needed

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Conduct a comprehensive status survey of these species to evaluate the abundance and distribution of *Thelypteris inabonensis, Thelypteris verecunda,* and *Thelypteris yaucoensis* in Puerto Rico. Surveys should include both traditional and non-traditional sites.

2. Once thorough surveys are conducted, a PVA would be needed to determine the number of self-sustainable populations needed to protect and delist these fern species.

3. Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of the species.

4. Efforts to protect populations within privately owned lands should be initiated to reduce habitat deterioration and promote sustainable land use practices.

5. Develop propagation techniques for *Thelypteris inabonensis, Thelypteris verecunda,* and *Thelypteris yaucoensis,* to establish new self- sustainable populations in protected areas.

V. REFERENCES

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis*

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

_____ **Downlist to Threatened**
_____ **Uplist to Endangered**
_____ **Delist**
__X__ **No change is needed**

Review Conducted By Xiomara Labiosa, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico, (787) 851-7297, extension 222.

FIELD OFFICE APPROVAL:

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

Approve Edwin Muñiz Date 2/24/2015

REGIONAL OFFICE APPROVAL:

Approve Aaron Valt Date 5-12-15

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

U.S. FISH AND WILDLIFE SERVICE
5-Year Status Review of

***Thelypteris inabonensis* (no common name),**

***Thelypteris yaucoensis* (no common name), and**

***Thelypteris verecunda* (no common name).**

Addendum 1: Summary of new information gathered since the 2015 5-Year Status Review.

I. GENRAL INFORMATION

A. Methodology used to complete the review

On June 23, 2021, the U.S. Fish and Wildlife Service (Service) published a notice in the Federal Register (86 FR 32965) announcing the five-year status review for *Thelypteris inabonensis*, *Thelypteris yaucoensis*, and *Thelypteris verecunda*. It requested new information and comments from species experts 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 for *Thelypteris inabonensis*, *Thelypteris yaucoensis*, and *Thelypteris verecunda* since the previous 5-year status review approved on May 12, 2015.

B. Reviewers

Lead Region: Carrie Straight, South Atlantic-Gulf and Mississippi Basin Region, Atlanta, GA (404) 679-7226.

Lead Field Office: Maritza Vargas and Marielle Peschiera, Caribbean Ecological Services Field Office (CESFO), Boquerón, Puerto Rico. Maritza_vargas@fws.gov and Marielle_peschiera@fws.gov

C. Background

1. **Federal Register Notice Citation Announcing Initiation of this Review:** June 23, 2021; 86 FR 32965.

2. **Review History:** The 2015 5-year status review recommended that *T. inabonensis*, *T. verecunda*, and *T. yaucoensis* continue to be endangered.

3. **Species' Recovery Priority Number at start of review (48 FR 43098):** 5. At the time of listing, *T. inabonensis*, *T. verecunda*, and *T. yaucoensis* were recognized as species with a high degree of threat and a low recovery potential.

4. **Recovery Plan:**
   Name of Plan: Puerto Rico Endangered Ferns Recovery Plan

Date issued: January 17, 1995

Amendment: Puerto Rico Endangered Ferns Recovery Plan Amendment
Date Issued: September 24, 2019

II. REVIEW ANALYSIS

B. Recovery Criteria

1. **Does the species have a final, approved recovery plan containing objective, measurable criteria?** Yes

2. **Adequacy of recovery criteria**
   a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? Yes

   b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria? Yes

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 amended recovery criteria to delist the species listed in the 2019 recovery plan amendment are below.

   1. Existing populations (number populations in parentheses) of *E. serpens* (2), *P. calderonense* (3), *T. estremerana* (3), *T. verecunda* (3), *T. inabonenis* (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 E)

   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).

   None of these criteria have been fully met, details about populations can be found in the 2015 review preceding this amendment and below.

