***Aristida chaseae* (no common name)**
***Aristida portoricensis* (pelos del diablo)**
***Lyonia truncata var. proctorii* / (no common name)**
***Vernonia proctorii* / (no common name)**

5-Year Review:
Summary and Evaluation


Lyonia truncata var proctorii


Vernonia proctorii


Aristida portoricensis

(Pacheco, FWS photos)

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

5-YEAR REVIEW
***Aristida chaseae* (no common name),**
***Aristida portoricensis* (pelos del diablo),**
***Lyonia truncata var proctorii* / (no common name)**
***Vernonia proctorii* / (no common name)**

I. GENERAL INFORMATION

A. Methodology used to complete the review: On September 21, 2007, the U.S. Fish and Wildlife Service (Service) published a notice in the *Federal Register* (72 FR 54061) announcing the 5-year review of the plants, *Aristida chaseae, Aristida portoricensis* (pelos del diablo)**,** *Lyonia truncata* var *proctorii,* and *Vernonia proctorii*. The notice requested new information concerning the biology and status of the species and a 60-day public comment period was opened. We received no comments from the public.

Service biologists prepared this 5-year review of *Aristida chaseae,* pelos del diablo*, Lyonia truncata var proctorii* and *Vernonia proctorii* that summarizes the best available information on these four plant species. The sources of information used for this review included the final listing rules, approved recovery plans for the four species, and distribution and status reports. For *Aristida chaseae*, new information consists of a propagation study and report conducted in 2006 by Dr. Gary J. Breckon and Omar A. Monsegur-Rivera from the University of Puerto Rico, Mayagüez, Biology Department, and status and field reports from Service biologists Carlos Pacheco and Omar Monsegur. For *Vernonia proctorii*, new information consists of a peer-reviewed article about nomenclatural clarification of genera Vernonia. Additionally, unpublished field observations and reports from Service biologist Carlos Pacheco were also incorporated into the review. New information on pelos del diablo consists of an herbarium voucher identifying the species on the Island of Cuba. We also requested information and comments from botanical experts familiar with these species (see List of Peer Reviewers). No comments were received.

Please see Addendum I (page 22-35) for updated information on this plant that we have gained while conducting our new five-year review initiated in 2017 (82 FR 29916) for Lyonia truncata var. proctorii, and Vernonia proctorii, and in 2018 (83 FR 10737) for Aristida chaseae and Aristida portoricensis. Our new signature page is included on page 35. What precedes this new information (pp. 2-21) is the first five-year review announced in September 21, 2007 (72 FR 54061) and completed and signed in 2010.

B. Reviewers:

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

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

C. Background

1. Federal Register Notice citation announcing initiation of this review: September 21, 2007; (72 FR 54061)

2. Species Status: 2010 Recovery Data Call:

The Service considered the status of *Aristida chaseae* as improving. *Aristida chaseae* is known from the Cabo Rojo National Wildlife Refuge (CRNWR) and La Tinaja Farm (hereafter LTF) which is part of the Cartagena Lagoon National Wildlife Refuge (CLNWR) and Cerro Mariquita area adjacent to the LTF in the Sierra Bermeja mountain range. In 1995, Dr. F. Axelrod from the University of Puerto Rico, Río Piedras Campus, collected *A. chaseae* from Punta Melones area in the municipality of Cabo Rojo (Collection Voucher 8742 at the Herbarium of the University of Puerto Rico, Rio Piedras). Dr. Axelrod collected *A. chaseae* from Punta Melones in subsequent years (Voucher 10033 in 1996, Voucher 12344 in 2002, and Voucher 12903 in 2004). He describes the species from an exposed serpentine area on the grassy slopes of Punta Melones, but does not provide a map showing these localities. Service biologist C. Pacheco visited Punta Melones and its surrounding areas in 2007 and 2008, but could not locate the species. In November 2009, Service biologists C. Pacheco and O. Monsegur found the species in Peñones de Melones, but they provided no population estimate for this locality (USFWS 2009, unpublished data). On August 19, 2010, C. Pacheco and O. Monsegur visited the same locality estimating the population at around 578 individuals on an area of 5,349.23 square meters (0.534 ha / 1.321 acres). Additionally, in 2009, the Service provided maintenance to the *A. chaseae* population in the CRNWR to alleviate competition from exotic grasses *Megatirsus maximum* (guinea grass) and *Cenchrus ciliaris* (buffer grass). At that time, the population seemed to be healthy, producing seeds and recruits. On August 23, 2010, Service biologist C. Pacheco, J. Zegarra and R. González conducted a rapid assessment on the status of the species at the CRNWR estimating its population at around 474 individuals on an area approximately of 275 square meters (0.03ha / 0.07 acres) (USFWS 2010, unpublished data).

The Service considered the status of pelos del diablo as stable. Pelos del diablo is currently known from Cerro Mariquita in Sierra Bermeja Pelos del diablo has not been observed at the historic site known as Cerro Las Mesas. Over the past year, no changes in the species' status were reported.

The Service considered the status of *Lyonia truncata* var *proctorii* as **s**table. In 1991, Proctor conducted a population survey on the species, estimating 63 individuals in two subpopulations located on the eastern and northwest cliffs of Cerro Mariquita. Breckon and Kolterman (1994) concluded that this population size may be underestimated by 50% due to difficulties to access the population (extremely steep slopes). On January 21, 2008, Service biologists conducted a preliminary survey on the species finding only 13 individuals on the eastern cliffs of Cerro Mariquita. On February 19, 2009, Service biologist visited the northwest subpopulation estimating the population at around 12 individuals. Because the areas where the species is located are very difficult to access and localities reported by Proctor (1991) and Breckon and Kolterman (1994) are unclear, comprehensive surveys with secure rappelling equipment should be conducted to establish the overall status of the species. However, during the last three years changes in land use and habitat conditions have not been documented at the Cerro Mariquita area.

The Service considered the status of *Vernonia proctorii* as improving. On January 26, 2008, Service biologists conducted a preliminary survey of the species estimating its population at 150 individuals on about 10 acres in the Laguna Cartagena National Wildlife Refuge (LCNWR) in Cerro Mariquita. Since 2008, the Service has been propagating the species at the CRNWR green house, producing approximately 50 individuals. In October 2009, 36 individuals were planted in the CRNWR. Because the number of known populations increased from one to two, no significant changes in land use or threats to the species have been documented and both populations (natural and planted) seem to be healthy and producing flowers and fruits, we consider the status of *Vernonia proctorii* to be improving.

3. Recovery Achieved for *Lyonia truncata var proctorii,* and pelos del diablo:1 (1=0-25%) of species' recovery objectives achieved.

Recovery Achieved for *Vernonia proctoria and Aristida chaseae*: 2 (2=26-50%) of species recovery objectives achieved.

4. Listing History

Original Listing: *Aristida chaseae, Lyonia truncata var proctorii* and *Vernonia proctorii*
FR notice: 58 FR 25755
Date listed: April 27, 1993
Entity listed: Species
Classification: Endangered

Original Listing: *Aristida portoricensis* (pelos del diablo)
FR notice: 55 FR 32255
Date listed: August 8, 1990
Entity listed: Species
Classification: Endangered

5. Review History:
The April 27, 1993 final rule (58 FR 25755, USFWS 1993) and the Recovery Plan for Sierra Bermeja Plants *Aristida chaseae, Lyonia truncata var proctorii,* and *Vernonia proctorii* approved on July 31, 1995 (USFWS 1995), the August 8, 1990 final rule (55 FR 32255, USFWS 1990) and the Recovery Plan for *Aristida portoricensis* (pelos de diablo) approved on May 16, 1994 (USFWS 1994) are the most recent comprehensive analyses for these four plant species and are used as the reference point documents for this 5-year review.

The perennial endemic grass *Aristida chaseae* (Family Poaceae), was discovered in 1913 by Agnes Chase near the ward Boquerón, in the municipality of Cabo Rojo, Puerto Rico (USFWS 1995). It was only known from this type locality until it was re-discovered by Paul McKenzie in 1987 on the CRNWR (USFWS 1993; USFWS 1995). This population was estimated at 150 to 180 plants, and it was located approximately 8 km (4.97 miles) to the south of the type locality (USFWS 1993; Proctor 1991a). McKenzie *et al*. 1989 searched for the species in areas surrounding the CRNWR and Boquerón, including the type locality, and discovered no additional populations. The authors suggested that the disappearance of *A. chaseae* from the

type locality was apparently due to competition from vigorous, introduced grass species, such as *Cenchrus ciliaris* (yerba de salinas), *Bothriochloa pertusa* (yerba huracán), *Dichanthium annulatum* (pajón), *Cynodón dactylon* (yerba bermuda), *Panicum maximum* (yerba guinea), and *Brachiaria subquadripara* (McKenzie *et al*. 1989; USFWS 1993; USFWS 1995). Later in 1987, *A. chaseae* was found on the rocky, exposed uppers slopes of Cerro Mariquita in Sierra Bermeja, between elevations 150 to 301 meters (492 to 988 ft) (USFWS 1993; USFWS 1995, McKenzie *et al*. 1989). The Sierra Bermeja is the oldest geologic formation in Puerto Rico, it has serpentine-derived soils and it is located east of the CRNWR in the Cabo Rojo and Lajas municipalities. McKenzie *et al*. 1989 reported *A. chaseae* as "not uncommon on the Sierra Bermeja", but suggested that its restricted distribution on exposed, rocky areas, was because of competition from introduced grasses.

