Tuberolabium guamense
(no common name)

5-Year Review
Summary and Evaluation

U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
Honolulu, HI

5-YEAR REVIEW
Species reviewed: *Tuberolabium guamense* (no common name)

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1.0 GENERAL INFORMATION

1.1 Reviewers:

Toni Mizerek, Biologist, Pacific Islands Fish and Wildlife Office (PIFWO)
Lauren Weisenberger, Plant Recovery Coordinator, PIFWO
Megan Laut, Conservation and Restoration Team Manager, PIFWO

Lead Regional Office:
Interior Region 12, Portland Regional Office

Lead Field Office:
Pacific Islands Fish and Wildlife Office

Cooperating Field Office(s):
N/A

Cooperating Regional Office(s):
N/A

1.2 Methodology used to complete the review:

This review was conducted by staff of the Pacific Islands Fish and Wildlife Office of the U.S. Fish and Wildlife Service (Service), beginning in Jaunary 2020. The review was based on the final rule listing this species; the final critical habitat designation; peer reviewed scientific publications; unpublished field observations by the Service, Territory of Guam and the Commonwealth of the Northern Mariana Islands (CNMI), and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information. The evaluation of Toni Mizerek, Biologist, was reviewed by Lauren Weisenberger, Plant Recovery Coordinator, and Megan Laut, Conservation and Restoration Team Manager.

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2018. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 156 species in Oregon, Washington, Hawaii, Palau, Guam, and the Northern Mariana Islands. Federal Register 88(83): 20088–20092, May 7, 2018.

1.3.2 Listing history:

Original Listing
FR notice: [USFWS] U.S. Fish and Wildlife Service. 2015. Endangered and Threatened Wildlife and Plants; Endangered Status for 16 Species and Threatened Status for 7 Species in Micronesia; Final Rule. Department of the Interior, Federal Register 80 (190): 59424-59497, October 1, 2015.

Date listed: October 1, 2015
Entity listed: *Tuberolabium guamense*
Classification: Threatened

Revised Listing, if applicable
FR notice: N/A
Date listed: N/A
Entity listed: N/A
Classification: N/A

1.3.3 Associated rulemakings: N/A

1.3.4 Review History:
This is the first 5-year review for *Tuberolabium guamense*.

1.3.5 Species' Recovery Priority Number at start of this 5-year review:
5

1.3.6 Current Recovery Plan or Outline:
Name of plan or outline: Recovery Outline for 23 Mariana Island Species
Date issued: February 2020
Dates of previous revisions, if applicable: N/A

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?
____**Yes**
__X_**No**

2.1.2 Is the species under review listed as a DPS?
____**Yes**
____**No**

2.1.3 Was the DPS listed prior to 1996?
____**Yes**
____**No**

2.1.3.1 Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 policy standards?

____Yes
____No

2.1.3.2 Does the DPS listing meet the discreteness and significance elements of the 1996 DPS policy?

____Yes
____No

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?

____Yes
____No

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

____Yes
__X_No

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

____Yes
____No

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery?

____Yes
____No

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:
A synthesis of the threats (Listing Factors A, C, and D) affecting this species is presented in section 2.3.2 and Table 2. Listing Factor B (overutilization for commercial, recreational, scientific, or educational purposes) and Listing Factor E (other species-specific threats) are not known to be a threat to this species.

The recovery plan is currently being drafted. However, the Hawai‘i and Pacific Plants Recovery Coordinating Committee (HPPRCC) has outlined the actions and

goals for stages leading towards recovery (2011). These stages are described below.

Current information is lacking for many Mariana Island plant species on the status of the species and their habitats, breeding systems, genetics, and propagule storage options. The following downlisting and delisting criteria for plants have therefore been adopted from the revised recovery objective guidelines developed by the HPPRCC (2011). Many of the plant species in the Mariana Islands are at very low numbers or declining rapidly, so the USFWS also developed criteria for avoiding imminent extinction and an interim stage before downlisting, based on the recommendations of the HPPRCC, to assist in tracking progress toward the ultimate goal of recovery. These criteria are assessed on a species-by-species basis, especially as additional information becomes available.

In general, long-lived perennials are those taxa either known or believed to have life spans greater than 10 years; short-lived perennials are those known or believed to have life spans greater than one year but less than 10 years; and annuals are those known or believed to have life spans less than or equal to one year. When it is unknown whether a species is long- or short-lived, the USFWS has erred on the side of caution and considered the species short-lived. This will be revised as more is learned about the life histories of these species. Narrow extant range and broad contiguous range are recognized as not needing different numbers of individuals or populations, but that the populations will be distributed more narrowly or more broadly, respectively, across the landscape. Obligate outcrossers are those species that either have male and female flowers on separate plants or otherwise require cross-pollination to fertilize seeds, and therefore require equal numbers of individuals contributing to reproduction as males and females, doubling the number of mature individuals. Species that reproduce vegetatively may reproduce sexually only on occasion, resulting in the majority of the genetic variation being between populations, therefore requiring additional populations. Species that have a tendency to fluctuate in number from year to year require a larger number of mature individuals on average to allow for decline in years of extreme habitat conditions and recuperation in numbers in years of more normal conditions.

