Helecho de Bosque Enano or Elfin Tree Fern
(*Cyathea dryopteroides*)

5-Year Review:
Summary and Evaluation

Photo by Omar Monsegur, U.S. Fish and Wildlife (2012)

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

5-YEAR REVIEW
Helecho de Bosque Enano or Elfin Tree Fern (*Cyathea dryopteroides)*

I. GENERAL INFORMATION

A. Methodology used to complete the review: On September 27, 2006, the U.S. Fish and Wildlife Service (Service) published a notice in the *Federal Register* (71 FR 56545) announcing the 5-year review of the Elfin tree fern. The notice requested new information concerning the biology and status of the species and a 60-day public comment period was opened. No information on the elfin tree fern was received from the public.

This 5-year review was prepared by the lead Service biologist and summarizes the information that the Service has gathered in the species' file since the plant was listed on July 16, 1987. The sources of information used for this review included the original listing rule, the recovery plan, distribution and status reports, peer-reviewed literature, unpublished field observations and reports, and personal communications with qualified biologists and experts on the species.

B. Reviewers

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

Lead Field Office: Carlos Pacheco, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico. (787) 851-7297, extension 221.

C. Background

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

2. Species Status: 2012. Uncertain. The status and distribution of the elfin tree fern has not been re-evaluated since 1981 (Proctor 1989). On February 29, 2012, Service biologist Omar Monsegur and Jorge E. Saliva, visited the area of Monte Jayuya in the municipality of Ponce finding 11 individuals of elfin tree fern in an area of approximately 4.5 acres (1.8 ha) (Monsegur and Saliva, USFWS unpubl. data 2012). The surveyed area does not correspond to a historical collection site for the species (Figure 1). This population probably was not evaluated as part of the previous survey for the species (Proctor 1981). Since other historical sites have not been re-assessed, currently, the overall status of species is unknown.

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

4. Listing History
Original Listing
FR notice: 52 FR 22936
Date listed: July 16, 1987

Entity listed: species
Classification: endangered

5. Associated rulemakings: None.

6. Review History:

The June 16, 1987 final rule (52 FR 22936) and the *Ilex cookii* and *Cyathea dryopteroides* Recovery Plan (hereafter the "Plan"), approved on January 31, 1991 (USFWS 1991), are the most comprehensive analyses of the species' status and are used as the reference point documents for this 5-year review.

The elfin tree fern, family Cyatheaceae, was first discovered in 1915 by Britton and Brown at Monte Cerrote in the municipality of Adjuntas (Vivaldi *et al*. 1981). This locality is known as the type locality because the species was described from the material collected here. The species was later found in Monte Jayuya in municipality of Ponce, Monte Guilarte in the municipality of Adjuntas, and Cerro Rosa in the municipality of Ciales (USFWS 1991).

On the July 16, 1987 final rule (52 FR 22936), the Service reviewed the best scientific and commercial available information, analyzed the five listing factors and their application to this species and listed the elfin tree fern as endangered. The Service identified Factor A (present or threatened destruction, modification, or curtailment of its habitat or range), Factor B (overutilization for commercial, recreational, scientific, or educational purposes), Factor D (the inadequacy of existing regulatory mechanisms), and Factor E (other natural or manmade factors affecting its continued existence) as the main threats to the species. The recovery plan was signed on January 31, 1991 (USFWS 1991), and included the description, information on distribution, habitat characteristics, reproductive biology, and conservation of the species. The information included in the plan will not be repeated in this review.

The Service conducted a 5 year review for the elfin tree fern 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 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 consider modifying that species' status. No new information or additional data was received for the elfin tree fern. Therefore, no change in this plant's listing classification was found to be appropriate.

Every year the Service reviews the status of listed species and updates their information in the Recovery Data Call (RDC). The last RDC for the elfin tree fern was completed in 2012. 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): 5. At the time of listing, the elfin tree fern was recognized as a species with high degree of threat and a low recovery potential.

8. Recovery Plan:
Name of plan: *Ilex cooki* and *Cyathea dryopteroides* Recovery Plan.
Date issued: January 31, 1991.

II. Review Analysis

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

1. Is the species under review listed as a DPS? The Endangered Species Act (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?** No. The elfin tree fern has an approved recovery plan (USFWS 1991) establishing reclassification from endangered to threaten status as the recovery objective; however, the recovery plan does not have fully measurable criteria for reclassification. In addition, the plan does not contain measurable recovery criteria for delisting.