The endemic grass pelos del diablo (*A. portoricensis*)(Family Poaceae) is known only to occur on serpentine slopes and red clay soils in southwestern Puerto Rico (USFWS 1990; USFWS 1994) It was first collected in1903 from the Cerro Las Mesas area located within the Mayagüez municipality in southwestern Puerto Rico (USFWS 1994). In 1927, Jose I. Otero reported this species in the Guanajibo and Hormigueros, but these collection sites have not been relocated since and both populations appear to have been eliminated (USFWS 1990; USFWS 1994). At the time of listing, pelos del diablo was only known from a very few plants located at Cerro Las Mesas in Mayagüez, and along the upper, rocky slopes of the Cerro Mariquita in Sierra Bermeja (USFWS 1990; USFWS 1994; McKenzie *et al*. 1989). This locality in Sierra Bermeja is the same area occupied by *A. chaseae*. Based on observations of the authors of this review during a site visit to Sierra Bermeja in 2008, both *A. chaseae* and pelos del diablo are located at LTF, which is part of Cartagena Lagoon NWR, and Cerro Mariquita, privately-owned site located adjacent to LTF. Although a population census was not conducted, both species meet the classification of "not uncommon" in the area. As previously discussed by McKenzie *et al*. 1989, both species are still restricted to exposed upper slopes of the mountain range. Serpentine soils are typically very mineralized and granular, which can result in rapid drainage and periods of moisture deficiency (Cedeño-Maldonado and Breckon 1996). Serpentine outcrops are limited to the southwestern part of Puerto Rico occupying little less than 1% of the total area of the island (Cedeño-Maldonado and Breckon 1996). Serpentine-derived soils support a significant level of plant endemism.

The plant *Lyonia truncata var proctorii*, (Family Ericaceae), was discovered in September 1987 by Dr. George Proctor, and described by Dr. Walter Judd in 1990 (USFWS 1995). The species was known only from the type locality, Cerro Mariquita in Sierra Bermeja, Puerto Rico. In 1991, Dr George Proctor conducted the first status report on *Lyonia truncata var proctorii*, finding the species on an exposed cliffs and ledges of upper Jurassic chert (Proctor 1991b; Breckon and Kolterman 1994a; USFWS 1995). In their report, the authors mentioned two populations of *Lyonia truncata* var *proctorii* in Cerro Mariquita; one at the northwest of the summit area with 18 individuals and other at the east of the summit area with 45 individuals (Proctor 1991b). Proctor estimated the entire population at around 63 plants (Proctor 1991b). Breckon and Kolterman conducted two field trips in late April and early May of 1994, finding 33 individuals of *Lyonia truncata* var *proctorii* in an area of 1,855 square meters (0.46 acre) (Breckon and Kolterman 1994a). These authors also states that the population estimate reported by Proctor in 1991 could be underestimated by as much

as 50% because the species is found on extremely steep slopes difficult to survey (Breckon and Kolterman 1994a; USFWS 1995).

The plant *Vernonia proctorii* (Family Asteraceae) was discovered in September of 1987 by George Proctor, Dr. Horst Haneke, and Paul McKenzie and described by Lowell E. Urbatsch in 1989 (Urbatsch 1989; USFWS 1995). The species was known from one locality (i.e. type locality) at Cerro Mariquita in Sierra Bermeja, Puerto Rico. Urbatsch estimated the *Vernonia proctorii* population in about 75 plants growing on open rocky chert slopes in Cerro Mariquita (Urbatsch 1989). Proctor, in 1991, conducted a status survey on the species estimating the population at around 950 individuals (Proctor 1991c, Breckon and Kolterman 1994b; USFWS 1995). However, Breckon and Kolterman conducted two field trips in late April and early May of 1994, finding 7 individuals in an area of 1,855 square meters (0.46 acres)(Breckon and Kolterman 1994b).

A. chaseae, Lyonia truncata var. proctorii and Vernonia proctorii were recommended for Federal listing by Dr. George Proctor during a September 1988 meeting concerning the revision of the candidate plant species list in Puerto Rico and the U.S. Virgin Islands. They were subsequently included as category 1 species (species for which the Service has substantial information supporting the appropriateness of proposing to list them as endangered or threatened) in the notice of review for plants published in the Federal Register on February 21, 1990 (55 FR 6184). A proposal to list the species as endangered was published in the *Federal Register* on September 3, 1992 (57 FR 40429). The final rule to list the species was published in the *Federal Register* on April 27, 1993 (USFWS 1993).

Pelos del diablo was recommended for Federal listing by the Smithsonian Institution. The species was included among the plants being considered as endangered or threatened species by the Service, as published in the Federal Register (45 FR 82480) dated December 15, 1980; the November 28, 1983, update of the 1980 notice (48 FR 53680); and the September 27, 1985, revised notice (50 FR 39526). Pelos del diablo was designated a category 1 candidate species (species for which the Service has substantial information supporting the appropriateness of proposing to list them as endangered or threatened) in each of the three notices (USFWS 1990). A proposal to list the species as endangered was published in the *Federal Register* on October 10, 1989 (54 FR 41473). The final rule to list the species was published in the *Federal Register* on August 8, 1990 (USFWS 1990).

In the April 27, 1993 final rule (58 FR 25755), the Service reviewed the best scientific and commercial information available, analyzed the five listing factors and their application to these species and listed the plants *A. chaseae*, *Lyonia truncata* var *proctorii* and *Vernonia proctorii* as endangered. The Service identified Factor A (present or threatened destruction, modification, or curtailment of its habitat or range), Factor D (the inadequacy of existing regulatory mechanisms) and Factor E (other natural or manmade factors affecting its continued existence) as the main threats for these three species. The recovery plan was signed on July 31, 1995 (USFWS 1995). In the August 8, 1990 final rule (55 FR 32255), the Service reviewed the best scientific and commercial information available, analyzed the five listing factors and their application to this species and listed pelos del diablo as endangered. The Service identified Factor A (present or threatened destruction, modification, or curtailment of its habitat or range), Factor D (the inadequacy of existing regulatory

mechanisms) and Factor E (other natural or manmade factors affecting its continued existence) as the main threats for this grass species. The recovery plan was signed on May 16, 1994 (USFWS 1994). The recovery plans for these four species include the description of the species and information about distribution, abundance, habitat characteristics, reproductive biology and conservation. The information included in these plans will not be repeated in this review.
Every year the Service reviews the status of listed species and updates species information in the Recovery Data Call (RDC). The last RDC for *A. chaseae,* pelos del diablo, *Lyonia truncate var proctorii* and *Vernonia proctorii* was completed in 2010.

The Service conducted a five-year review for pelos del diablo in 1991(56 FR 56882). In this review, the status of many species was simultaneously evaluated with no in-depth assessment of the five factors or threats as they pertain to the individual species. The notice stated that the Service was seeking any new or additional information reflecting the necessity of a change in the status of the species under review. The notice indicated that if significant data were available warranting a change in a species' classification, the Service would propose a rule to modify the species' status. No new information or additional data was received. Therefore, no change in the plant's listing classification was found to be appropriate.

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

11C. *A. chaseae* was recognized as a species with a moderate degree of threat and a low recovery potential.
5C. Pelos del diablo and *Vernonia proctorii* were recognized as species with high degree of threat and low recovery potential.
6. *Lyonia truncata var proctorii* was recognized as sub-species with high degree of threat and low recovery potential.

7. Recovery Plan:

Name of plan: *Aristida chaseae*, *Lyonia truncata var. proctorii*, and *Vernonia proctorii* Recovery Plan
Date issued: July 31, 1995

Name of plan: *Aristida portoricensis* Recovery Plan
Date issued: May 16, 1994

II. REVIEW ANALYSIS

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

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

B. Recovery Criteria

1. Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes. *A. chaseae***,** *Lyonia truncata var proctorii and Vernonia proctorii* have an approved recovery plan establishing downlisting as the recovery objective. However, the plan does not contain measurable recovery criteria for delisting. Pelos del diablo has an approved recovery plan establishing delisting as the recovery objective; however, the three recovery criteria are not measurable.

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. When the recovery plans were signed, very little information on the species' biology, life history and habitat requirements was available. Population estimates for *A. chaseae* and pelos del diablo were not available.

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria? No.

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

The approved recovery plan for *A. chaseae*, *Lyonia truncata* var *proctorii* and *Vernonia proctorii* establishes that these species could be considered for reclassification to threatened when the following criteria are met:

1. The known populations on privately owned land in Sierra Bermeja are placed under protective status.

2. New populations (the number of which should be determined following the appropriate studies) capable of self-perpetuation have been established within protected areas, such as the Cabo Rojo National Wildlife Refuge.

The approved recovery plan for pelos del diablo establishes that this species could be considered for delisting when the following criteria are met:

1. The known population on privately owned land in Sierra Bermeja is placed in protective status.

2. An agreement between the Fish and Wildlife Service, Soil Conservation Service, and the University of Puerto Rico has been prepared and implemented.

3. New populations capable of self-perpetuation have been established within protected areas.

Criterion 1 for *A. chaseae*, *Lyonia truncata* var *proctorii* and *Vernonia proctorii*, and the first criterion for pelos del diablo has been partially met. At the time the plans were approved, LTF and Cerro Mariquita were privately-owned and under grazing activities. *A. chaseae*, pelos del diablo, *Lyonia truncata var proctorii* and *Vernonia proctorii* were known to occur at these hills in Sierra Bermeja. The U.S. Department of Interior acquired LTF in 1996 and it is managed by the USFWS as part of the LCNWR for conservation of fish and wildlife resources. Currently, the known population of *Lyonia truncata var proctorii*, approximately 80% of the known individuals of *Vernonia proctorii*, and approximately half of the individuals of *A. chaseae* and pelos del diablo are located within LTF and thus protected. However, remaining individuals of *A. chaseae*, pelos del diablo and *Vernonia proctorii* in Sierra Bermeja occur in Cerro Mariquita which continue to be in privately-owned land under cattle grazing activities. For these reasons, we consider this criterion partially met.