Preventing Extinction

Stabilizing (interim), downlisting, and delisting objectives have been updated according to the draft revised recovery objective guidelines developed by the HPPRCC (2011). The HPPRCC identifies an additional initial objective, the Preventing Extinction Stage, in addition to the Interim Stabilization, Delisting, and Downlisting objectives. Furthermore, life history traits such as breeding system, population size fluctuation or decline, and reproduction type (sexual or vegetative), have been included in the calculation of goals for the number of populations and reproducing individuals for each stage. The goals for each stage remain grouped by life span defined as annual, short-lived perennial (fewer than 10 years), or long-lived perennial.

Based on the above guidelines, *Tuberolabium guamense* is categorized as a short-lived epiphytic perennial herb. To prevent extinction, which is the first step in recovering the species, the taxon must be managed to control threats (e.g., fenced to protect against ungulates) and have 50 individuals (or the total number of individuals if fewer than 50 exist) from each of three populations represented in *ex situ* (secured off-site, such as a nursery or seed bank) collections that are well managed. In addition, a minimum of three populations should be documented on the islands where they now occur or occurred historically. Each of these populations must be naturally reproducing (i.e., viable seeds, seedlings), with a minimum of 50 mature, reproducing individuals per population.

This recovery objective has not been met (see Table 1).

Interim Stage

To meet the interim stage of recovery of *Tuberolabium guamense*, 300 mature, reproducing individuals are needed in each of three populations, with at least one population on each island from which the species was known historically, as long as suitable habitat exists. All major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an *ex situ* collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004) that is secured and well managed. Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management.

This recovery objective has not been met (see Table 1).

Downlisting Criteria

As *Tuberolabium guamense* is currently listed as Threatened, no species-specific downlisting criteria are provided.

Delisting Criteria

In addition to achieving 5 to 10 populations with 500 mature, reproducing individuals per population and all of the goals of the interim stabilization stage, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Multi-island species should be represented by at least three populations on each of the islands from which they were known historically, as long as suitable habitat exists. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. Delisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers

more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes major limiting factors, breeding system, population structure and density, and proven management methods for major threats. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis.

This recovery objective has not been met (see Table 1).

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:
Tuberolabium guamense Ames is an epiphytic orchid in the family Orchidaceae (Ames 1914; Wood 1990; WCSP 2012a,b) and has no common name. The leaves are ovate to oblong (13 x 1.5 cm), leathery in texture with a smooth edge and lacking a petiole. The leaves grow out of conspicuous roots, which elevate the plant above tree trunks on which it grows (detailed species description in Raulerson and Rinehart 1992, p. 127).

Epiphytic orchids like *Tuberolabium guamense* grow in the forest canopy and sub-canopy, and use the tree only as a physical substrate upon which to grow (they are not parasites). They obtain moisture and nutrients from mutually symbiotic relationships with mycorrhizal fungi, which are often species-specific in their host associations. *T. guamense* orchids were known to occur low in the canopy, on tree trunks or shrubs in low sunlight. However, recent surveys have documented *T. guamense* at heights up to 50ft. and exposed to high sunlight (GPEPP 2019, in litt.)

Little is known about the life history of *Tuberolabium guamense*. As an epiphytic orchid, *T. guamense* plants are supported by the tree trunk and lower branches. They cling strongly onto their hosts with a well-developed root system and use the moisture from the air and bark of the host for nourishment. *Tuberolabium guamense* takes advantage of the microclimate of the trunk and lower branches, and prefers shade or moderate light to full sunlight (Raulersen and Rhinehart 1992).

Orchids are often pollinated by insects, but some are able to self-pollinate (Stebbins 1957). It is not known whether *Tuberolabium guamense* requires an insect pollinator, but the short two-day flower life suggests self-fertilization may occur. Epiphytic orchids often have brightly colored or fragrant flowers and nectar, or even chemical pheromones, designed to attract highly species-specific pollinators. Although *T. guamense* flowers are small and less conspicuous than other species of orchid, they are fragrant. Environmental cues may trigger more regional-scale pollination and seed set (Raulerson and Rinehart 1992). Seeds are minute and dust-like, and are dispersed by gravity and wind. Seeds have very little energy reserves, and rely on ambient nutrients, moisture, and mycorrhizal symbionts for germination and establishment (Baskin and Baskin 2014, p. 910).

2.3.1.2 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:
Tuberolabium guamense is endemic to the Mariana Islands, and is believed to have been historically widespread throughout the native forests of these islands. The estimated number of individuals across the species range is 26,906 (239 in Rota and 26,667 on Guam). This estimate is based on many targeted surveys on military land typically related to potential future projects. Beginning in November 2019, surveys of Joint Region Marianas area of responsibility and areas specific on Guam and CNMI began to specifically document *T. guamense* and other federally listed species in areas not previously surveyed including public lands (UOG 2019). These surveys are still ongoing. Currently, there are 4 populations in the southern half of Guam totaling 12,647 individuals (over 7,000 of which are found in a single population on DOD lands), and 5 populations (all on DOD lands) in northern half of Guam totaling 14,020 individuals. Individuals on Rota have not been observed or monitored since survey efforts prior to the time of listing. Demographic features or trends are unknown for *T. guamense*.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):
There is no information on *T. guamense* genetics, genetic variation, or trends in variation.