C. Updated information and current species status is documented below.

1. Biology and Habitat

a. Is there relevant new information regarding the species' abundance, population trends (e.g., increasing, decreasing, stable), demographic features

(e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends? Yes

During 2016 and 2017, Fairchild Tropical Botanic Garden (FTBG) through a Cooperative Agreement with the Puerto Rico Department of Natural and Environmental Resources (PRDNER) and the Service, collected spores for long term storage and propagation of several fern species in Puerto Rico, including *Thelypteris verecunda* and *Thelypteris yaucoensis*. However, due to its remote location, *Thelypters inabonensis* was not surveyed. The work conducted by FTBG also included surveys to determine the status of those ferns, and collection of tissue samples for genetic studies.

Thelypteris inabonensis. The Service is unaware of any new surveys, assessments or any additional information of *T. inabonensis* since the last 5-year status review in 2015, which indicated that only 46 individuals of this species are known to occur within the Toro Negro Commonwealth Forest.

***Thelypteris verecunda*.** Similarities between *T. verecunda* and *T. reptans* have created uncertainty in the identification of individual plants. This uncertainty is addressed in section C.1.b. and C.1.c., below. Until more information is available clarifying the status of *T. verecunda* it will be treated as a distinct valid entity.

As of the previous 5-year status review, only 20 individuals of *T. verecunda* were known from the municipality of Hatillo, but no estimates were provided for the populations of Charcas Ward in the municipality of Quebradillas and Salto Collazo in Cidral Ward, in the municipality of San Sebastian (Table 1; USFWS 2015). In 2017, FTBG biologists visited these locations, identifying in Salto Collazo six individuals that appeared consistent with *T. abdita, T. reptans*, and/or *T. verecunda* (Table1; Possley *et al*. 2020). These were not located by the waterfall, but underneath an adjacent bridge. At Charcas Ward, they documented five individuals of what resembled *T. verecunda* (Possley and Lange 2017, USFWS 2019). Additionally, this species' range was extended to Camuy and Utuado, where eight individuals of what appeared to be *T. verecunda* were found at Sumidero Tres Pueblos in the Camuy Caverns Park (Possley and Lange 2017, USFWS 2019) and a single individual, of what seemed to be *T. verecunda,* at Angeles Ward in the municipality of Utuado (Table 1), about 4.5 km (2.8 mi) from the Camuy Caverns Park location (Llerandi 2017, pers. comm.). According to Llerandi (2017, pers. comm.), this individual was located in a disturbed cliff at a house backyard along with individuals of *T. reptans*. Although this location looked similar to the type locality (Charcas Ward, Quebradillas), Llerandi (2017, pers. comm.) stated this site seemed to be dryer than the species' location at Quebradillas and the Camuy Caverns Park.

Table 1. Summary of known abundance of *Thelypteris verecunda*.

Municipality - Population	1993 (listing)	2015 review	2021 review
Bayaney Ward, Hatillo	20	20	20
Charcas Ward, Quebradillas	unknown	unknown	5*
Salto Collazo, Cidral Ward, San Sebastian	unknown	unknown	6*
Camuy Caverns Park, Camuy	-	-	8*,**
Angeles Ward, Utuado	-	-	1*,**

* Individuals may be another species.

** New locations found in 2017.

Thelypteris yaucoensis. Similarities between *T. yaucoensi* and *T. asplenoides* have created uncertainty in the identification of individual plants. This uncertainty is addressed in section C.1.b. and C.1.c., below. Until more information is available clarifying the status of *T. yaucoensis* it will be treated as a distinct valid entity.

Thelypteris yaucoensis is known from Los Tres Picachos in the municipality of Ciales, and two locations in the municipality of Yauco: Pico Rodadero and Rubias Ward (Table 2). In 2016, Possley and Lange documented 59 individuals of what they thought was *T. yaucoensis* at Pico Rodadero. However, similarities between *T. yaucoensis* and *T. asplenioides* raised questions on the species identity (Possley and Lange 2017, USFWS 2019). In 2017, FTBG revisited the 2016 Pico Rodadero specimen, after Omar Monsegur collected a similar looking plant on Cerro Punta which keyed out to *T. asplenioides*. Since the 2016 specimens' upper surface of the frond was glabrous (as opposed to having "few to many" minute stellate hairs, per Proctor's key), they keyed out to be *T. asplenioides* and not *T. yacoensis* (Possley *et al*. 2020). The species' known location at Rubias Ward was not visited during the FTBG surveys in 2016-2017. Nevertheless, Service biologists on January 26, 2017 visited the site and reported that the habitat for the species was no longer suitable as there was evidence of landslides and debris deposited by humans throughout the area (Labiosa 2017). Photos taken during that site visit show the lack of canopy and the presence of dense stands of invasive vegetation. Nevertheless, they did recommend future searches for the species in nearby areas with better habitat conditions (Labiosa 2017). Efforts need to be made at Rubias Ward to expand survey areas to those with better habitat conditions.