Criterion 2 for *A. chaseae*, *Lyonia truncata* var *proctorii* and *Vernonia proctorii*, and has not been met. No studies have been conducted about number of self-sustained populations needed to establish a self-perpetuation of any of these species. Although several experiments to propagate the species were conducted, a propagation program for these species has not been established.

Criterion 2 for pelos del diablo has not been met. Based on the information in the species file, an agreement between the Service, Soil Conservation Service (currently known as Natural Resources Conservation Service), and the University of Puerto Rico to protect remaining individuals of pelos del diablo in Cerro Las Mesas was not prepared and implemented. The exact location of the previously known individuals located at Cerro Las Mesas is not currently available in the files. This criterion cannot be met until this population is re-discovered and property owners are identified.

Criterion 3 for pelos del diablo have not been met. No study was conducted on the number of individuals needed to establish a self-sustained population of this grass species. Propagation experiments have not been conducted for the species.

C. Updated Information and Current Species Status

1. Biology and Habitat

a. 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.

At the time of listing, *A. chaseae* was *kn*own only from the CRNWR and the Cerro Mariquita in Sierra Bermeja. At that time, McKenzie estimated the *A. chaseae*

population at the CRNWR at around 180 plants (USFWS 1993). In 2010, Service biologist conducted a rapid status assessment on the species at the CRNWR and Peñones de Melones providing an estimate of around 474 plants at the CRNWR and at around 578 plants at Peñones de Melones (USFWS 2010, unpublished data). Population estimates on *A. chaseae* and pelos del diablo at the Cerro Mariquita are not available. However, the author of this review considers both species as "not uncommon" in Cerro Mariquita.

In 2007, 2008 and 2009, Service biologist Carlos Pacheco conducted several site visits to assess the population of *Lyonia truncata* var *proctorii* and *Vernonia proctorii* in Sierra Bermeja. At the time of listing, 63 individuals of *Lyonia truncate var proctorii* were known from two subpopulations located on the eastern and northwest cliff of Cerro Mariquita (Proctor 1991). Breckon and Kolterman (1994) concluded that this population size may be underestimated by 50% due to the difficulties to access the site where the species occur. On January 21, 2008, Service biologists conducted a preliminary survey on *Lyonia truncate var proctorii* finding 13 individuals on the eastern cliffs of Cerro Mariquita. On February 19, 2009, a Service biologist visited the northwest subpopulation estimating the population at around 12 individuals. Proctor (1991c) estimated the *Vernonia proctorii* abundance in Cerro Mariquita at around 950 individuals. On January 26, 2008, a Service biologist estimated its population at 150 individuals on an area of 10 acres. Because the areas where the species is located are very difficult to access and localities reported by Proctor (1991) and Breckon and Kolterman (1994) are unclear, comprehensive surveys with secure rappelling equipment should be conducted to establish the overall status of the species.

The assessments on *Lyonia truncata* var *proctorii, Vernonia proctorii,* and *Aristida chaseae* provided some insight on the species' status, but did not provide enough information to estimate the species' abundance nor establish population trends. No new information regarding pelos del diablo abundance or population trends was found during this review.

b. Genetics, genetic variation, or trends in genetic variation (*e.g.*, loss of genetic variation, genetic drift, inbreeding, etc.): There is no new information on genetics related to these plants.

c. Taxonomic classification or changes in nomenclature: We found new information regarding taxonomic re-classification or changes in nomenclature for *Vernonia proctorii*. In 1989, Urbatsch described the plant under the genus *Vernonia*. Dr Harold Robinson, from the Department of Botany of National Museum of Natural History, Smithsonian Institute, conducted a comprehensive study about the American Vernonieae and concluded that none of the elements called *Vernonia* in the Eastern Hemisphere belong to the genera *Vernonia,* and they must all be transferred to other genera (Robinson 1999). The author used the pollen, style bases, raphids, inflorescence from involucres, anther appendage, and chemistry as some characters for the reclassification. Robinson changed 114 species from the genus *Vernonia* to the genus *Lepidaploa,* including *Vernonia proctorii* which the author called *Lepidaploa proctorii* (Robinson 1999). However, the Integrated Taxonomic Information System (ITIS) and the Germplasm Resources

Information Network (GRIN) of USDA continue using *Vernonia proctorii* as the taxon and *Lepidaploa proctorii* as the synonymy.

No new information regarding taxonomic classification or changes in nomenclature was found for *A. chaseae*, pelos del diablo nor *Lyonia truncata* var *proctorii.*

d. Spatial distribution, trends in spatial distribution (*e.g.*, increasingly fragmented, increased numbers of corridors, etc.), or historic range (*e.g.*, corrections to the historical range, change in distribution of the species within its historic range, etc.): Service biologists conducted rapid assessments on populations of *Lyonia truncata* var *proctorii, Vernonia proctorii,* and *Aristida chaseae* providing some insight on the species' distribution (Figure 1). In addition, herbarium collections were visited updating information regarding historic range of *A. chaseae* and *A. portiricensis*.

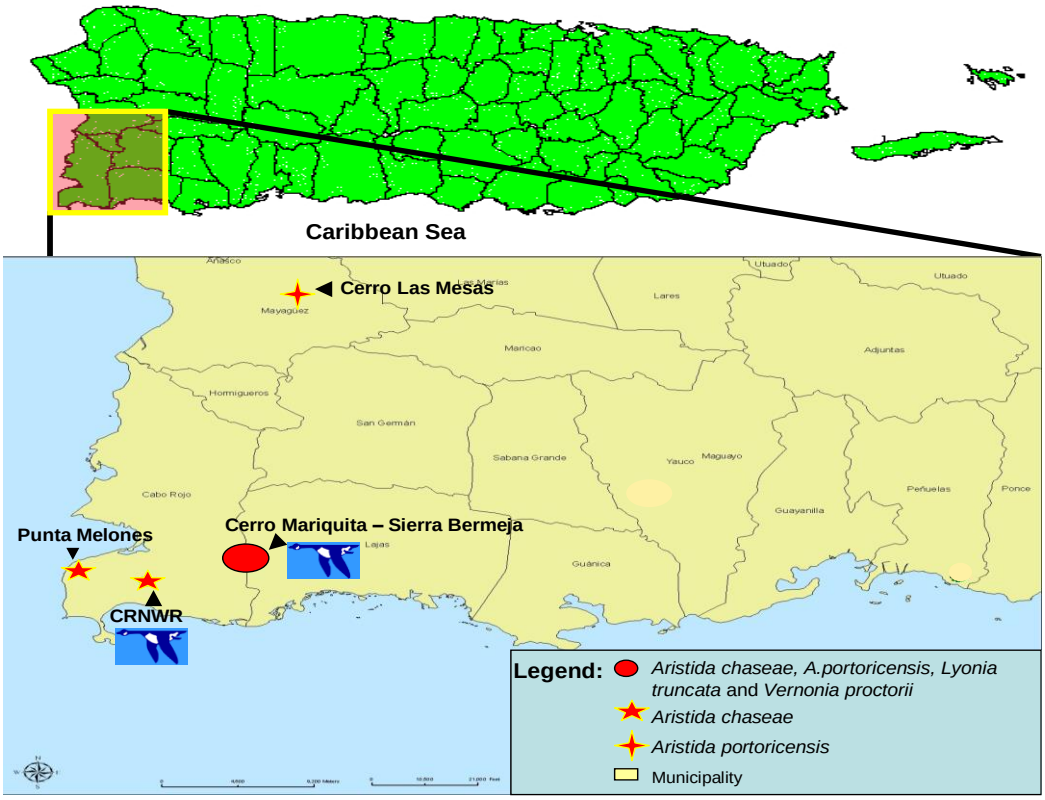
At the time of listing, *A. chaseae* was known from two sites: the CRNWR and the upper slopes of the Cerro Mariquita in Sierrra Bermeja. At that time, the status of the species at the type locality in Boquerón ward was unknown. In 1995, Dr. Frank Axelrod collected the species at the Punta Melones area in the Boquerón Ward (Collection Voucher 8742 at the Herbarium of the University of Puerto Rico, Rio Piedras). Punta Melones site is located at approximately 2.63 miles (4.23 km) northwest from the already known population at the CRNWR. At that time, Dr. Axelrod described the area and habitat where the species was found, but did not provide a map showing the collection sites. In 2007 and 2008, a Service biologist searched for the species at Punta Melones and its surrounding areas, but the species was not found. In November 2009, service biologists collected the species at Peñones de Melones, a site located at .33 miles (0.53 km) east from Punta Melones area and at 2.35 miles (3.78 km) northwest from the population at the CRNWR (USFWS 2010, unpublished data). Because the location of the population previously reported by Dr. Axelrod is not clear and the proximity of the recently found, the author considered for the purpose of this review both localities, Peñones de Melones and Punta Melones as one population. Based on the above information, *A. chaseae* is known from three localities: Cerro Mariquita in Sierra Bermeja, CRNWR and Peñones de Melones (Figure 1).

Service biologists conducted a rapid assessment on the status of *A. chaseae* at the CRNWR and at Peñones de Melones sites. At both localities, the species shows a very limited ***spatial distribution*** and seems to be in favor of clumped pattern distribution (USFWS 2010, unpublished data). At the CRNWR, the *A. chaseae* is found on an area of approximately of 275 square meters (0.03ha / 0.07 acres), and at the Peñones de Melones the species is found on an area of 5,349.23 square meters (0.534 ha / 1.321 acres). Seeds and seedlings were found only around the mature plants, suggesting that the current limited distribution was related to the absence of a biotic dispersal agent (USFWS 2010, unpublished data).