2.3.1.4 Taxonomic classification or changes in nomenclature:
Synonyms are *Saccolabium guamense* (Blume) and *Trachoma guamense* (Ames) (Garay 1972; Raulersen and Rhinehart 1992, p. 127; Smithsonian Institution 2014).

2.3.1.5 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.):
Tuberolabium guamense is endemic to the Mariana Islands, and is found on the islands of Guam (Territory of Guam) and Rota (Commonwealth of the Northern Mariana Islands). The final listing rule for *Tuberolabium guamense* (previously called *Trachoma guamense*) includes the islands of Guam, Rota, Aguiguan (or Aguijan), and Tinian as part of the species range (USFWS 2015, p. 59427). This range determination was based on a series of voucher specimens from the Herbarium at the University of Guam and listed on the Consortium of the Pacific Herbarium website in 2012. However, a review of the vouchers used to determine the species range for the listing rule identified some inconsistencies between the vouchers and the published information (see Raulerson and Rinehart 1992, p. 127) on the species. The Serivce concurs with Raulerson and Rinehart (1992) that the correct range of *Tuberolabium guamense* is Guam and Rota, and does not include the islands of Aguiguan and Tinian as reported in the final listing rule (see USFWS 2015, p. 59427).

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):
Tuberolabium guamense is predominantly found in native volcanic (Guam only), and limestone forests on native vegetation, and rarely on introduced vegetation with one exception of the introduced tree *Vitex parviflora*, which seems to be a suitable host for the orchid. Of 27 host species (trees, shrubs, and lianas) recorded for nearly 5,000 *T. guamense*, 92% were native, hosting 87% of the individual orchids found in recent surveys (DON 2020a). Native canopy species in the forest ecosystem (underlined taxa are known hosts of *Tuberolabium guamense*) include but are not limited to: *Artocarpus mariannensis, Barringtonia asiatica, Claoxylon* spp., *Cordia subcordata, Cyathea* spp., *Cyanometra ramiflora, Elaeocarpus joga, Ficus prolixa, Guamia mariannensis, Hernandia labyrinthica, H. sonora, Maytenus thompsonii, Merrilliodendron megacarpum, Ochrosia mariannensis, Pandanus dubius, P. tectorius, Pisonia grandis, Pouteria obovata,* and *Premna obtusifolia*. Other key native host tree species include *Eugenia reinwardtiana* and *Aglaia mariannensis* (Falanruw et al. 1989, pp. 6–9; Raulerson and Rinehart 1991, pp. 6–7, 11, 14, 20, 24, 28, 33, 50, 52–53, 62– 63, 72, 91, 96, 104; Ohba 1994, pp. 19–29; Mueller-Dombois and Fosberg 1998, pp. 257, 268, 270–271).

With the exception of avoiding the driest (<83 inches (in; 2,100 millimeters [mm]) annual rainfall) and hottest (>80° Fahrenheit (F; 26°Celcius [°C] annual minimum) conditions on Rota, *Tuberolabium guamense* seems to have little specificity for precipitation or temperature

within the current ranges recorded on Guam and Rota. The orchid occupies sites across gradients in space that span large differences in rainfall, temperature, and elevation within the ranges on these islands. Annual rainfall in the Marianas forest ecosystem ranges from 78 to 100 in. (2,000 to 2,500 mm), with a rainy season (June or July through October or November) accounting for about two-thirds of the annual rainfall. Temperature in the Marianas forest ecosystem ranges from 75° to 82°F (24° to 28°C), with low and high extremes of 64°F and 95°F (18°C and 35°C).

Elevation also contributes to variations in vegetation, as observed on Mt. Alutom, Mt. Almagosa, Mt. Lamlam, and Mt. Bolanus on Guam; the Rota Sabana; and on the slopes of the northern islands (Stone 1970, pp. 9, 14, 18–24; Falanruw 1989, pp. 4–6; Mueller-Dombois and Fosberg 1998, pp. 262–264). However, *Tuberolabium guamense* is well represented across these gradients in elevation. The moisture-retaining, moss-and epiphyte-rich species assemblages of the forest ecosystem in the Mariana Islands do not show a strong correlation with elevation or temperature. This is also true for *T. guamense*, which can be found near the coast at some locations and at mid- to high elevations at other locations.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range (Factor A):

Agricultural, military training and urban development loss of degradation of habitat—The total loss of native forest on Guam and Rota after human settlement and ultimately development is estimated at 83 and 53 percent respectively (Amidon et al. 2017). Approximately 22% of Guam and 6% of Rota is currently developed (Spies et al. 2019), reducing the available habitat for *Tuberolabium guamense*.

Ongoing military training also contributes to reduced available or less suitable habitat, primarily due to the establishment of Marine Corps Base Blaz (USFWS 2015). The buildup associated with establishing this Base will result in a loss of approximately 1,219 acres of limestone forest, 613 acres of herbaceous scrub and 3,221 acres of developed/barren land. More than 14,000 individual *Tuberolabium guamense* were found within areas cleared for this project, and this total is excluded from our total estimate of the current number of individuals (DON & USFWS 2020).