   Recovery actions identified to help reverse the decline of these plants include the protection of existing populations and their habitats, and the establishment of new populations at other appropriate protected sites through monitoring of existing populations, protection of the fern's current habitat, conducting research on the life history of the species, evaluating methods for propagation, looking for reintroduction sites, and enhancing existing populations by propagating and producing seedlings.

2. **Adequacy of recovery criteria**

   a. Do the recovery criteria reflect the best available information on the biology of the species and its habitat? Yes. When the recovery plan was signed, very little information on the species' biology, life history, and habitat requirements was available. At present, we have not received additional information about the habitat and biology of the species.

   b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria? No. The plan did not address all the five listing factors in the recovery criteria.

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

The plan establishes that the species could be considered for reclassification from endangered to threatened status when the following criteria is met:

1. At least two new populations capable of self-perpetuation have been established within protected units of the Commonwealth Forests (Monte Guilarte or Toro Negro) or on Federal land within the Caribbean National Forest (now El Yunque National Forest).

The plan establishes that this criterion should be considered as minimum requirement, but may be modified if new populations of mature plants are discovered, particularly if on private land, creating the necessity to place greater emphasis on protection, rather than propagation.

This criterion has not been met. At present, propagation of the elfin tree fern has not been attempted. Additionally, there is no information about the minimum number of individuals needed per population, species' habitat requirement, and phenology. Therefore, until the species' population dynamics 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. Abundance, population trends (e.g., increasing, decreasing, or stable), demographic features, or demographic trends:

The elfin tree fern is known from four populations: one population of 10 individuals at Monte Guilarte, Guilarte Commonwealth Forest; one population of about 25 individuals at Cerro Rosa, Toro Negro Commonwealth Forest; and two populations at Monte Jayuya, Toro Negro Commonwealth Forest (more than 70 individuals) (Vivaldi *et al*. 1981; Proctor 1989; USFWS 1991; J. Roman, PRDNER, pers. comm., 2012; Monsegur and Saliva, USFWS unpubl. data, 2012). These Commonwealth forests are administered by the Puerto Rico Department of Natural and Environmental Resources (PRDNER). Of the four populations, only the two populations located at the Toro Negro Commonwealth Forest have been recently visited. Mr. José R. Roman, former Manager for the Toro Negro Commonwealth Forest, estimated the species population at around 60 individuals in one site located at Monte Jayuya, an area previously affected by Hurricane Georges in 1998 (J. Roman, PRDNER, pers. comm., 2012). On February 29, 2012, Service biologists Omar Monsegur and Jorge E. Saliva visited the area of Monte Jayuya at the Toro Negro Commonwealth Forest finding a second population consisting of about 11 individuals of elfin tree fern in an area approximately of 4.5 acres (1.8 ha) (Monsegur and Saliva, USFWS unpubl. data, 2012). Although Vivaldi *et al*. (1981) documented 3 subpopulations at Monte Jayuya, the surveyed area by Monsegur and Saliva does not

correspond to a historical collection site. Therefore, this last population probably was not evaluated as part of previous surveys for the species (Figure 1).

There was a historically reported population at Monte Cerrote, Adjuntas; however, this population is no longer extant. The recovery plan states that it is possible that other small populations survive in other tracts of dwarf or elfin forest in the central mountains; however, no site specific information is provided (USFWS 1991).

Figure 1. Map showing the area surveyed for elfin tree fern (*Cyathea dryopteroides*) in Monte Jayuya (Monsegur and Saliva, USFWS unpubl. data, 2012).