At the time of listing, *A. portoricensis* was known from only two localities: at Cerro Mariquita in Sierra Bermeja and at Cerro Las Mesas in Mayagüez, both localities are in Puerto Rico. According to DNER herbarium voucher SJ014582, the plant was found and collected by E. L. Ekman in Pimar del Rio in Cuba Island (Ekman 1920, unpublished

data). We were not aware of this locality at the time of listing and the information is considered as new information for the purpose of this review. Based on this information, *A. portoricensis* is not endemic to Puerto Rico and its ***current range*** of the species includes to Puerto Rico and Cuba.

Figure 1. Currently distribution of *Aristida chaseae, Aristida portoricensis, Lyonia truncata* var *proctorii* and *Vernonia proctorii* in Puerto Rico (USFWS 2010, unpublished data).



e. Habitat (*e.g.*, amount, distribution, and suitability of the habitat or ecosystem): There is no new information on habitats for these plants.

f. Other relevant information on species: Service biologists were able to produce 68 *Vernonia proctorii* seedlings under green house conditions. Seed germination and growth was optimal in partial shade and wet soil (USFWS unpublished data, 2008). Based on our observations, we believe that the recovery potential of *Vernonia proctorii* is higher than previously though. Nonetheless, seedlings and saplings were not observed in the wild during our surveys. We need to conduct additional studies on seed germination, sapling survival, and recruitment to further understand and recover this species.

Monsegur-Rivera and Breckon (2006) studied propagation techniques for *A. chaseae.* During their study at the CRNWR, they found no germination or seedlings of *A. chaseae* in the wild. They tested two methods: 1) propagation by seed collected from the wild and 2) asexual propagation by dividing clumps. Seeds were collected by the second week of October 2001 from plants at the CRNWR. They conducted germination experiments in 15 plastic greenhouse trays with soils collected at the same area where the

plants are located at the refuge. Based on the paucity of germination in previous preliminary tests, they reasoned that a dormancy period might be involved. The first germination experiment started in December 2001, when three trays were moved to the greenhouse and watered. The trays were watered daily in full sun to prevent the soil from drying out. After 5 months, the germination was very poor (2.3%, 17 seeds germinated out of 750 seeds). Further, germination declined in the trays started after three month of dormancy and apparently stopped after five month. First germination occurred between 36 and 40 days after planting and extended up to 151 days in the case of the last germination (Monsegur-Rivera and Breckon 2006). By having a second dormancy period (Monsegur-Rivera and Breckon 2006) germination slightly more than doubled to 38 seeds out of 733 seeds or 5.1%. Taking the two treatments together and totaling the number of seeds germinated per original starting date of treatment, the germination rate was only 7.3%.

Monsegur-Rivera and Breckon (2006) divided ten large clumps of *A. chaseae* from the wild in half and transferred them to a one-gallon plastic pot filled with soil from the site. The potted halves were moved to the greenhouse and watered as needed. Seventy percent of the potted clump halves survived and, in 2005, eight individuals produced (7 produced by dividing in half large clumps in the wild, and one individual produced by seed) were planted at the Cabo Rojo NWR. Clumps of guinea grass were removed from the area around the transplants at the time of replanting and on several following visits. Subsequent watering was conducted. All but one of the transplanted individuals died one year later (Monsegur-Rivera and Breckon 2006). The transplanted seedlings that rose from germination experiments proved difficult to maintain.

2. Five Factor Analysis (threats, conservation measures, and regulatory mechanisms)

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

When the plants *A. chaseae*, *Lyonia truncata* var *proctorii* and *Vernonia proctorii* were listed in 1993, the Service identified habitat destruction and modification as one of the factors affecting the continued existence of the species. At that time, these three species were found in Sierra Bermeja, a privately owned site subjected to agricultural, rural and tourist development. In addition, the final rule for pelos del diablo also identified proposed copper and gold mining as a threat to the species in Cerro Las Mesas. In 1996, DOI acquired La Tinaja Farm (LTF) in the Sierra Bermeja mountain range. The Service incorporated this land to the Cartagena Lagoon National Wildlife Refuge, protecting 50% of the known populations of *Lyonia truncata* var *proctorii*, approximately 80% of the known individuals of *Vernonia proctorii*, and its suitable habitat, and about 50% of the populations of *A. chaseae* and pelos del diablo. However, the remaining individuals of these species in Sierra Bermeja are located in the adjacent Cerro Mariquita area, which remains under private ownership. Although the Cerro Mariquita area was classified by the Puerto Rico Planning Board as a District of Conservation Resource 1 (CR1) (the most restrictive for development, precluding tourist and residential development and mining activities), this classification allows agricultural (e.g. cattle grazing) and rural developments (one house in 25 acres of land). In 2006 and 2007, private landowners cut new roads to gain access through their properties to

the peak of Cerro Mariquita affecting indeterminate amount of habitat for these species (Pacheco, USFWS 2009, field observations). Therefore, the threat of habitat destruction and modification still exist for *A. chaseae*, pelos del Diablo, *Lyonia truncata var proctorii* and *Vernonia proctorii*.

A. chaseae population at Peñones de Melones is found on a site that may be affected by the proposed projects called Monte Carlo Resort – Boquerón Bay Villas (FWS Project Identification Number 72023-023) and Punta del Sol Hotel (FWS Project Identification Number 72023-085). The Punta Melones and Peñones de Melones area are currently under development pressure. According to the field observations conducted by the author of this review; the Punta Melones and the Peñones de Melones area has been impacted by residential and tourist development, and by agricultural practices such as cattle and goat grazing. Currently, the Service is working with the private landowners, federal and states agencies providing technical assistance to protect the species and its habitat at these areas.

Based on the above discussion, we believe that these four species are currently threatened by Factor A and the imminence or degree of the threat should be considered as moderate.

(b) Over utilization for commercial, recreational, scientific or educational purposes;

In the final rules, this was not considered a factor in the decline of these four species. At the present time, we are not aware that over-utilization for commercial, recreational, scientific or educational purposes constitutes a limiting factor for these species.

(c) Disease or predation;

In the final rule, this was not considered a factor in the decline of these four species. At the present time, we are not aware that disease or predation constitutes a limiting factor for these species. Currently, we do not have any evidence that herbivores substantially target these species since more succulent, exotic grasses are present in these areas.

(d) Inadequacy of existing regulatory mechanisms.

When listed, this factor was considered a threat to the species. In 2004, the DNER 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 plants *A. chaseae*, *Lyonia truncata var proctorii* and *Vernonia proctorii* have been included in the list of protected species and designated as endangered. Pelos del diablo was also included in the list of protected species, but it was designated as critically endangered. This regulation under Article 2.06 prohibits collecting, cutting, removing, among other activities, listed plant individuals within the jurisdiction of Puerto Rico. Additionally, the individuals and habitat of *A. chaseae*, pelos del diablo, *Lyonia truncata var proctorii* and *Vernonia proctorii* within LTF, and individuals within the CRNWR are protected by the National Wildlife Refuges Act of 2000. All plants existing on the National Wildlife Refuge System are protected from collecting (50 CFR 27.51). Additionally, Comprehensive Conservation Plans (CCPs) for the LCNWR and

CRNWR are in progress. The CCPs will include measures for the protection and recovery of threatened and endangered species within these refuges.

Based on the presence of Federal and Commonwealth laws and regulations protecting these plants, and the absence of evidence supporting lack of enforcement of regulations to protect these species or governmental measures to prevent destruction of its habitat, we believe that inadequacy of existing regulatory mechanisms should no longer be considered a threat.

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

A. chasea and pelos del diablo are currently threatened by competition from introduced grasses and forbes (e.g. legumes). The disappearance of *A. chaseae* from the type locality in Boquerón was apparently due to competition from vigorous, introduced grass species (McKenzie *et al*. 1989; USFWS 1993; USFWS 1995). McKenzie *et al*. (1989) suggested that the restricted distribution of these two grasses on exposed, rocky areas of Sierra Bermeja was related to competition from introduced grasses. The population of *A. chaseae* at the CRNWR is limited to a narrow strip approximately 100m (328 ft) long on both sides and down the center of a dirt trail. There are dense stands of guinea grass on both sides of the population.

One of the most important factors affecting the continue survival of the species *Lyonia truncata var proctorii* and *Vernonia proctorii*, is their limited distribution. *Lyonia truncata var proctorii* is only found in a limited area on the edge of a precipice of the upper Jurassic chert in Cerro Mariquita. *Vernonia proctorii* is found on the steeper slopes of Cerro Mariquita. Any seismic event in this area and heavy rain that result in a landslide may affect a significant portion of the population. In September 2009, the Service observed three landslides at the Cerro Mariquita due to the heavy rain. Fortunately, no individuals of these species were affected.

The species *A. chaseae*, pelos del Diablo, and *Vernonia proctorii* are found on exposed and scrub woodland within the driest part of the top of Cerro Mariquita. This area is susceptible to human-induced catastrophic events such as fires. Fire has frequent occurrence in this extremely dry portion of the Southwestern Puerto Rico. The rapid growth of exotic grasses on areas where these species occur is a threat because of competition and represent an increase in fuel that may increase the impact of fire. Because so few individuals are known to occur in a limited area, the 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 above discussion, we believe that these four species are currently threatened by other natural or manmade factors, such as competition from introduced grasses, human-induced fires, and landslides. We consider the imminence of this factor as low.