Development associated with other military projects continues to threaten *T. guamense*. Seventy-nine percent of current extant individuals occur on DOD property. In the second half of 2020, USFWS completed or is currently in consultation on four military projects where a total of 75 ac. of

habitat suitable for *T. guamese* will be cleared. Recent surveys of these areas found *T. guamense* in one 4.1ac. project footprint. The action agency will translocate 19 individuals in hopes that these persist. However, without long term commitments toward species recovery, these individuals are removed from the current population estimates.

Management actions—In an attempt to minimize the effects of habitat loss and degradation of individuals when found within habitat that will be disturbed and/or developed, salvage and translocation has been utilized to minimize the impacts (see USFWS 2017). However, the long-term success of salvage and translocation is currently unknown. The DON committed to salvage and translocate a minimum of 1,000 individuals followed by one year of maintenance and monitoring with 50 percent survival criteria. To date, 6,357 *T. guamense* have been translocated and 76% of those survived for one year (DON 2020, in litt.). This translocation effort is the first of its kind, and early results seem promising after one year post-translocation. However, the first year included management to promote survival through the first year, and included supplemental watering, as well as fertilizer and pesticide applications when it was determined necessary to prevent mortality. Therefore, translocation success past one year is unknown, and first-year management practices and monitoring are not planned to continue past that time period. Furthermore, these methods are not consistent with established translocation guidelines put forth by the International Union for the Conservation of Nature, the Center for Plant Conservation, and the Hawai‘i Rare Plant Restoration Group, or implementation plans development through biological opinions with the U.S. Army Garrsion, Hawai‘i (see HRPRG 2000; MIT 2003; IUCN 2013; CPC 2019). Therefore, these translocated individuals are not considered in current population estimates due to the uncertainty of long-term survival within the population.

Ungulate destruction and degradation of habitat— Feral ungulates, primarily pigs (*Sus scrofa*) and Philippine deer (*Cervus mariannus*), trample vegetation, contribute to erosion, graze often to the point of clearing understory vegetation and prevent regeneration by damaging or eating seeds or seedlings (USFWS 2015). By foraging and trampling native plants, severe erosion can result as well as establishment of nonnative vegetative communities. Recent studies on Guam indicate that while pigs and deer consume seeds, pigs dispersed many seeds while deer did not. Additionally, deer decreased seedling abundance while pigs did not (Gawel et al. 2018).

Management Actions—A number of ungulate exclusion areas have been established on Guam and others are expected to protect forested habitat from further degradation from these threats. Habitat restoration is

intended for many of these fenced areas, but has not begun in most areas. There are currently 1,132 ac of forested area on Guam fenced to exclude ungulates, out of the over 30,000 ac estimated. However, ungulate removal has occurred in only 20% of the fenced areas (Mizerek pers comm., 2020). Fencing to exclude ungulates from approximately 2,700 additional acres of forested areas in many separate parcels are planned over the next 20 years. *Tuberolabium guamense* individuals can be found in over 90% of the areas fenced for ungulates (including the 80% that still have ungulates present inside), but only three populations, all found on DOD property, are partially protected by these fences. One population has only 612 out of 7,022 individuals fenced, and the percentage of the other two populations in the fenced areas is unknown (one population has over 10,000 individuals and the other has 1,690). We currently do not know if the fences are ungulate free or if animals are trapped within the fence.

Brown Tree Snake destruction and degradation of habitat—The introduction of the brown tree snake (BTS; *Boiga irregularis*) poses a threat to the persistence of habitat needed for the recovery of *Tuberolabium guamense*. The introduction of the brown tree snake to Guam in approximately 1949, has caused the extirpation of a large percentage of bird and small animal species and appears to be responsible for elimination of all or most of the species that disperse seeds and pollinate native plants on Guam (Rodda et al. 1997 p. 565-567, Fritts and Rodda 1998 pp. 115, 131, Savidge 1987 entire, Perry and Morton 1999, p. 137; Rodda and Savidge 2007, p. 311; USFWS 2015). Almost three quarters of the native tree species on Guam were once dependent on birds to eat their fruits and disperse their seeds and germination of some tree species is reduced when the seed coat is not digested by passing through the gut of a bird (USFWS 2015). The only remaining native avian frugivore on Guam is the Micronesian starling (*Aplonis opaca*) (Pollock et al. 2019). On Saipan, the median dispersal distance modeled by Rehm et al. (2018, pp. 1, 5) for five bird species and 15 tree species was 184 feet (56 meters). In the absence of dispersal, seeds fall under the parent tree resulting in reduced connectivity between disjunct plants and reduced survival of seedlings due to conspecific competition (Nathan and Muller-Landau 2000). Loss of seed dispersers on Guam has resulted in reduced recruitment, altered spatial distribution of native tree species, reduced species richness, and reduced forest regeneration on Guam in comparison to the other islands (Rogers et al. 2017). Elimination of seed dispersers has cascading effects on other trophic levels, and can affect ecosystem stability (Perry and Morton 1999, p. 137; Fricke et al. 2017). The brown tree snake's elimination of native plant seed dispersers is an indirect threat that negatively impacts the habitat of *T. guamense*.