Los Tres Picachos have not been visited since 1991, therefore the status of the species in that location is unknown.

Table 2. Summary of known abundance of *Thelypteris yaucoensis*.

Municipality - Population	1993 (listing)	2015 review	2021 review
Los Tres Picachos , Ciales		Unknown	Unknown
Pico Rodadero, Yauco		Unknown	Unknown

Municipality - Population	1993 (listing)	2015 review	2021 review
Rubias Ward, Yauco	65 individuals between all three locations	-	Unknown

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

New information on *T. verecunda* support the hypothesis that the species is of hybrid origin sharing parts of its genome with both *T. abdita* and *T. reptans* (Possley *et al.* 2020). As explained by Possley *et al.* (2020), *Goniopteris* (a genus of ferns in the family of Thelypteridaceae) is a very morphologically plastic group, and plants that have been described as *T. verecunda* may simply be within the natural range of variation within *T. reptans*. Nevertheless, some hybrids are capable of reproducing and evolve as a unique genetic lineage and, therefore, deserving protection.

No new information on the genetic variability of *Thelypteris yaucoensis* and *Thelyteris inabonensis* was found during this review. Overall, the genetics, genetic variation, and trends of *T. inabonensis*, *T. verecunda* and *T. yaucoensis* are still poorly known and no information on loss of genetic variation, genetic drift, etc., is currently available. Nevertheless, research is underway and will shed light on *T. verecunda* and *T. yaucoensis* genetic variation and, therefore, species identity.

c. Taxonomic classification or changes in nomenclature.

No new information regarding taxonomic classification or changes in nomenclature was found during this review. However, as stated above similarities between *T. yaucoensis* and *T. asplenioides* raised questions on *T. yaucoensis* identity. As for *Thelypteris verecunda* identity, new genetic information states that the species seems to be from hybrid origin, sharing parts of its genome with both *T. abdita* and *T. reptans* (Possley *et al*. 2020). As of 2020, genetic research at the University of Vermont and at the University of Florida were assessing these two species' genetic variation, which could change their taxonomic classification.

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

Thelypteris vercunda's range was extended from 4 known localities in the 2015 5-year status review, to 6 localities. This, after new individuals, which appeared to be *T. verecunda*, were found at at Sumidero Tres Pueblos in the Camuy Caverns Park (Possley and Lange 2017, USFWS 2019) and Angeles Ward in the municipality of Utuado (Llerandi 2017, pers. comm.).

Thelypteris yaucoensis 2017 survey efforts found that species known habitat within Rubias Ward, Yauco, was degraded and not suitable habitat. Nonetheless, better quality habitat nearby was identified. The Service suggest expanding efforts to habitat surrounded the known locality at Rubias Ward.

e. Other relevant information

No other relevant information for any of the species is currently known.

2. Five factor analysis

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

The stressors to these species continue to be the same described in the 2015 5-year status review (see pages 8-9 above).

Thelypteris inabonensis. This species is still only known from the Toro Negro Commonwealth Forest, a public and protected land managed for conservation by the PRDNER. Specifically, the known population is located at the headwaters of the Inabon River and Cerro Rosa, a remote area with no potential for urban development. The Service still considers Factor A is not a threat to this species as the habitat is remote and protected.

Thelypteris verecunda. Possley *et al.* (2020) identified deforestation and urban development as threats to the *T. verecunda* individuals in the municipalities of Quebradillas and San Sebastian. For example, at Salto Collazo in San Sebastian, any construction work on road PR-111 or improvements to a bridge found in that area could affect the *T. verecunda* individuals adjacent to the road. Nevertheless, since the 2015 5-year status review, no road improvements or development appear to have been conducted in the area as observed on Google Earth aerial images (2015-2021). The situation is similar to Salto Collazo at Charcas ward in the municipality of Quebradillas, where the species is found adjacent to roads and private properties with areas that have been cleared of vegetation as observed on Google Earth aerial images (2015-2021), and described by Possley *et al.* (2020), suggesting that development and road improvements could affect the species. Nonetheless, we have no recent evidence indicating that *T. verecunda* has suffered from those threats in that area.