3. Synthesis

Lyonia truncata var proctorii and *Vernonia proctorii* were listed in 1993 due to restricted distribution and extremely low population size. The species are considered endemic to the serpentine Sierra Bermeja mountain range and are currently known only from the LTF and

Cerro Mariquita area. The population of *Lyonia truncata var proctorii* has been estimated at between 25 to 125 individuals since it was listed in 1991. The population of *Vernonia proctorii* is currently estimated at 986 individuals. During this review, we found no consistency and accuracy on any of these species' population estimates. Furthermore, some of the locations reported for both species are unclear and a number of the population sites are difficult to access.

Aristida chaseae and pelos del diablo are perennial endemic grasses restricted to a few sites in the southwestern Puerto Rico. *A. chaseae* is known from close to 500 individuals in a narrow strip in the CRNWR, approximately 600 individuals at Peñones de Melones and from an undetermined number of individuals at the rocky, exposed upper slopes of Cerro Mariquita in the Sierra Bermeja. Pelos del diablo is considered "not uncommon" on the Sierra Bermeja, but limited to rocky, exposed upper slopes of Cerro Mariquita mountain range. In recent years, pelos del diablo has not been observed at the historic site known as Cerro Las Mesas in the municipality of Mayagüez. However, based on the information currently available to us the current range of pelos del diablo includes Puerto Rico and Cuba.

Based on our 5 listing factors analysis, *A. chaseae*, pelos del diablo, *Lyonia truncata* var *proctorii* and *Vernonia proctorii* are currently threatened by Factor A (present or threatened destruction, modification, or curtailment of it habitat or range). Although some of the individuals are located at La Tinaja Farm, a number of individuals of these three species are located in the adjacent Cerro Mariquita area, which remains under private ownership. In spite of the Cerro Mariquita area being classified by the Puerto Rico Planning Board as a District of Conservation Resource 1 (CR1), it allows for agricultural (e.g. cattle grazing) and rural developments (current zoning allows for the construction of one house in 25 acres of land). Grazing induced habitat modification, dispersal of invasive grass species, predation of seedlings and saplings, and land clearing pose a serious threat to these species. In addition, the *A. chaseae* population at Peñones de Melones is threatened by urban development. The four species are currently threatened by other natural or past manmade factors, such as competition from exotic grasses, human-induced fires, and landslides.

The ESA defines an endangered species as any species which is in danger of extinction throughout all or significant portion of its range. Therefore, based on the information gathered during this review, we believe that *A. chaseae*, pelos del diablo, *Lyonia truncata* var *proctorii* and *Vernonia proctorii* meet the definition of endangered because of limited distribution, habitat lost and modification, and natural or manmade factors.

III. RESULTS

A. Recommended Classification:

__X__ No, no change is needed for *A. chaseae*, pelos del diablo, *Lyonia truncata var proctorii* and *Vernonia proctorii*.

B. New Recovery Priority Number:

8C for *A. chaseae*. At the time of listing, the *A. chaseae* was recognized as species with moderate degree of threat and low recovery potential (RPN=11C). Based on the new information gathered during this review, we have determined that *A. chaseae* has a moderate to high degree of threat and low recovery potential; therefore we recommend a species recovery priority of 8C (RPN=8C).

11C for pelos del diablo. At the time of listing, the pelos del diablo was recognized as species with high degree of threat and low recovery potential (RPN=5C). Based on the new information gathered during this review, we have determined that pelos del diablo has a moderate to low degree of threat and low recovery potential; therefore we recommend a species recovery priority of 11C (RPN=11C).

11 for *Vernonia proctorii*. At the time of listing, the *Vernonia proctorii* was recognized as species with high degree of threat and low recovery potential (RPN=5). Based on the new information gathered during this review, we have determined that *Vernonia proctorii* has a moderate to low degree of threat and low recovery potential; therefore we recommend a species recovery priority of 11 (RPN=11).

9 for *Lyonia truncata var proctorii*. At the time of listing, the *Lyonia truncata var proctorii* was recognized as sub-species with high degree of threat and low recovery potential (RPN=6). Based on the new information gathered during this review, we have determined that *Lyonia truncata var proctorii* has a moderate to high degree of threat and low recovery potential; therefore we recommend a recovery priority of 9 (RPN=9).

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- Revise the recovery plans to include new information on the species and the development of measurable criteria for delisting the species.
- Conduct comprehensive surveys of these four species at Sierra Bermeja to determine relative abundance and distribution.
- Conduct surveys at Cerro Las Mesas to determine if pelos del diablo is still present at this area.
- Conduct surveys at Punta Melones and Peñones de Melones to determine the status of *A. chaseae* at these areas.
- Promote Conservation agreements with private landowners to protect and enhance existing populations.
- Initiate propagation programs for these species to enhance existing populations in the Sierra Bermeja mountain range and establish new populations of *A. chaseae* and pelos del diablo in protected areas in southwestern Puerto Rico.
- Work closely with private landowners in the Sierra Bermeja mountain range and Peñones de Melones to protect individuals on private lands from existing agricultural practices and control exotic grasses.
- Implement fire prevention practices in Sierra Bermeja, CNRWR and Peñones de Melones during dry season.

- Continue to provide technical assistance to Service's Refuge Division for the development of the CCPs for CRNWR and LCNWR and to address current threats within the refuge.
- Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of the species in the wild.
- Determine the number of self-sustainable populations needed to delist the species.
- Additional surveys should be conducted for the four species in Puerto Rico.
- Continue protecting existing populations and their habitat.
- Work closely with International Affairs to obtain information from pelos del diablo on the Island of Cuba.

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Appendix A

Summary of peer review for the 5-year review of *Aristida chaseae, Aristida portiricensis, Lyonia truncate* var *proctorii* and *Vernonia proctorii*.

The document was reviewed internally by Marelisa Rivera and Edwin E. Muñiz. They mostly provide editorial comments. Once the comments were added to the document, it was sent to four outside peer reviewers (see below). The outside peer reviewers were chosen based on their qualifications and knowledge of the species. We indicated our interest in all comments the reviewers may have about *Aristida chaseae*, *Aristida portiricensis*, *Lyonia truncate* var *proctorii* and *Vernonia proctorii*, specifically in any additional information on the status and the current threats of the species.

The due date of the peer review comments was on September 15, 2010. No comments were received during the comment period.

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U.S. FISH AND WILDLIFE SERVICE

5-YEAR REVIEW for *A. chaseae*, pelos del diablo, *Lyonia truncata var proctorii* and *Vernonia proctorii*

Current Classification Endangered

Recommendation resulting from the 5-Year Review

X No change is needed for *A. chaseae*, pelos del diablo, *Lyonia truncata var proctorii* and *Vernonia proctorii*

Review Conducted By Carlos Pacheco, Caribbean Ecological Services Field Office

FIELD OFFICE APPROVAL:

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

Approve Edwin Muñiz Date 16 Sept 2010

REGIONAL OFFICE APPROVAL:

for

Cynthia Dohner, Lead Regional Director, Fish and Wildlife Service

Approve Amon L Valdez Date 12-2-10

U.S FISH AND WILDLIFE SERVICE
5-YEAR REVIEW

Addendum I: Summary of new information gathered since the 2010 *Aristida chaseae, Aristida portoricensis, Lyonia truncata var. proctorii,* and *Vernonia proctorii* 5–Year Review

On March 12, 2018, the U.S. Fish and Wildlife Service (Service) published a notice in the Federal Register (83 FR 10737) announcing the five-year status review of *Aristida chaseae* and *Aristida portoricensis*. On June 30, 2017, the Service published a notice in the Federal Register (82 FR 29916) announcing the five-year status review of *Lyonia truncata var. proctorii*, and *Vernonia proctorii*. It requested new information and comments from species experts and biologists familiar with these endangered plants concerning their biology and status. No comments were received from the public. No part of this review was contracted to an outside party. This addendum summarizes information that the Service has gathered since the last joint *A. chaseae, A. portoricensis, L. truncata var. proctorii*, and *V. proctorii* 5-year status review approved on December 2, 2010.

C. Updated information

1. Biology and Habitat

Between 2010 and 2018, the Service, the Puerto Rico Department of Natural and Environmental Resources (PRDNER), the University of Puerto Rico at Mayagüez (UPRM), and the Fairchild Tropical Botanic Garden (FTBG) worked collaboratively on the implementation of recovery actions (e.g., surveys, propagation protocols) for *A. chaseae, A. portoricensis, L. truncata var. proctorii,* and *V. proctorii*. The obtained new information is summarized on Table 1 and discussed below.

Aristida chaseae and ***Aristida portoricensis***

Aristida chaseae and *A. portoricensis* were originally reported from Cerro Mariquita mountain, the highest peak in the Sierra Bermeja range, between the municipalities of Lajas and Cabo Rojo, Puerto Rico. Within Cerro Mariquita, the species are known to occur at La Tinaja Tract, which is part of the Laguna Cartagena National Wildlife Refuge (LCNWR). The highest point of La Tinaja Tract lies a few meters below Cerro Mariquita peak (Weaver and Chinea, 2003), borders to the west with a private land known as the Lozada Farm, and on the east with the private land known as Finca María Luisa (also known as Finca Escabí) (Figure 1).

In 2013, Morales-Pérez developed a distribution map of *A. chaseae* and *A. portoricensis* within La Tinaja Tract. Most of the recorded plants are located on the western half of La Tinaja Tract, and a small amount were recorded on the southeast part on exposed rock of slopes and ridges (Morales-Perez, 2013). Although no population estimates were provided, his map shows hundreds of individuals of *Aristida spp.* lumped into four discrete areas of La Tinaja Tract (Morales-Perez, 2013). Even though the map does not differentiate between the two species, this information represents the first distribution and relative abundance map of *Aristida spp.* at this site.