Management actions—Of the 1,132 ac. of currently fenced areas, 60 ac have BTS fences to prevent BTS ingress but suppression efforts

within are ongoing and data is not available to determine outcomes of the efforts. The BTS Technical Working Group is working to accomplish three overarching goals: (1) preventing the escape of BTS from Guam to other location, (2) suppressing and controlling BTS numbers to reduce their impact on the island of Guam and to restore the island's ecosystem, and (3) eradicating BTS from Guam (USFWS 2020a). A major biosecurity focus within the Mariana Islands is preventing the spread of BTS to the CNMI from Guam. Federal agencies support local capacity both in Guam and the CNMI. Efforts to control or eradicate BTS are ongoing and have included large scale toxicant application in the environment, trapping, trained snake-detector dogs, nighttime spotlight searches, scientific research and public education. The Department of Agriculture, Wildlife Services, in coordination with the National Wildlife Research Center (NWRC), U.S. DoD Environmental Security Technology Certification Program, and the Department of Interior-Office of Insular Affairs (U.S. Geological Survey, USFWS), are using aerial applications of acetaminophen to suppress BTS over forested areas at Andersen Air Force Base (Dorr, et al. 2016, in litt.; Phillips 2014, in litt; BTSTWG 2015, entire). In addition, repeated and sustained applications could drastically reduce BTS abundance on a landscape scale (Siers, et al. 2018, in litt.).

Rodent destruction and degradation of habitat—Rats also negatively impact forest systems by limiting regeneration of native vegetation. Plant regeneration is reduced by rats eating fleshy fruits, seeds, flowers, stems, leaves, roots, and other plant parts (USFWS 2015). Rats are present where *Tuberolabium guamense* is found on both Guam and Rota, including the Polynesian rat (*Rattus exulans*), the Norway rat (*R. norvegicus*), and a putative new southeast Asian *Rattus* line, originally thought to be *R. diardii* (synonymous with *R. tanezumi*) (Wiewel et al. 2009, pp. 210, 214–216). Rodent populations may be suppressed by the brown tree snake where they both occur, and rodent threats are expected to increase as brown tree snake suppression is implemented (USFWS 2015).

This steady, ongoing habitat degradation due to the presence of introduced ungulates, BTS and the resulting exclusion of pollinators and seed dispersers, and rats results in less available quality forest habitat, including native forest and mixed/secondary forest subtypes of the forest habitat on which *Tuberolabium guamense* depends. Subsequently, the range for *T. guamense* has diminished (Willsey et. al. 2019).

Management actions—None.

Established ecosystem-altering invasive plant modification and degradation of habitat— Non-native plants degrade native habitats through a variety of processes including modifying light availability, soil-water regimes, nutrient cycling and fire regimes and converting the plant

communities from native to non-native dominated (USFWS 2015). Although *Tuberolabium guamense* has adapted to utilize some nonnative species as host trees (e.g., *Vitex parviflora,* betelnut), changes in forest composition and species diversity impact the availability of physical and biological resources. Subsequent cascading impacts include reduced recruitment, reduced population sizes, and reduced connectivity.

Vitex parviflora forms dense, impenetrable thickets, which can limit native species recruitment, and has been evaluated as a high risk invasive plant species by the Hawai‘i Pacific Weed Risk Assessment (HPWRA 2015). it is unknown the long-term impacts on *Tuberolabium guamense* population resiliency by *Vitex parviflora*, though individuals have been observed to grow and reproduce when this invasive species acts as a host tree. Currently, four populations that make up over 72% of known individuals occur in habitats where at least some portion is considered degraded and specifically where over 3,000 individuals occur. An additional 10,000 individuals are found in habitats classified as *Vitex parviflora* habitats within four populations (two of which have also had degraded habitat classified as well), and can be considered as heavily-degraded as dominated by this invaive tree. In total, over 11,000 individuals (out of 26,667 total) are found on *Vitex parviflora*, roughly half of which are found in *V. parviflora*-dominated habitat.

Management actions—None. Since *Vitex parviflora* has been identified as non-native invasive species, there are various projects to remove the species as part of habitat restoration efforts (DON 2017, JRM 2019). As *T. guamense* can be found on this invasive species, this conservation action does not directly benefit *T. guamense* in the short term but should in the long term if native habitat is restored and *T. guamense* is still able to disperse onto the native vegetation.

Fire destruction and degradation of habitat— Fire is a primary threat to native species and native ecosystems especially on Guam (USFWS 2015). Wildfire is among the primary factors resulting in the conversion of forest to grassland. *Tuberolabium guamense* is currently found in forests on Guam and Rota. Wildfires burn an annual average of 1.6 to 2.4 percent of the land area in the Northern Mariana Islands and 3.5 to 4.0 percent of the land area of Guam (Minton 2006, Dendy 2019 in litt., and Trauernicht and Kunz 2019). In 2019, 396 wildfires burned 7,970 acres of grassland and 890 acres of forest and shrub vegetation on Guam, approximately double the annual average (Trauernicht and Chimera 2020 and FSRD 2020). On Rota in 2019, 1,163 acres of grassland and 428 acres of forest and shrub burned, more than double than annual average (Trauernicht 2020).