A new population of *Thelypteris verecunda* also was found at the Camuy Caverns Park (Possley and Lange 2017, USFWS 2019). This park is owned and protected by the Commonwealth of Puerto Rico, with the only activity at the park being public guided tours to the caverns. The *T. verecunda* individuals at this location are found on steep cliffs close to a road. Thus, any road work or landslide resulting from heavy rains (e.g., from hurricanes) could affect them. Additionally, any activity associated to the cleanup and improvements of the park, for example, due to disturbances from hurricanes, particularly near roads, could have a direct impact on these individuals. Also, the single *T. verecunda* individual reported by Service biologist I. Llerandi in the municipality of Utuado (2017, pers. comm.), was found at a disturbed cliff in a private backyard, suggesting it could be affected by habitat modification.

Thelypteris yaucoensis. This species is known to occur on both protected and private lands. According to Possley *et al.* (2020), the individuals of this species at

Pico Rodadero, and other private lands, face the same threats stated in the 2015 5-year status review: deforestation and urban development (Possley *et al*. 2020). As explained in the previous 5-year status review, agriculture is still being conducted at Rubias Ward, which result in habitat modification. However, we do not have evidence of impacts from agriculture on these species. As for those individuals found at the summit area of Pico Rodadero, threats from activities like ATV riding, hiking, camping, and others already identified in the 2015 5-year status review, continue to threaten the species and its habitat.

b. Overutilization for commercial, recreational. Scientific or education purposes.
As in the 2015 5-year status review, this factor is still not identified as a threat to any of the three species.

c. Disease and predation
As in the 2015 5-year status review, this factor is still not identified as a threat to any of the three species.

d. Inadequacy of existing regulatory mechanisms its continued existence.
Since the previous 5-year status review, the Service has not received any information indicating this factor is a threat to neither of the three species. The three species are still protected under the same laws and regulations stated in the 2015 5-year status review. Additionally, the *Thelypertis verecunca* habitat at the Camuy Caverns Park is protected under the Puerto Rico National Parks System Act, Act No. 9 of April 8, 2001, as emended.

e. Other natural or manmade factors affecting its continued existence:
The natural stressors to these species continue to be the same as described in the 2015 5-year review (see pages 11-15 above).

Due to the limited distribution and low number of known individuals of the three fern species, we still identify the natural or manmade factors described in the 2015 5-year status review as threats to *Thelypteris inabonensis, Thelypteris verecunda*, *Thelypteris yaucoensis*.

The small population size and limited distribution is further exacerbated by severe weather events like hurricanes. Recently, two major hurricanes (i.e., Irma and María) struck Puerto Rico, severely affecting forested vegetation throughout the Island. Hurricane María moved across the island of Puerto Rico from the southeast to the northwest, with sustained winds of 155 miles/hour (250 kilometer/hour) (Pasch *et al.* 2017). An initial impact estimate indicated that Hurricane María may have cause mortality and severe damage to 23-31 million trees across the Island (Feng *et al.* 2018). Unfortunately, no post-hurricane assessments were conducted for the three fern species. Since these ferns are small and close to the ground they are not likely to be directly impacted by hurricane winds. However, the mortality of trees and, therefore, opening in the canopy, may cause changes in microhabitat conditions (e.g., temperature, humidity) (Lugo 2008) that may negatively impact their survival. Additionally, habitat disturbance associated to hurricanes promotes or accelerates the colonization of exotic and invasive plants species (Lugo 2008).