During 2014 and 2016, Service biologists and personnel from the FTBG visited Finca Maria Luisa (Figure 1) and found a new population of *A. chaseae* and *A. portoricensis* on the northern section of this property, which is under a conservation easement with the conservation organization Para La Naturaleza (PLN 2014), but where agricultural practices are still being conducted (Lange et al. 2017). However, they also found that an undetermined number of individuals of both species were affected by goats trampling and grazing (Lange et al. 2017). In addition, a "robust" new population of *A. chaseae* and *A. portoricensis* were documented at Finca Solins (also known as El Conuco; Figure 1), another private property also located in the Sierra Bermeja mountains and owned by PLN (PLN 2014). According to habitat assessments conducted by staff from Envirosurvey, Inc. (2017), this property and the adjacent properties, have plenty of suitable habitat for *A. portoricensis, A. chaseae,* and *Vernonia proctorii*.

Also, during 2014 and 2016, personnel from the FTBG visited a private property named Upper Rancho Hugo in the Sierra Bermeja mountains. According to Lange et al. (2017), here they documented the healthiest population of *A. portoricensis* of all the areas they had visited in Sierra Bermeja in 2016. In 2016, Service biologist C. Pacheco also conducted a rapid assessment for *A. portoricensis* in this property, and counted 970 individuals in one acre. This private property is located just southeast of El Conuco. Hence, these individuals can be considered an extension of the population recorded at the El Conuco. The area surveyed had little signs of past habitat disturbance or exotic species (e.g., Guinea grass [*Megathyrsus maximum*]). However, the southern section and lower slopes of the property were dominated by exotic grasses and showed evidence of past human induced fires. In fact, a recent human induced fire affected the upper sections of the property and the population of *A. portoricensis* (O. Monsegur, USFWS, 2019, pers. comm.).

In 2018, botanists from UPRM documented the presence of *A. portoricencis* on a private property at Cerro Las Mesas in the municipality of Mayagüez that is suspected to be the type locality for the species (Figure 2) (58 FR 32255; final listing rule). However, they did not estimate the population abundance at that time. Steven Del Rosario, a graduate student from UPRM is currently conducting a study sponsored by PRDNER on the distribution, population structure, and reproductive biology of *A. portoricencis* at this site and neighboring areas. The information from this research will provide insight on the species' phenology, and the ongoing threats to the species and its habitat at this site (S. Rosario, UPRM graduate student, 2018, pers. comm.).

In 2010, Service biologists C. Pacheco and O. Monsegur visited Peñones de Melones in the municipality of Cabo Rojo and recorded 578 individuals of *A. chaseae* in an area of approximately 275 squares meters (Figure 2) (USFWS 2010). The Peñones de Melones area is composed mainly of private lands and was once the site of the proposed Monte Carlo Resort – Boquerón Bay Villas (FWS Project identification number 72023-023), and Punta del Sol Hotel (FWS Project identification number 72023-085). To date, these projects have not been built but these lands remain available for development. During 2014 and 2016, personnel from the FTBG visited the area and recorded *A. chaseae* but no population estimates were provided (Lange et al., 2017). However, Lange et al. (2017) reported that the population is competing with exotic grasses. In addition, they reported grazing activity in the area but there were no signs of damage to *A. chaseae.*

In May 2019, Service biologists Carlos Pacheco and Angel Colón-Santiago conducted a rapid assessment for *A. chaseae* in Peñones de Melones and reported 512 individuals in 612.9 square meters (USFWS, unpublished data, 2019). The individuals seemed under stress by the drought season. However, some mature individuals were flowering.

In the 2010 5-year status review for these species, the known populations of *A. chaseae* and *A. portoricensis* where located at the Cabo Rojo National Wildlife Refuge (CRNWR), La Tinaja Tract, Cerro Mariquita (Cartagena Lagoon National Wildlife Refuge), and Peñones de Melones (Figure 2). As of the date of this review, *A. chaseae* is known to occur from two new localities (Finca María Luisa and El Conuco), and *A. portoricensis* is known to occur within two new localities (Finca María Luisa and Rancho Hugo) (Figure 1). In addition, the *A. portoricensis* type locality at Cerro Las Mesas has been confirmed, and appears to extend to neighboring private lands. Thus, the known range of both species has slightly expanded.

Lyonia truncata var. proctorii

In 2013, two new localities of *L. truncata var. proctorii* were reported during surveys at La Tinaja Tract by Morales-Pérez (2013). These localities (lower slopes) were estimated with a total of 280 individuals; about 80 percent of those individuals were recorded within the LCNWR land (La Tinaja), and 20 percent were documented southwest of the property in an adjacent private land known as Lozada Farm (Morales-Pérez 2013). Morales- Pérez (2013) reported a third locality of the species in the upper slope at Cerro Mariquita where the species was originally reported. However, it was not accessed due to the steepness of the site for conducting surveys.

Previously, Service biologists had documented about 25 individuals on two subpopulations at Finca Lozada and Cerro Mariquita (13 in the eastern cliff, and 12 in the northwest site) (USFWS 2010). In 2016, Service biologists visited the northwest section of the Finca Lozada and observed around 49 individuals of *L. truncata var. proctorii* (C. Pacheco, Service, unpublished data, 2016). We believe this increment in the number of individuals of *L. truncata var. proctorii* is the result of greater search efforts, and not necessarily due to an increase in the population. Overall, the population is characterized as old population structure (composed of only mature plants) with no evidence of natural recruitment in the wild (O. Monsegur-Rivera, Service, 2018, pers. comm.).

Vernonia proctorii

Morales-Pérez (2013) recorded *V. proctorii* at Cerro Mariquita. The study reported a total of 618 individuals, but recommended a more complete assessment since areas adjacent to the tract were not surveyed, including Finca Lozada property (Morales-Pérez 2013). In addition, *V. proctorii* was documented at Finca Maria Luisa and Upper Rancho Hugo for the first time by Service biologists and personnel from the FTBG during the 2014 and 2016 visits. No population estimates were provided for Finca María Luisa. However, the species was present in two distinct areas that are affected by grazing (Lange et al., 2017). In addition, individuals located at gentle slopes were co-occurring with species associated with disturbed sites such as *Croton flavens* (yellow balsam); while the individuals located at the steeper gradient slopes co-occurred with native species (Lange et al., 2017). Nonetheless, the surveys by Lange et al. (2017) do not provide estimates in the number of individuals. In addition, we anticipate the presence of *V.*

proctorii at neighboring private properties to El Conuco and Maria Luisa since the seed of the species are dispersed by wind. In the Upper Rancho Hugo, the biologists identified three individuals (Lange et al., 2017).

At the time of listing, Proctor (1991) reported about 950 individuals of *V. proctorii* at Cerro Mariquita. However, in 2008, Service biologists documented only one natural population composed of approximately 150 individuals at this site (USFWS 2010). The finding of approximately 618 individuals at Cerro Mariquita and one additional population (in two distinct areas) in a private property adjacent to Cerro Mariquita, represent an expansion of the species distribution within the Sierra Bermeja area. Since additional suitable habitat for the species has been identified in Sierra Bermeja, a more comprehensive assessment should be conducted to gather additional information about species abundance and structure.