Wildfires in the Mariana Islands are primarily human-caused and are usually limited to previously burned grass-dominated areas (Minton 2006,

Dendy 2019 in litt.). However, during severe droughts such as the February through June wildfire seasons during El Nino years (Aydlett 2017), these grass fires burn into forest and shrubland (Athens and Ward 2004, Kunz 2018, Dendy 2019, and Trauernicht 2019). Where trees and shrubs are killed by fire, C_4 grasses outcompete seedlings of other species for light, water, and nutrients, resulting in forest conversion to grassland (Fosberg 1960, Stone 1970, D'Antonio, and Vitousek 1992, Minton 2006, NRCS 2011, Johnson 2012, and Leary 2018).

Fire damages and destroys native plant species, including *Tuberolabium guamense,* and all plant parts such as dormant seeds, seedlings, and juvenile and adult plants. Fires can also impact microclimatic conditions creating conditions favorable to nonnative plants.

The majority of fires on Guam occur in the southern half of the island where they are routinely set to increase hunting success by drawing deer into the landscape with emerging vegetation post fire (Minton 2006). For example, the 2,854 acre Bolanos Conservation Area in southern Guam was predominantly ravine forest. By 2006, the amount of ravine forest was reduced by 50 percent. Burning is a major factor that continuously reduces the amount of ravine forest each successive dry season likely due to seasonal conditions in addition to intentionally set fires (DAWR 2019). As recently as December 2019, suitable habitat for *T. guamense* was surveyed and found that individuals had been burned and killed in an area that had just burned (UOG 2019). There are 12,647 individuals of *Tuberolabium guamense* in four populations in the highly fire-prone southern half of Guam. Almost all of these individuals were not discovered until recently, yet all four populations have seen at least one and up to five fires since 2015 burn within 500m of individuals within them.

Management actions—None. Guam Forestry personnel cut firebreaks and did wildfire outreach and education covering mitigation and prevention (FSRD 2020), but these do not directly benefit *T. guamense*.

Typhoons and climate change degradation or loss of habitat—The Mariana Islands lie in the world's most prolific typhoon basin. Typhoons cause a number of impacts to native species and native ecosystems. Disturbed or destroyed vegetation due to typhoons modifies light availability and facilitates invasion by invasive plant species that compete for space, water, and nutrients, and alter basic soil hydrology and nutrient cycling processes (USFWS 2015, Wilsey et al. 2019). Climate change is expected to increase typhoon frequency and intensity, increase temperatures, and decrease precipitation, which can result in changes to the microclimate of a species (IPCC 2014, pp. 6-11). Several studies have examined the effects of cyclones on forests and found that high cyclone wind velocities overrode the sheltering effects of forest interiors and

spread damage across the landscape independent of forest edges (Pohlman et al., 2008; Catterall et al., 2008; Grimbacher et al., 2008). During typhoons, intense winds can defoliate trees, break primary branches, and uproot or topple trees. Forests can take several years to recover and during this time the habitat is susceptible to encroachment from invasive trees, shrubs, and vines (Marler 2001, p. 1). "Dry" typhoons have very little rainfall, causing salt water to be carried by the wind and deposited far inland. This causes the leaves on most dicot trees to wither and fall within two days of a storm and can cause mortality (Kerr 2000, p. 895). Droughts and vegetation changes following typhoons can cause an increase in wildfires (Aydlett 2017, in litt.). Such changes may lead to the direct loss of *T. guamense* or habitat needed for its conservation.

Management actions – None.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes (Factor B):
Not a threat.

2.3.2.3 Disease or predation (Factor C):
Slug herbivory—*Tuberolabium guamense* is at risk of slug herbivory. The Cuban slug (*Veronicella cubensis*) is a recent introduction to the Micronesian islands. These terrestrial mollusks are generalist feeders, and can attack a wide variety of plants, and switch food preferences if potential food plants change (Robinson and Hollingsworth 2006). There have no studies specifically focused on the potential impacts of slug herbivory on *T. guamense*.

Management actions—None.

2.3.2.4 Inadequacy of existing regulatory mechanisms (Factor D):
Tuberolabium guamense is not locally listed in Guam, and a program for the conservation and management of the species has also not been developed (DAWR 2019). The Commonwealth of the Northern Mariana Islands (CNMI) does recognize *T. guamense* as a federally-listed Threatened species, though not locally, and the need to protect and conserve the species (USFWS 2016). Therefore, the local government, particularly with the largest percentage of populations and individuals, does not offer protections for or conservation of the ecosystem that this species is dependent upon.

Additionally, four conservation areas (Anao, Bolanos, Cotal and Masso Reservoir) belong to the Government of Guam and were established to protect and preserve the natural resources of the island. The Guam Public Law 16-62 identified conservation reserves with an objective of "wise use of soil, water, plants, and animals of the reserve". However, rules for

economic use of these areas were not created and a Draft Master Plan was never formally adopted; therefore, enforcement of the conservation areas was not established.