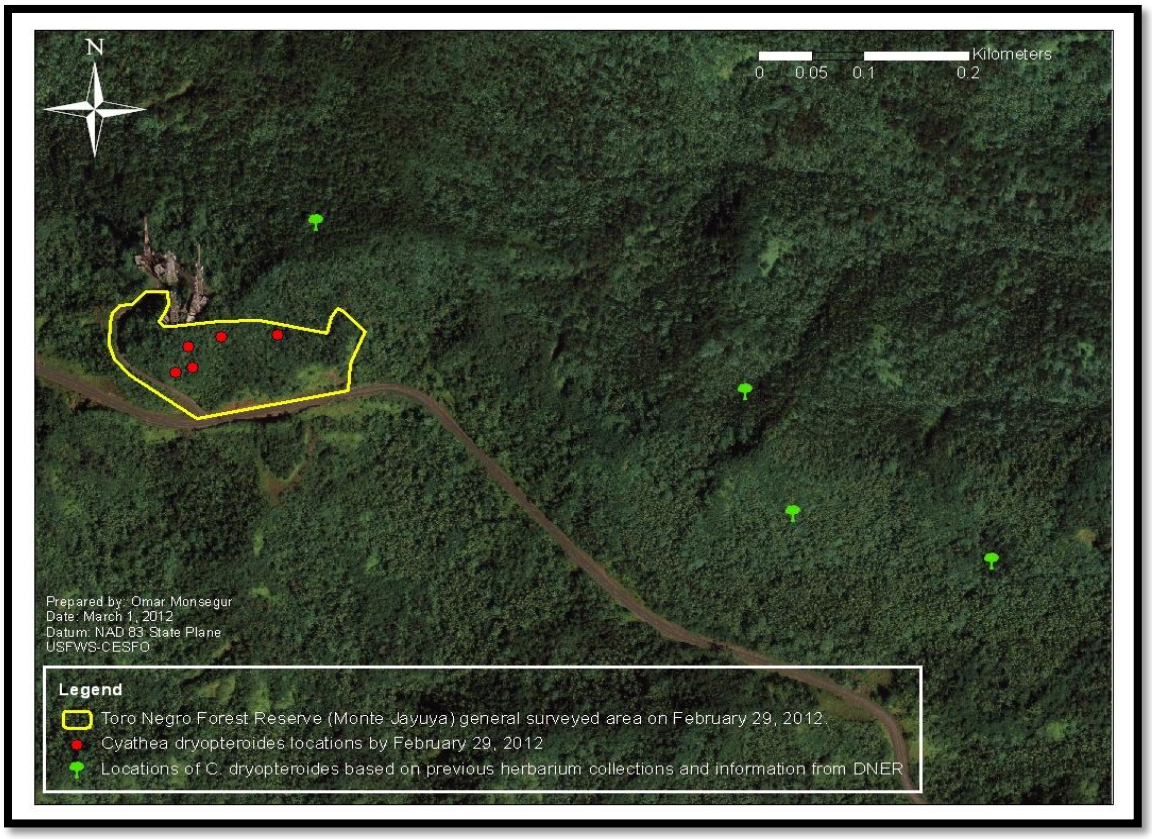

Table 1. Number of individuals of the Elfin tree fern (*Cyathea dryopteroides*) per populations in Puerto Rico. (USFWS unpubl. data, 2013).

Location	Historical Species abundance (# of individuals)	Current Status of the Population
Monte Jayuya, Ponce	70 (J. Roman, PRDNER, pers. comm., 2012	2 populations known (Monsegur and Saliva unpubl. data, 2012).
Cerro Rosa, Ciales	25 (Proctor 1989)	unknown
Monte Gularte, Adjuntas	10 (Vivaldi *et al*. 1981)	unknown
Total	105	Over all status: Unknown

Overall, the populations of the elfin tree fern have been poorly monitored and no information on population trends and demographic features are currently available.

b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, and inbreeding): No information on the genetic variability within the 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 the elfin tree fern are poorly known and no information on loss of genetic variation, genetic drift, etc., are 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. Species' spatial distribution, trends in spatial distribution (*e.g.*, increasingly fragmented, increased numbers of corridors, etc.), or historic range?

The endemic elfin tree fern is restricted to elfin or dwarf forests of the central mountains of Puerto Rico (Conant and Cooper-Driver 1980; Vivaldi *et al*. 1981; Proctor 1989). The fern has been reported from four sites; Monte Cerrote and Monte Guilarte in Adjuntas, Monte Jayuya in Ponce, and Cerro Rosa in Ciales. The elfin tree fern was first collected in 1915 by Britton and Brown at Monte Cerrote. However, it is believed that the population at Monte Cerrote is no longer extant as the fern has not been recollected at this site (Proctor 1989). In 1943, the species was collected by Sargent at Monte Jayuya and in the late 1960's, Roy O. Woodbury collected the species at Monte Guilarte. The fern continues to be found at the historic locations in Monte Jayuya (Gerardo Hernández, PRDNER, pers. comm., 2007) and Monte Guilarte (Damián Torres, PRDNER, pers. comm., 2007), despite the occurrence of several major tropical storms since the time of listing. In 1988, George R. Proctor (former botanist for PRDNER) discovered a new population of the elfin tree fern with around 25 individuals at the Cerro Rosa in Ciales (USFWS 1991).