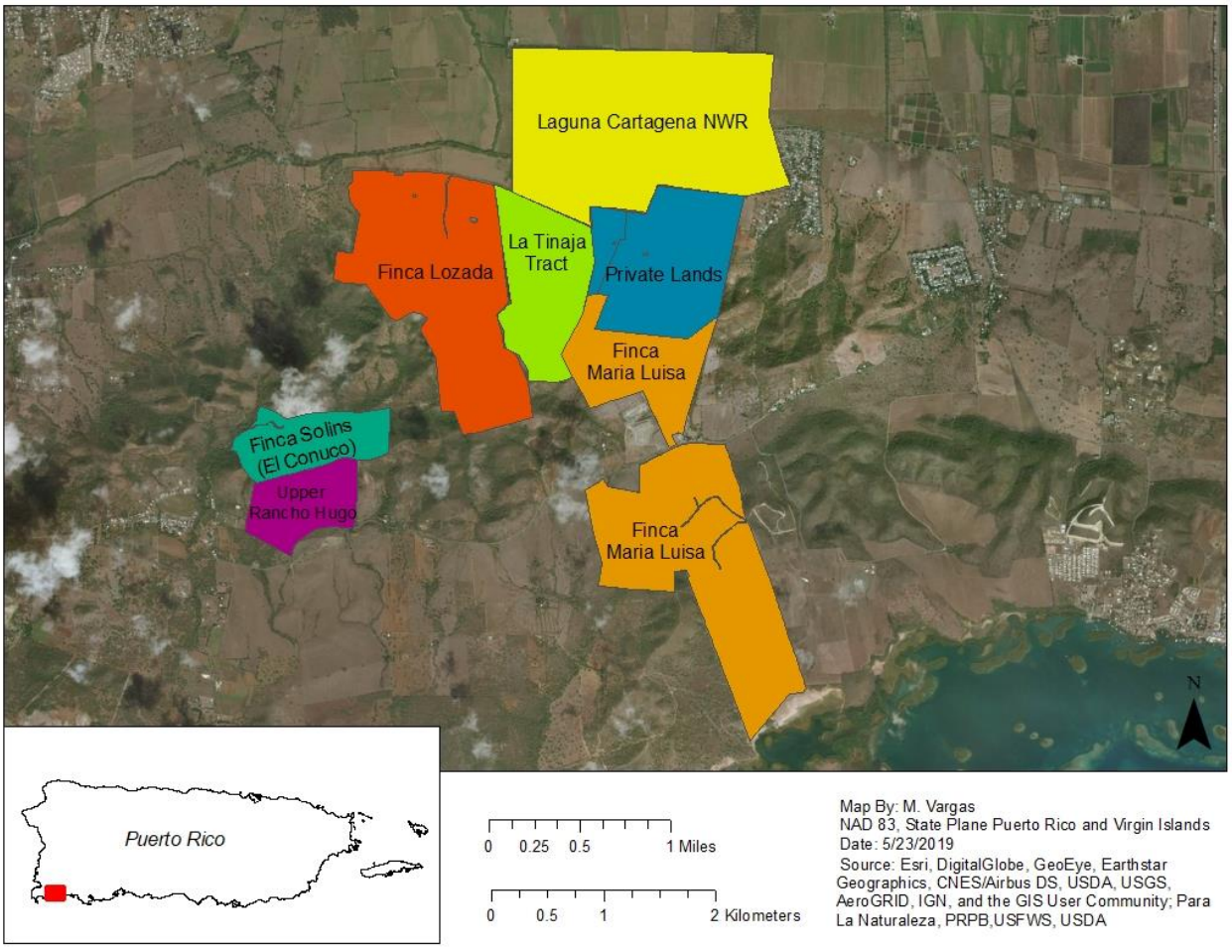

Figure 1: Properties in Sierra Bermeja where the listed plant species have been documented.

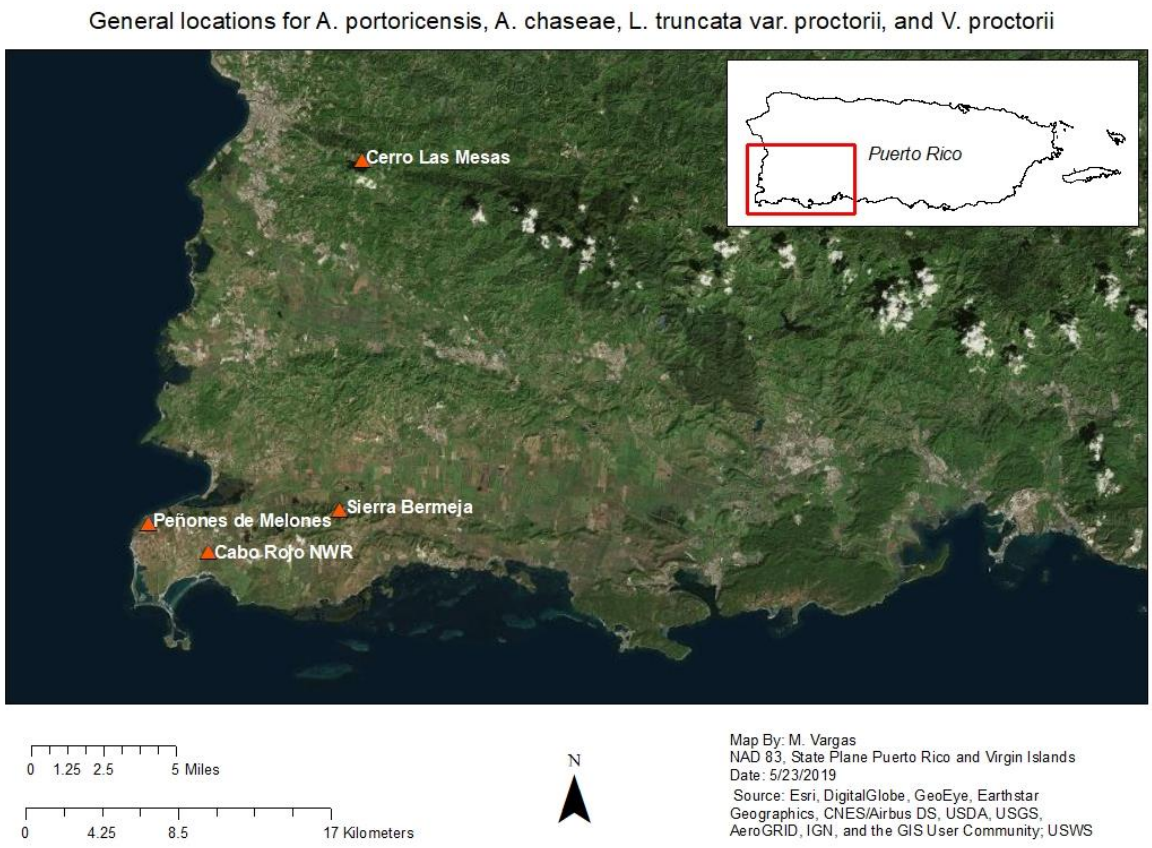

Figure 2: General locations for *A. portoricencis, A. chaseae, L. truncate var. proctorii,* and *V. proctorii*

Other relevant information on species.

Propagation and Reproductive Biology

During 2014 and 2016, Service biologists and personnel from the FTBG collected seed material of the four species. The FTBG conducted a study to determine seeds viability, germination rates, storage potential, and developed propagation protocols for each of these species (Lange et al. 2017). Tests varied since the available quantity of collected seeds was not the same for all species. Summarized results are presented below for each species:

A. chaseae* and *A. portoricensis

Lange et al. (2017) test seed viability for *A. chaseae* using different treatment techniques and criteria, such as visual inspection, forceps test under the microscope and Tretrazolium. The results showed that the highest germination rates, 52% for *A. chaseae* and 34% for *A. portoricensis*, occurs within material that was hand selected under microscope; however, the authors highlight this is a slow process (Maschinski et al., 2018). To determine the storage potential, seeds were exposed to fresh, desiccation, and frozen storage treatments. Results showed that desiccation treatment had the higher germination rates, 80% for *A.*

chaseae and 67% for *A. portoricensis* (Maschinski et al., 2018). The relatively low viability of seeds despite the forceps test may be the result of the harvesting of immature seed material (Maschinski et al., 2018). In addition, Maschinski et al. (2018) stressed that wind pollinated species show a low seed viability due to several factors (e.g., low plant density, distance to pollen source and short plant height). The findings from Maschinski et al. (2018) demonstrate that both species tolerate orthodox seed-storage protocols, meaning that large numbers of seeds can be frozen long-term at a low cost, and thus it is feasible to seed bank these species.

L. truncata var. proctorii

To determine the storage potential, seeds were exposed to fresh, desiccation, and frozen storage treatments. Results showed that the species benefits from desiccation treatments resulting in an approximate 60% germination rate (Lange et al. 2017). Moreover, the germination rates after storage are a very important finding as the species has no recruitment in the wild (e.g., no evidence of seedlings), and shows an old population structure. In addition, it highlights the potential for long-term conservation (seed banking) of this rare endemic.

V. proctorii

Seed viability for *V. proctorii* greatly varied depending the collection site. Sampling material from Finca Maria Luisa showed a 46% of seed viability, while sampling material from Finca Lozada showed a 4% of seed viability (Lange et al. 2017). The low viability was presumed to be the result either of the timing of the seed harvest, or due to the predation of seed material by an undetermined insect pest (Lange et al. 2017). To determine the storage potential, seeds were exposed to fresh, desiccation, and frozen storage treatments. Results showed that germination occurs faster with the fresh treatment, but all treatments had a 5% maximum germination rate within 66 days. Lange et al. (2017) also tried vegetative propagation, but none of the samples propagated.

According to Lange et al. (2017), the reports of low viability of seeds for *V. proctorii* and the *Aristida spp.* might be an artifact of collection methods (e.g.; date of collection), seed storage, predation of seeds, and germination techniques. In addition, Lange et al. (2017) determined that seeds of all four species present in Sierra Bermeja are capable of orthodox storage, meaning that a large numbers of seeds can be frozen or desiccated for long term and still viable. Because of this collaborative agreement, a long-term storage of seeds of all four species is now in place at the USDA National Laboratory for Genetic Resource Preservation in Colorado, and at the Fairchild Tropical Botanic Garden in Florida (Lange et al. 2017). Moreover, propagation and reintroduction guidelines were developed for further conservation efforts of these four species (Lange et al. 2017).

Table 1: Summary of information gathered during this review compared to previous known information.

Species	Location	Number of species	
		2010	2019
A. Chaseae	Cabo Rojo National Wildlife Refuge (CRNWR)	474 individuals (USFWS 2010)	Recorded but no population estimate provided (Lange et. al. 2017)
	La Tinaja Tract/ Cerro Mariquita (LCNWR)	Recorded but no population estimate provided. (USFWS 2010)	Hundreds (Morales-Perez 2013)
	Peñones de Melones	578 individuals (USFWS 2010)	512 individuals (USFWS, unpublished data, 2016)
	Finca Maria Luisa *		Recorded but no population estimate provided (Lange et. al. 2017)
A. portoricensis	Cerro Las Mesas	Not found (USFWS 2010)	Found but no estimate provided (S. Rosario, UPRM graduate student, 2018, pers. comm.
	La Tinaja Tract/ Cerro Mariquita (LCNWR)	Recorded but no population estimate provided. (USFWS 2010)	Hundreds (Morales-Perez 2013)
	Finca Maria Luisa *		Recorded but no population estimate provided (Lange et. al. 2017)
	Upper Rancho Hugo*		970 individual in one acre (USFWS, unpublished data, 2016)

L. truncata var. proctorii	Cerro Mariquita and La Tinaja Tract (LCNWR)	25 (USFWS 2010)	280 (Morales-Pérez 2013)
	Finca Lozada (Cerro Mariquita northwest section of the farm)	12 (USFWS 2010)	49 (USFWS, unpublished data, 2016)
V. proctorii	Cerro Mariquita	150 (USFWS 2010)	618 (Morales-Pérez 2013)
	Upper Rancho Hugo*		3 (USFWS, unpublished data, 2016)
	Finca Maria Luisa*		No population estimate provided. (Lange et. al. 2017)

*New localities.