The Bolanos population of *Tuberolabium guamense* is approximately half within the Bolanos Conservation Area and half outside on undesignated and unprotected lands. This makes up 15 percent of the total number of *T. guamense* individuals on Guam. Bolanos and other conservation areas are accessible for public entry where hunting is allowed with a valid permit (DAWR 2019). Intentionally set fires for hunting are the likely cause of the majority of fires in these areas. In December 2019, targeted surveys to determine *T. guamense* presence in Bolanos Conservation Area discovered recently burned forested areas which directly affected orchids (UOG 2019). Existing regulatory mechanisms are inadequate to address threats, specifically loss and destruction of habitat due to development, ungulates and fire to *T. guamense* because without being locally listed, no conservation or management programs were developed. Also, the conservation areas on Guam offer little to no protection against these primary threats without the establishment of rules, plans or enforcement.

Management actions—*Tuberolabium guamense* is identified in the Guam Wildlife Action Plan as a species of greatest conservation need. Guam Division of Aquatics and Wildlife recently developed goals, objectives and action ideas but progress is unknown. In May 2019, Guam's Director of Agriculture stated a commitment to establish permanent conservation areas for endangered species. The Director also agreed to work with the 35th Guam Legislature to pass legislation to ensure endangered species are protected in perpetuity (DOA 2019 in litt.). Progress on these efforts are also unknown.

2.3.2.5 Other natural or manmade factors affecting its continued existence (Factor E): N/A

Additional Current Management Actions:

- Surveys and monitoring—
  - Joint Region Marianas (JRM) surveyed for ESA-listed species, including *T. guamense*, at the Naval Munitions Site (NMS) and Naval Base Guam Telecommunication Site. Surveys were conducted to document locations and estimate population densities in sites that are proposed for ungulate exclusion and forest restoration as well as gain a better understanding of the species distribution and population sizes (JRM 2019).
  - DOD has funded contractors to conduct surveys for listed plants, with focus on *Tuberolabium* guamense, on public lands, including Bolanos Conservation Area, as part of the Recovery and Sustainment Partnership Initiative to increase coordination on

conservation management actions between DOD and DOI, as part of a Memorandum of Understanding between DOD and DOI (DOD and DOI 2018).

- Captive propagation for genetic storage and reintroduction—The Guam Extinction Prevention Program (GPEPP) has 9 plants in their nursery representing one wild individual from Mount Alifan, and 20 explants in micropropagation representing one individual from University of Guam campus property in Mangilao (GPEPP 2018).
- Habitat Protection—
  - An island-wide Habitat Conservation Plan for Guam, that would provide a collaborative and comprehensive approach to endangered species conservation on non-federal lands, is beginning to be developed (USFWS 2020b), but will take years to be finalized.
  - A 2020 Memorandum of Understanding between JRM and the USFWS outlined a mutual understanding regarding the intentions and future considerations of a Department of Defense Readiness and Environmental Protection Integration Initiative (REPI) to address conservation of upland vegetation communities (DON and USFWS 2020).
  - Range Fire Management Plan for Marine Corps Ranges on Guam. A range fire management plan to reduce range/wildfire potential, protect and enhance natural and cultural resources, integrate applicable permit and reporting requirements and implement ecosystem management goals, sustainable training, and objectives already supported on existing Marine Corps installations is being drafted.

Table 1. Status and trends of *Tuberolabium guamense* from listing through 5-year review.

Date	No. wild individuals	No. outplanted	Preventing Extinction Criteria identified by HPPRCC	Preventing Extinction Criteria Completed?
2015 (listing)	240	0	All threats managed in all three populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
2020	~ 26,906	0	All threats managed in all three populations	Partial. Some fencing constructed, ungulate removal ongoing
			Complete genetic storage	No

			3 populations with 50 mature individuals each	Yes

Table 2. Threats to *Tuberolabium guamense* and ongoing conservation efforts.

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Development, military training, urbanization	A	Ongoing	Partial: Development of HCP and REPI habitat protection.
Degradation of habitat by ungulates	A	Ongoing	Partial: There are established ungulate exclosures but eradication within is not complete. Additional ungulate exclosures are planned.
Degradation of habitat by Brown tree snake	A	Ongoing	DoD, USGS, USDA-APHIS, DOI, USFWS, and local collaborations to develop and implement BTS control measures.
Degradation of habitat by rodents	A	Ongoing	None
Degradation of habitat by established ecosystem-altering invasive plant species	A	Ongoing	None
Degradation and destruction by fire	A	Ongoing, Potential on islets	Firebreaks are being created and outreach and education occur, but none directly benefit *T. guamense*
Climate change degradation or loss of habitat, including typhoons	A	Ongoing	None
Predation by slugs	C	Ongoing	None
Inadequacy of existing regulatory mechanisms	D	Ongoing	There are discussions about adding *T. guamense* to Guam's ESA and measures adopted to protect species in Guam's conservation areas but progress is unknown.

2.4 Synthesis

There are approximately 26,906 *Tuberolabium guamense* individuals in 13 populations on Guam and Rota. There is no new data for the populations on Rota in the last five years. There are very few seeds or propagules in collections, and

there is no outplanting effort to increase resiliency of existing populations, or redundancy throughout the species' range.