Plant specimens deposited in herbaria can be mapped using the information provided in their labels. The elfin tree fern appears to have always been rare or of limited distribution; therefore, location of the fern in the field still is a challenge. In 2012, Service biologists visited the Monte Jayuya and found 11 individuals in an area approximately of 4.5 acres (1.8 ha) (Monsegur and Saliva, USFWS unpubl. data, 2012).

e. Habitat or ecosystem conditions (*e.g.*, amount, distribution, and suitability of the habitat or ecosystem)?

The elfin tree fern is known only from the elfin or dwarf forest of the central mountains of Puerto Rico (Proctor 1989). This forest type is found on exposed peaks and ridges above 2,723.1 feet (ft) (830 meters (m)) in elevation. Topography is rough and highly

dissected by intermittent streams, although the elfin forest is found on more rounded mountain tops. Soils are very steep, well to moderately well-drained, very strongly acid, and clayey over a layer of highly weathered rock (NRCS 2013, online data at http://websoilsurvey.nrcs.usda.gov). The vegetation in these areas is evergreen montane forest where only a single strata is present, and the stocky, relatively small (8-10 m (26.3-32.8 ft) trees present form a dense thicket (Ewel and Whitmore 1973).

Based on historical records of the elfin tree fern, the species seem to be associated to small remnants of dwarf forest vegetation at the highest elevation points of Puerto Rico, particularly to shady forest of sierra palm (*Prestoea acuminate*) with a relatively open understory (Omar Monsegur, USFWS, pers. comm., 2012). At present, the species is characterized by edge vegetation, predominantly fern species; including *Gleichenella pectinata* and *Cyathea arborea*, both native species associated with disturbed areas (Monsegur and Saliva, USFWS unpubl. data, 2012). *Gleichenella pectinata* is an aggressive, fire-tolerant, colonizer of disturbed areas (see Factor E discussion below for further detail about native invasive species threats). Additionally, *Hypolepis repens*, a native vine like fern, is covering the forest understory in areas adjacent to gaps in the forest and climbing over small shrubs and ferns (including *Cyathea dryopteroides*) (Monsegur and Saliva, USFWS unpubl. data, 2012). The presence of tree species characteristic of primary forests, such as *Magnolia portoricensis*, in disturbed areas within the surveyed site shows that the area was previously forested by native vegetation. The current status of the area may be the result of the cumulative effects of hurricanes (*e.g.*, Hurricane Georges) and human activities in the area (*e.g.*, maintenance of communication towers and power lines).

f. Other relevant information

There is no information on the current status of the elfin tree fern. At present, we are still missing information to help the species recover to the maximum extent possible. The limited amount of reported individuals and lack of data regarding their viable potential to naturally recruit (or propagate) is an essential issue that needs to be addressed.

2. Five Factor Analysis

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

When the elfin tree fern was listed in 1987, the Service identified habitat destruction and modification as one of the most significant factors affecting the continued existence of the species. Currently, the species is known from the highest elevation points in Puerto Rico; the peak of Monte Jayuya, Cerro Rosa and Monte Guilarte, all are above 3,900 feet (1,180 meters) from sea level. Although the known populations are located within Commonwealth Forests, these areas may be subjected to development for expansion of telecommunication infrastructure.

Installation of telecommunication towers

Both the final listing rule (52 FR 22936) and the species' recovery plan (USFWS 1991) indicate that the construction of new communication facilities or expansion of existing ones would affect the elfin tree fern. In Puerto Rico, towers for cellular communication, radio, television, military and governmental purposes have long represented a threat to those plant species that happen to occur on mountaintops. Their proliferation has increased with the advent of cellular phone and related technologies. While the towers themselves may not occupy a very large area, associated construction activities, access roads and facilities have a much wider impact, resulting in the elimination of potential habitat for the species. Additionally, construction of new access road and trails were identified as a factor that could directly (i.e., destruction of individuals) or indirectly (i.e., slope instability) reduce the number of elfin tree fern and its habitat at Monte Jayuya (Omar Monsegur, USFWS, pers. comm., 2012).

Permits to build new communication facilities or expand currently existing ones within or near Commonwealth forests are prevalent (PRDNER 2004b). The species characteristic of being associated with remnants of dwarf forest vegetation may indicate that it is associated to late successional vegetation. Under natural conditions, this habitat should be relative undisturbed and be affected only by severe tropical storms and hurricanes. Destruction or modification of this kind of habitat may be irreversible. Therefore, the microhabitat conditions necessary for the recovery of the species may be lost if habitat is modified for the construction of further communication facilities.