Threat Factors Analysis

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

In the 2010 5-year review, the Service considered habitat destruction and modification as one of the factors affecting the continued existence of *A. chaseae, A. portoricensis, L. truncata var. proctorii,* and *V. proctorii* since these species can be found in privately owned properties within and adjacent to the Cerro Mariquita area. In fact, during this current review additional localities of these species were found within privately owned lands under agricultural practices. The Puerto Rico Planning Board classified the Sierra Bermeja area as a District of Conservation Resource (CR) (https://gis.jp.pr.gov/mipr), which has specific restrictions on development activities in order to protect the natural resources of the area (PRPB, 2015). However, the mountain range is within the Agricultural Reserve for agricultural activity and residential use, which allows some agricultural activities, and construction of residential homes with the implementation of best management practices with some limitations (JPPR 2015, pp. 118-129). Because of this designation, cattle grazing, hay cutting and rural development on this mountain range are authorized. Observations from Service staff since 2006 indicate that private landowners continue to affect the habitat through activities like cutting some new access roads on their properties (C. Pacheco and O. Monsegur-Rivera, Service, 2017, pers. observations). Also, cattle trampling activity was documented at the Finca Maria Luisa in the northern area of property (Envirosurvey, Inc. 2017; Lange et al. 2017). More recently, despite the conservation zoning of Sierra Bermeja, Service staff has

observed evidence of bulldozing and clearing of native vegetation in the proximity of known populations of these species (O. Monsegur-Rivera, Service, 2018, pers. comm.). These practices have resulted in habitat modification and degradation, soil erosion, and possible elimination of individuals. In addition, proposed development projects such as Monte Carlo Resort and Punta del Sol Hotel at Punta Melones (FWS, 2010) may pose a threat to *Aristida spp.*. Therefore, even though there are different populations protected under conservation easements in private properties, the threat of habitat destruction and modification still exist for *A. chaseae, A. portoricensis, L. truncata var. proctorii,* and *V. proctorii*.

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

In the final rule, this factor was not considered a threat in the decline of these four species. At the present, we are not aware that over utilization for commercial, recreational, scientific or educational purposes constitute a limiting factor for *A. chaseae, A. portoricensis, L. truncata var.,* and *V. proctorii.*

c) Disease or predation:

In the final rule, this factor was not considered a threat in the decline of these four species. However, on November 2014 and January 2016, evidence of grazing activity by cattle, horses- and goats was observed at the Finca Maria Luisa (Lange et al. 2017) and at Finca Lozada (C. Pacheco, Service, 2018, pers. comm.).

Also, Cerro Mariquita and Upper Rancho Hugo are adjacent to private lands where grazing pose a threat to these species due to proximity with the populations. However, we do not have substantial information stating that herbivores target these species since exotic grasses and other succulent plants occur in these properties. Hence, the current effect of grazing on these species is unknown.

Based on the above, and the lack of substantial information we believe that disease or predation should not be considered a threat for *A. chaseae, A. portoricensis, L. truncata var.,* and *V. proctorii* until more information regarding the impact of grazing of these species is gathered.

d) Inadequacy of existing regulatory mechanisms:

In the final listing rule, this factor was considered a threat to *A. chaseae, A. portoricensis, L. truncata var.,* and *V. proctorii*. As stated in the 2010 5-year status review, the species are protected under the Commonwealth's Law No. 241-1999 (12 L.P.R.A. Sec. 107), known as Nueva Ley de Vida Silvestre de Puerto Rico (New Wildlife Law of Puerto Rico). The purpose of this law is to protect, conserve and enhance both native and migratory wildlife species; declare property of Puerto Rico all wildlife species within its jurisdiction, regulate permits, regulate hunting activities, and regulate exotic species among others activities. This law also has provisions to protect habitat for all wildlife species, including plants. In 2004, the PRDNER approved Regulation 6766 or *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 govern the management of threatened and endangered species in the Commonwealth

of Puerto Rico). Article 2.06 of Regulation 6766 prohibits collecting, cutting, removing, among other activities, listed plant individuals within the jurisdiction of Puerto Rico (DRNA 2004, p. 11). The provisions of Law No. 241-1999 and Regulation 6766 extend to private lands. Although there are legal mechanisms in place for the protection of *A. chaseae, A. portoricensis, L. truncata var.,* and *V. proctorii* (e.g., laws, regulations, zoning), sometimes the enforcement of such mechanisms on private lands is challenging since accidental damages (e.g., by cutting, pruning, or mowing) or impacts from agriculture can result in habitat modification that can affect these four species. In fact, Envirosurvey, Inc. (2017) expressed concern about cattle trampling activities at Finca Maria Luisa (see factor A). Another form of impact to these species is from agriculture, for example, zoning laws allow agricultural practices than can result in habitat modification that can affect the four species. The knowledge on the natural range of *A. chaseae, A. portoricensis, L. truncata var.*, and *V. proctorii* has increased since the time of listing and they have been recorded in new areas subject to agriculture and urban development. In such cases, despite the existence of regulatory mechanisms, habitat modification could have occurred in these newly documented areas.

Nonetheless, the LCNWR/La Tinaja Tract and the CRNWR are managed in accordance with the National Wildlife Refuge Improvement Act of 1997. Collection of plants is prohibited per 50 CFR 27.51 as well as per the Endangered Species Act. Additionally, the Comprehensive Conservation Plans (CCPs) for LCNWR and CRNWR include measures for the protection and recovery of threatened and endangered species within these Refuges (USFWS 2011a, p. 35; USFWS 2011b, p. 47).

In short, these plants are widely distributed in conservation lands, and therefore, so the threat due to inadequacy of regulatory mechanisms has been largely reduced. However, the occurrences of these species on private lands continue to need enforcement, attention, and outreach plans to explain the importance of these species and avoid adverse effects on these species.

e) Other natural or manmade factor affecting its continued existence:

According to Lange et al. (2017), *A. chaseae, A. portoricensis, L. truncate var. proctorii,* and *V. proctorii* are currently threatened by competition with exotic invasive grasses and forbes (e.g.; Legumes). The habitat intrusion by these exotic grasses is promoting a fire regime that pose a direct threat to *A. chaseae, A. portoricensis, L. truncata var. proctorii,* and *V. proctorii,* as these endemics are not adapted to fires. In addition, frequent human-induced fires threaten the species. In fact, the populations of *A. chaseae, A. portoricensis,* and *V. proctorii* at Finca Solins and Upper Rancho Hugo, and neighboring lands were affected by a human induced fire on April 29, 2019 (O. Monsegur-Rivera, Service, 2019, pers. comm.).

In the 2010 5-year status review, after a heavy rain event, Service biologist observed three landslides at Cerro Mariquita. In 2017, Lange et al. reported that since the four species are found in steep slopes at Cerro Mariquita, landslides after heavy rain events could pose a threat to these species.

Base on the above, we believe that there have not been changes with respect to Factor E since the 2010 5-year status review, and that these four species still threatened by other natural or manmade factors, such as competition with introduced invasive grasses, human-induced fires, and landslides (see page 16 of 2010 5-year status review).

IV. Synthesis

The limited new information presented in this addendum complement the information presented on the 2010 5-year status review for these four species. Since 2010, and following the recommendations made in the 2010 5-year status review, efforts have been made to assess the species, resulting in the discovery of new populations of *A. chaseae, A. portoricensis, L. truncata var. proctorii,* and *V. proctorii* in properties within Sierra Bermeja. However, no population estimates were provided as part of these assessments. Currently, work is being conducted to assess the distribution and structure of *A. portoricensis* population at Cerro Las Mesas in the municipality of Mayagüez (type locality). The ongoing habitat assessments has provided an insight on the threats by exotic plant species, and the trampling and grazing by exotic mammals, and identified possible development threats in some of the private properties.

In addition, reproductive biology and propagation studies have been conducted to determine seed viability, germination rates, and storage potential, showing that all four species are capable of orthodox storage, meaning that a large numbers of seeds can be frozen or desiccated for long terms and still viable. Also, propagation protocols have been developed for each of the species as per recommendations made in the 2010 5-year status review.

Based on the information gathered during this review, the knowledge on the number and distribution of these species has increased. However, all four species continue to be threatened by habitat destruction or modification, and other natural or manmade factors such as competition with introduced plant species, human-induced fires, and landslides. Despite the existence of regulatory mechanisms, habitat modification could have occurred in several newly documented areas, so enforcement and education is needed. Based on the above, we believe that *A. chaseae, A. portoricensis, L. truncata var. proctorii,* and *V. proctorii* continues to meet the definition of an endangered species.

Future Recommended Recovery Actions

- Protection of currently known natural populations occurring on privately owned lands by establishing long-term conservation mechanisms such as Habitat Conservation Plans (HCP), conservation easements and conservation agreements with the landowners.
- Develop conservation and management plans with landowners that includes education on species description and needs and fire management.
- Establishment of new populations on protected lands within the Sierra Bermeja or other suitable habitats in southwestern Puerto Rico.

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FY 2019 APPROVAL*

Lead Field Supervisor, Fish and Wildlife Service

Approve Edwin Muñiz Date 6/10/2019

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

Field Supervisor signature on this document reflects:

1. _____ We have no new information, received no new public comments, and the original five factor analysis remains an accurate reflection of the species current status.

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