Threats remain largely uncontrolled, with most efforts in the planning stage (see Additional Current Management Actions), and other efforts not having a substantial impact on populations of *Tuberlobium guamense.* Translocations of whole plants, for instance, have been attempted but long-term results and success are unknown. Some fire breaks and invasive plant removal have not benefitted *T. guamense*. The largest threats, particularly habitat degradation and loss due to fires, development, and invasive species, are continuing uncontrolled, and with compounding effects on the long-term resiliency of the species. Re-establishing from typhoons and fires are critical to maintaining resiliency, but limited by the increase of typhoons due to climate change, and the lack of control or regulations against fires. Furthermore, the continue degradation of habitats due to invasive species limits the habitats ability to recover from these stochastic events, but furthering their spread and reducing the ability of the native forest to regenerate.

The minute, dust-like seeds of the epiphytic *Tuberolabium guamense* are wind-dispersed. There are no soil seed banks, so habitat degradation and loss will prevent this species from re-establishing, until habitat is re-established, by re-growth from damaged and defoliated trees, where suitability for *T. guamense* could be diminished due to the presence of invasive plants and animals. If and when suitable habitat recovers, nearby existing populations of *T. guamense* are necessary to produce the source of seeds to disperse and create new populations. Upon first establishment, generations would need to thrive with vigor and fecundity, to re-establish populations. The populations of *T. guamense*, therefore, are likely dependent on each other's resiliency, potentially forming metapopulations, that are reliant upon the health of nearby populations to re-establish after typhoons and fires. Unfortunately, these fires and typhoons continue to increase in frequency and intensity.

Preventing extinction, interim stabilization, downlisting, and delisting objectives are provided in HPPRCC's Revised Recovery Objective Guidelines (2011). To prevent extinction, which is the first step in recovering the species, the taxon must be managed to control threats (e.g., fenced and protected from fire) and have 50 individuals (or the total number of individuals if fewer than 50 exist) from each of three populations represented in an *ex situ* (at other than the plant's natural location, such as a nursery or arboretum) collection. In addition, a minimum of three populations should be documented where they now occur or occurred historically and each of these populations must be naturally reproducing (i.e., viable seeds, seedlings, or saplings) with a minimum of 50 mature, reproducing individuals per population.

The preventing extinction goals for this species have not been met (Table 1), although there are three populations (on Guam) with 50 mature individuals each, genetic storage goals have not been met and recruitment has not been

documented. Of greater concern is the lack of threat control to *T. guamense*. Threats are not all controlled throughout the range of the species. Specifically, the amount of suitable habitat is decreasing, ungulates are excluded from only a small portion of suitable habitat and fires directly impact *T. guamense* and their habitat (Table 2). Therefore, *T. guamense* meets the definition of Threatened as it is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

3.0 RESULTS

3.1 Recommended Classification:

____Downlist to Threatened
____Uplist to Endangered
____Delist
___*Extinction*
____*Recovery*
____*Original data for classification in error*
__X__**No change is needed**

3.2 New Recovery Priority Number:

Brief Rationale:

3.3 Listing and Reclassification Priority Number:

Reclassification (from Threatened to Endangered) Priority Number:____
Reclassification (from Endangered to Threatened) Priority Number:____
Delisting (regardless of current classification) Priority Number:____

Brief Rationale:

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Surveys and inventories—Continue to survey for *T. guamense* in historical locations and potentially suitable habitat that has not been surveyed.
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species and those that compete with *T. guamense* or modify their habitat. Develop approaches to controlling *Vitex parviflora* that do not negatively impact *Tuberolabium guamense* resiliency.
- Fire monitoring and control—Develop and implement fire prevention management plans.
- Establish local protection—Add *Tuberolabium guamense* to the Guam and the CNMI Endangered Species list. Create management plans and enforcement to effectively protect *T. guamense* found with Guam conservation areas.

- Captive propagation for genetic storage and reintroduction—Collect seeds and other propagules for storage and propagation efforts for maintenance of genetic stock. Determine whole plant translocation protocols to ensure long-term persistence of translocated individuals.
- Ungulate predation or herbivory—Construct ungulate exclosures, or erect strategic fencing, around naturally occurring *T. guamense* populations to protect this species and associated habitat from feral ungulates. Ungulate removal should occur as quickly as possible after exclosures are constructed.
- Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change
- Alliance and partnership development—Initiate planning and contribute to implementation of ecosystem-level restoration and management, especially between Guam and the CNMI to benefit this species.
- Research life history and habitat associations to better identify information that will help guide recovery, for example: specific micro-habitat conditions, pollinators, reproduction, etc.
- Research how edge habitat does or does not affect *T. guamense* survival.
- Research the effects of the slug herbivory, if any, on *T. guamense*.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Tuberolabium guamense*

Current Classification: Threatened

Recommendation resulting from the 5-Year Review:

____Downlist to Threatened
____Uplist to Endangered
____Delist
_X__No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: _____

Review Conducted By:
Toni Mizerek, Fish and Wildlife Biologist, PIFWO
Lauren Weisenberger, Plant Recovery Coordinator, PIFWO
Megan Laut, Conservation and Restoration Team Manager, PIFWO

FIELD OFFICE APPROVAL:

MEGAN LAUT Digitally signed by MEGAN LAUT
Date: 2020.09.30 15:22:48 -10'00'

for _____

Field Supervisor, Pacific Islands Fish and Wildlife Office