The species' rarity and restricted distribution makes it vulnerable to habitat destruction and modification. Installation of additional communications towers may represent a severe threat to the elfin tree fern and its habitat, which so far as we know is limited to Puerto Rico's highest mountain peak. Therefore, destruction, modification, or curtailment of elfin tree fern habitat or range continues to be a threat to the species. The immediacy of this threat is high, because of needs of telecommunications facilities to provide service to cellular phones and related technologies.

Military Training Maneuvers

In 1986, the Puerto Rico National Guard conducted several military training maneuvers and camping in areas where the elfin tree fern was found in the Toro Negro Commonwealth Forest. These activities may have resulted in loss of individuals and habitat modification through trampling and cutting (USFWS 1991). Because no military activities have been conducted in elfin tree fern area within the past 10 years, and the Service is not aware of potential future military activities within or near the Toro Negro Commonwealth Forest, we believe that military training maneuvers should not be considered as a current threat to the species.

Vegetation management and road maintenance.

When the Service listed this fern, habitat modification or direct destruction of plants through deforestation, selective cutting, or trampling was identified as the most serious

threat to the elfin tree fern (52FR22936). Currently, vegetation management around the existing telecommunication towers and associated facilities, and along the existing power lines that service these facilities may be a threat to the fern and its habitat (Monsegur and Saliva, USFWS, unpubl. data , 2012). Mr. José R. Román (former manager of the Toro Negro Commonwealth Forest, pers. comm., 2012), states that the telecommunication companies and the Puerto Rico Energy and Power Authority (PREPA) conduct maintenance activities such as trimming and clearing the vegetation without coordination with the forest manager, affecting the forest vegetation, including the elfin tree fern habitat.

Road maintenance activities were also identified as being a factor that could directly or indirectly reduce the number of plants near roads (USFWS 1991).

Since the population dynamics of the species is poorly known, we understand that the impacts discussed above could be detrimental to the species as a whole. Clearing of vegetation may result in direct (i.e., cutting of individuals) or indirect impacts (i.e., by opening forest gaps that can serve as corridors for invasives) to the species. Therefore, we conclude that vegetation management and maintenance of communication towers and facilities are a threat to the elfin tree fern due to changes in microclimate and plant species composition.

Based on the above discussion, the Service believes the present or threatened destruction, modification, or curtailment of the species habitat or range is a current threat to the elfin tree fern. Since the majority of the known populations are affected by habitat destruction or modification, we consider this threat as high in magnitude and imminent

(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 the elfin tree fern, because it is an attractive species that can be perceived as having ornamental value (USFWS 1987). The final listing rule further indicates that considerable commercial trade in fern species exists; prompting all species of the family Cyatheaceae to be listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). We are not aware that overutilization of this species for commercial or recreational purposes through collection for ornamental trade has occurred or is currently occurring, and there is only circumstantial evidence that this factor is impacting the elfin tree fern. Additionally, Commonwealth regulations prohibit collection of listed plant species (see Factor D evaluation below). Therefore, the Service believes that the elfin tree fern is not threatened by this factor.

(c) Disease or predation;

Disease and predation have not been documented as factor to be 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; and

In 1999, the Commonwealth of Puerto Rico approved the Law No. 241 known as the "Nueva Ley de Vida Silvestre de Puerto Rico" (New Wildlife Law of Puerto Rico). The purpose of this law is to protect, conserve, and enhance both native and migratory wildlife species (i.e., plants and animals); declare property of Puerto Rico all wildlife species within its jurisdiction, regulate permits, regulate hunting activities, and regulate exotic species among others. In 2004, the PRDNER approved the "Reglamento para Regir el Manejo de las Especies Vulnerables y en Peligro de Extinción en el Estado Libre Asociado de Puerto Rico" (Regulation 6766 to Regulate the Management of Threatened and Endangered Species in Puerto Rico). The elfin tree fern was included in the list of protected species and designated as endangered under Regulation 6766. Furthermore, Article 2.06 of Regulation 6766 prohibits collecting, cutting, removing, among other activities, listed plants within the jurisdiction of Puerto Rico.

Although the Commonwealth Law No. 241 and Regulation 6766 provide adequate protection for the species, the lack of effective enforcement makes them inadequate for the protection of the species and its habitat, particularly during vegetation management around the telecommunication facilities and maintenance of roads and trails (Monsegur and Saliva unpubl. data, 2012). Mr. José R. Román (former manager of the Toro Negro Commonwealth Forest, 2012, pers. comm.), states that the DNER has several documented incidents of vegetation-clearing activities that have destroyed elfin tree fern habitat conducted in the Commonwealth forest without coordinating with the forest manager to ensure they were conducted appropriately with existing regulations. When these incidents occur, they are violations of Commonwealth law. Under Factor A and Factor E, we discuss in more detail certain cases of lack of enforcement that have led to threats to the species and its habitat. For these reasons, we conclude that existing regulatory mechanisms are inadequate to protect the elfin tree fern and its habitat.