Such species can outcompete these ferns, which could have been be the case of the *Thelypteris verecunda* individuals at Rubias Ward and could also be the case with *Thelypteris yaucoensis* at Pico Rodadero. The later, caused mainly due to fires, which are common in the Pico Rodadero area, as observed in Google Earth aerial images (2019). Moreover, heavy rains caused by hurricanes sometimes result in landslides that affect those individuals in steep terrain as well as those on cliffs. For example, *T. verecunda* individuals located on roadside cliffs at the Camuy Caverns Park, can be impacted by landslides associated to heavy rainfall as well as those individuals located at Salto Collazo (San Sebastian), and the individual found at a disturbed cliff in Utuado. Also, evidence of landslides was observed by Service biologists at the location of *T. yaucoensis* in Rubias Ward (Labiosa 2017).

Ferns are also known to have high hybridization capacity (Sepúlveda-Orengo 2000), which makes them difficult to identify, increases their probability of being sterile or decreases their spore viability (Sepúlveda-Orengo 2000), and therefore makes them a conservation challenge. In fact, as explained above currently, *Thelypteris verecunda* and *Thelypteris yaucoensis* are being questioned as a true species or if they are just a morphovairant of a similar taxon.

D. Synthesis

Thelypteris inabonensis. *Thelypteris inabonensis* is only known from a population at the Toro Negro Commonwealth Forest. This population has not been visited since 1991 and, therefore, its current status is unknown, although its habitat is protected.

Thelypteris verecunda. Since the 2015 5-year status review, 12 new individuals of what appeared to be *Thelypteris verecunda* were found in the municipalities of San Sebastian, Quebradillas, and Utuado. Also, a new population of *T. verecund*a with other eight individuals presumably of this species was discovered at the Camuy Caverns Park, extending its range into protected land, and increasing its number of individuals and populations. Although surveys resulted in an increment in the number of individuals, and at least one additional population was found, the species continues to exhibit low numbers of individuals and low population numbers. The information gathered during this review suggests *T. verecunda* can be threatened by deforestation and development (Factor A) in San Sebastian, Quebradillas, and Utuado. Additionally, all populations can be affected by stochastic events such as landslides due to heavy rainfall (Factor E). Moreover, result of studies of *T. verecunda* suggest that the species may come from hybrid origin (*Possley* et al. 2020), nevertheless individuals of hybrid origin might still be a true species. Research is underway by Susan Fawcett at the University of Vermont to verify the species' genetics and taxonomy (Possley *et al.* 2020).

Thelypteris yaucoensis. *Thelypteris yaucoensis* is still only known from three localities (i.e., Los Tres Picachos in the municipality of Ciales, and Pico Rodadero and Rubias Ward in the municipality of Yauco), where, as of the 2015 5-year status review, only 65 individuals were known for the three locatiosn overall. In 2016, 59 individuals found at Pico Rodadero were later identified as another similar-looking species, *Thelypteris asplenioides*. Therefore, *T. yaucoensis* continues to exhibit low number of individuals in

three populations and continues to be threatened due to its small population size and limited distribution. Moreover, current human use of Pico Rodadero for hiking, ATVs and camping, increases the possibility of human induced fires, and therefore, threatens the species and its habitat. Since the last review, the population at Rubias Ward appears extirpated related to observed habitat degradation. Individuals at Los Tres Picachos have not been visited since 1991, therefore, no new information on this populations is known. Similar to *Thelypteris verecunda*, this species is being question as a true species or just a morphovariant of a similar taxon (Possley *et al.* 2020)

Based on the information gathered during this review, the Service believes that *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis* continue to be endangered.

III. RESULTS

A. Recommended Classification:

X No change is needed

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

Recommendations included in the 2015 5-years status review and the 2019 Amended Recovery Plan (USFWS 2019) still apply. Additionally, we recommend conducting assessments of the three species to determine status of individuals and species' habitat condition after hurricanes Irma and María.

V. REFERENCES

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Thelypteris inabonensis, Thelypteris yaucoensis,* and *Thelypteris verecunda.*

Current Classification: Endangered.

Recommendation resulting from the 5-Year Review:

No change needed

Review Conducted By: Marielle Peschiera, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

FIELD OFFICE APPROVAL FY 2021*

Field Supervisor, Caribbean Ecological Services Fish and Wildlife Service

Approve EDWIN MUNIZ Digitally signed by EDWIN MUNIZ Date: 2021.09.01 14:30:50 -04'00' Date _____

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