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

The most important factors affecting the continued existence of the elfin tree fern are its limited distribution, low reproductive capacity and highly specialized ecological requirements. In the Caribbean, native plant species, particularly endemics with limited distribution, may be vulnerable to natural or anthropogenic events such as hurricanes, landslides, human induced fires and reduced genetic variation. The elfin tree fern is more susceptible to natural disturbances such as hurricanes or landslides, because it is confined to geographically small areas (USFWS 1991).

Limited distribution.

The elfin tree fern is vulnerable to extinction due to low population numbers and restricted distribution (i.e., only 4 populations and 105 individuals historically reported), coupled with alteration or loss of habitat (USFWS 1991). Its low number of individuals and limited geographic range may reflect a remnant population of the elfin tree fern whose habitat has been altered or lost due to the installation and maintenance of telecommunications towers. The limited distribution of the elfin tree fern may also have exacerbated its vulnerability to natural or anthropogenic events such as hurricanes, landslides and genetic variation, compromising the continued existence of this species (USFWS 1991).

Low reproductive capacity/Highly specialized ecological requirements.

Little is known about the phenology, recruitment, and habitat requirement of the elfin tree fern. It is known that phenology is important in understanding a fern's biology and ecology, such as the timing of spore's maturity, germination of the gametophyte and subsequent sporophyte growth, and accumulation of biomass in the field (Lee *et al*. 2009). The low number of individuals per population may suggest that the elfin tree fern has highly specialized ecological requirements to growth or production of viable spores rarely occurs (Omar Monsergur, USFWS, 2012, pers. comm.). In the absence of knowledge on the reproductive capacity and habitat requirement of this species, it is difficult to predict its recovery after natural or anthropogenic events such as hurricanes, landslides and human induced fires, compromising the continued existence of the species.

Genetic Variation.

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

Invasive Species

Invasive native plants such as the fern *Gleichenella pectinata* may invade and alter diverse native dwarf forest communities, often resulting in plant monocultures that support few wildlife species (Omar Monsegur, USFWS, pers. obs., 2012). *Gleichenella pectinata* colonize disturbed areas faster than other native plants, thereby excluding native plants. *Gleichenella pectinata* may grow as an invasive by forming dense mats. Although the mats formed by this species serve as fuel for human induce fires, it seems to be fire tolerant (Omar Monsegur, USFWS, pers, obs., 2012). This invasive fern is currently found occupying areas disturbed by fire, landslides and road construction. If G. pectinata continues to spread and colonizes the elfin tree fern habitat, it could alter fire

regimes, microclimate and nutrient cycling of the habitat that elfin tree ferns depend on. Furthermore, the native vine-like fern *Hypolepis repens* was observed in the area colonizing forest gaps probably created by previous hurricanes and growing over the elfin tree fern in Monte Jayuya (Monsegur and Saliva, FWS, unpubl. data, 2012). At present, we have no information about the competitive abilities of elfin tree fern in such a situation. Therefore, the effect of the increase of invasive species within the elfin tree fern habitat should be considered as a possible threat to the species.

Human Induced Fire.

Human induced fire is a current threat for the species at Cerro Guilarte and Monte Jayuya. Areas potentially used by the species in Cerro Guilarte and Monte Jayuya have been affected by human induced fires (Omar Monsegur, USFWS, 2012, pers. obs.). The invasive species found in the area are fire-tolerant and make these sites susceptible to human-induced catastrophic fires. Since fires are not natural to this particular habitat, the native flora is not adapted to such disturbance. Fire effects could accelerate the colonization of invasive plants such as *Gleichenella pectinata* and change the vegetation composition of Monte Jayuya (see discussion under Factor A). The fern *Gleichenella pectinata* seems to be fire tolerant and form mats of dry material that serve as fuel for human induced fires. Although this invasive fern is located in the moist forest, during the dry season human-induced fires have been documented by the Service (Omar Monsegur, USFWS, 2012, pers. obs.). Because so few individuals of elfin tree fern are known to occur in a limited area, the risk of extinction is extremely high. Due to the very limited range, low number of individuals and the habitat requirements, we consider habitat destruction and modification by fires as a threat to the species.

Hurricanes and Landslides.

Hurricanes or tropical cyclones frequently affect the islands of the Caribbean. Hurricanes contribute to shaping vegetation and ecosystem processes, being it a factor in determining the structure and composition of biotic communities in the Caribbean forest (Walker *et al.* 1991, Lugo 2000). As a species endemic to the Greater Antilles, the elfin tree fern should be adapted to tropical storms, but its occurrence at the highest elevations of Puerto Rico, where winds may be stronger, may place it at increased risk, especially as climate change is predicted to increase the frequency and strength of tropical storms. Hurricane winds often lead to tree defoliation, loss of small and large branches, and up-rooted trees, resulting in damage to adjacent trees and understory plants when trees or branches fall and direct light damage to leaves of understory juveniles exposed to high light levels and temperature (Brokaw and Walker 1991). Additionally, high rainfall associated with tropical storms and hurricanes, sometimes about 24 inches (2 feet) of rain in a single storm event, can cause floods and interacts with topography and geologic substrate to induce mass wasting events, e.g. landslides (Lugo 2000). A massive landslide in the area where the species grows would not only take out the adult ferns and their young offspring, but their habitat 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. Due to the extremely limited range of the species and low number

of individuals, we believe that stochastic events such as severe tropical storms, hurricanes or landslides may have an adverse impact on the species.

Climate change.

Changes in climate can have a variety of direct and indirect impacts on species, and can exacerbate the effects of other threats. Rather than assessing "climate change" as a single threat in and of itself, we examine the potential consequences to species and their habitats that arise from changes in environmental conditions associated with various aspects of climate change. Vulnerability to climate change impacts is a function of sensitivity to those changes, exposure to those changes, and adaptive capacity (IPCC 2007, Glick *et al*. 2011).

An expected effect of climate change is the increase in the intensity of hurricanes and storms, followed by extended periods of drought (IPPCC 2012). Climate change may alter (modify) the surrounding vegetation around the populations of the elfin tree fern. The elfin tree fern is known to exist only in the highest mountain peaks in Puerto Rico. Extended periods of drought may result in changes in soil conditions and microclimate. If vegetation from lower elevation areas can invade and dominate the fern habitat this species would not be able to migrate to higher elevations because there are none. Hence, the species would no longer survive. Additionally, the elfin tree fern is known to occur in a limited number of areas subject to landslides, and human induced fires. Since the species has only a few known individuals in a limited range, we consider this threat as high in magnitude but not imminent because these events do not occur frequently.

Based on the above information, we conclude that the elfin tree fern is threatened by other natural or manmade factors, affecting its continued existence. The primary natural or manmade threat is its limited distribution and highly specialized ecological requirements. This threat is considered high and imminent. The other potential threats include: low reproductive capacity, possible low genetic variation, effects of vegetation management, hurricanes and landslides, human induced fire, and climate change. These are potential threats that may be expected to increase in the future depending on activities surrounding the species' habitat, placing the species at risk of extinction.

3. Synthesis

The elfin tree fern is found at four localities within the Commonwealth forest in Puerto Rico; two at Toro Negro Commonwealth forest and another at Guilarte Commonwealth forest. In Monte Cerrote, the species has not been found since 1915 despite search efforts. No new information regarding the species' status, population trends, phenology or habitat requirements is available.

Based on our analysis, the elfin tree fern is currently threatened by Factor A (present or threatened destruction, modification, or curtailment of it habitat or range), Factor D (inadequacy of existing regulatory mechanisms), and Factor E (other natural or manmade factors affecting its continued existence). Construction of new communication facilities

or modifications to existing ones, road construction, and trail and road maintenance activities threaten the species. Evidence supporting lack of enforcement of regulations to protect this species, or governmental measures to prevent destruction of its habitat were found during this review. Additionally, natural factors such as hurricanes and climate change are non-imminent threats to the species. The elfin tree fern can be perceived as having potential ornamental value, and thus, be threatened by collection, but the Service has no evidence that this is occurring. There is no substantive data indicating that Factor C (disease or predation) is a threat to the species.

The Endangered Species Act defines an endangered species as any species which is in danger of extinction throughout all or a significant portion of its range. Therefore, based on the information gathered during this review, we believe that the Elfin tree fern meets the definition of endangered because of its limited distribution and highly specialized habitat requirement, which make it vulnerable to habitat modification and stochastic event such as hurricanes and landslides.

III. RESULTS

A. Recommended Classification:

__X__ **No, no change is needed.**

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Evaluate the abundance and distribution of the elfin tree fern through surveys within traditional and non-traditional sites, using habitat models and best available plant survey methodology to determine current population numbers.

2. Identify the number of viable populations necessary to protect and stabilize the elfin tree fern population (wild, naturally-reproducing populations large enough to maintain sufficient genetic variation, and evolve and respond to natural habitat changes).

3. Appropriate government agencies should continue evaluating and implementing conservation measures to minimize possible adverse effects to this fern from construction, improvement of communication facilities, and construction/expansion of roads and trails in Toro Negro and Guilarte Commonwealth forests.

4. As new information is gained on the species, delisting criteria should be developed.

5. Studies should be conducted on the species' phenology and its habitat requirements.

6. Propagation techniques should be evaluated and developed for the species as new information is gained in order to establish new self sustainable populations in protected areas.

V. REFERENCES

Brokaw, N. V. L. and L.R. Walker. 1991. Summary of the Effects of Caribbean Hurricanes on Vegetation. Biotropica 23 (4a): 442-447.

Conant, D. S. and G. Cooper-Driver. 1980. Autogamus allohomoploidy in *Alsophila* and *Nephelea* (Cyatheaceae): a new hypothesis for speciation in homoploid homosporous ferns. Amer. J. Bot. 67: 1269-1288.

Ewel, J. L. & J. L. Whitmore. 1973. The ecological life zones of Puerto Rico and the U.S. Virgin Islands. USDA Forest Service. Res. Pap. ITF-18.

Honnay, O. and Jacquemyn, H. 2007. Susceptibility of rare and common plant species to the genetic consequence of habitat fragmentation. Conservation Biology 21:824-831.

Lee, P.-H., T. T. Lin and W. L. Chiou. 2009. Phenology of 16 species of ferns in subtropical forest of northeastern Taiwan. J. Plant Res. 122:61-67.

Lugo, A. 2000. Effects and outcomes of Caribbean hurricanes in a climate change scenario. The Science of the Total Environment 262: 243-251

Monsegur O. and J. Saliva. 2012. Population assessment of *Cyathea dryopteroides* at Monte Jayuya. USFWS. unpublish data. 9pp.

NRCS 2013, online data at http://websoilsurvey.nrcs.usda.gov. Accessed on 12/10/2012

Proctor, George R. 1989. Ferns of Puerto Rico and the Virgin Islands. New York Botanical Garden Press. 389 pp.

Puerto Rico Department of Natural and Environmental Resource. 2004a. "Reglamento para Regir las Especies Vulnerables y en Peligro de Extición en el Estado Libre Asociado de Puerto Rico". Department of State of Puerto Rico. Regulation Num. 6766. 61pp.

Puerto Rico Department of Natural and Environmental Resource. 2004b. "Reglamento de Permiso Especiales para Uaso de Comunicaciones Y Edificaciones Asociadas a Sistemas Electrónicos de Comunicación en los Bosques Estatales". Department of State of Puerto Rico. Regulation Num. 6769. 22pp.

Silander, S. R., H. de Rubio, M. Miranda, and M. Vázquez. 1986. Los Bosques de Puerto Rico. Compendio Enciclopédico de los Recursos Naturales de Puerto Rico. Departamento de Recursos Naturales, San Juan, Puerto Rico. 388 pp.

U.S. Fish and Wildlife Service. 1987. Endangered and Threatened Wildlife and Plants; Determination of endangered status for *Cyathea dryopteroides* and *Ilex cookii*. *Federal Register* Vol. 52: 22936.

U.S. Fish and Wildlife Service. 1991. *Ilex cookii* and *Cyathea dryopteroides* Recovery Plan. Atlanta, Georgia. 22 pp.

Vivaldi, J. L, R. O. Woodbury, and H. Díaz-Soltero. 1981. Status report *Alsophila dryopteroides* (Maxon) Tryon. Unpublished status report submitted to the U.S. Fish and Wildlife Service, Atlanta, Georgia. 41 pp.

Walker, L.R., N.V.L. Broakaw, D. J. Lodge, and R.B. Walde (Eds.). 1991. Ecosystem, plant and animal responses to hurricanes in the Caribbean. Biotropica 23: 313-521.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Helecho de Bosque Enano or Elfin Tree Fern (*Cyathea dryopteroides*)

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 Dr. Jorge E. Saliva and Carlos Pacheco, Caribbean Ecological Services Field Office

FIELD OFFICE APPROVAL:

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

Approve _____ Date 7/17/2013

REGIONAL OFFICE APPROVAL:

for
Lead Regional Director, Fish and Wildlife Service

Approve _____ Date 9-1-13