U.S Fish and Wildlife Service

Draft Recovery Plan for 23 Species in the Mariana Islands

Photos: *Hedyotis megalantha* (Lauren Gutierrez), *Phyllanthus saffordii* (Guam Plant Extinction Prevention Program), Slevin's Skink (*Emoia sleveni*) (Bjorn Lardner), and Rota blue damselfly (*Ischnura luta*) (Lainie Berry)

Draft Recovery Plan for 23 Species in the Mariana Islands

U.S. Fish and Wildlife Service
Portland, Oregon

Draft Approved: HUGH MORRISON Digitally signed by HUGH MORRISON Date: 2022.11.02 16:42:30 -07'00'

Acting Regional Director
Pacific Region 1

DISCLAIMER

Recovery plans delineate reasonable actions needed to recover and/or protect listed species. We, the U.S. Fish and Wildlife Service (Service), publish recovery plans, sometimes preparing them with the assistance of recovery teams, contractors, State agencies, and others. Objectives of the recovery plan are accomplished, and funds made available, subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities with the same funds.

Recovery plans do not necessarily represent the views or the official positions or approval of any individuals or agencies involved in the plan formulation, other than our own. They represent our official position only after signed by the Director or Regional Director. Draft recovery plans are reviewed by the public and may be subject to additional peer review before the Service adopts them as final. Recovery objectives may be attained and funds expended contingent upon appropriations, priorities, and other budgetary constraints. Recovery plans are guidance and planning documents only; identification of an action to be implemented by any public or private party does not create a legal obligation beyond existing legal requirements. Nothing in this plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in any one fiscal year in excess of appropriations made by Congress for that fiscal year in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and completion of recovery actions.

Literature citation of this document should read as follows:
U.S. Fish and Wildlife Service. 2022. Draft Recovery Plan for 23 Species in the Mariana Islands. Portland, Oregon. xiii+76 pps.

An electronic copy of this recovery plan is available at:

https://www.fws.gov/endangered/species/recovery-plans.html

ACKNOWLEDGMENTS

The Service gratefully acknowledges the contributions of the following individuals and organizations in developing the Draft Recovery Plan for 23 Species from the Mariana Islands. The primary authors of this draft recovery plan are Tyler Willsey and Dawn Bruns (Service, Pacific Islands Fish and Wildlife Office [PIFWO], Honolulu, Hawai‘i). Chelsie Javar Salas, Lauren Weisenberger, Mary Jo Mazurek, Jacqueline Flores, Heather Benedict, Toni Mizerek, Laura Alexandria P. Gombar, Diane Sether, Fred Amidon, and John Vetter (PIFWO) compiled information used to develop the document. Tom Mathies, Bob Reed, David Sischo, Mike Richardson, Mari Reeves, Bronson Curry, Dan Pohemus, and Steve Miller provided valuable information as species experts. Reviewers were Lauren Weisenberger, John Vetter, Megan Laut, Gregory Koob, Katherine Mullett (PIFWO) and David Leonard (Service, Pacific Regional Office, Portland, Oregon).

RECOVERY PLANNING PROCESS

The Service uses a three-part process to develop our recovery plans (click here for details). This approach is intended to reduce the time needed to develop and implement recovery plans, increase recovery plan relevancy over a longer timeframe, and add flexibility to recovery plans so they can be adjusted to new information or circumstances. Under this process, a recovery plan includes the statutorily-required elements under section 4(f) of the Endangered Species Act (Act) (objective and measurable recovery criteria, site-specific management actions, and estimates of time and costs), along with a concise introduction and our strategy for how we plan to achieve species recovery. The recovery plan is supported by two supplementary documents: a species status assessment or species biological report, which describes the best available scientific information related to the biological needs of the species and assessment of threats; and the recovery implementation strategy, which details the particular near-term activities needed to implement the recovery actions identified in the recovery plan. Under this approach, new information on species biology or details of recovery implementation may be incorporated by updating these supplementary documents without concurrent revision of the entire recovery plan, unless changes to statutorily-required elements are necessary.

Thus, this recovery plan document is one piece of a three-part framework:

1. The **Species Status Assessment** (SSA) or **Species Biological Report** (SBR) informs the recovery plan; it describes the biology and life history needs of the species, includes analysis of each species' historical and current conditions, and includes discussion of threats and conservation needs of each species. The SSA or SBR's format is structured around the conservation biology principles of resiliency, redundancy, and representation (Shaffer and Stein 2000, pp. 307-310; Smith et al. 2018, entire Wolf et al. 2015, entire). This document may be updated as needed based on new information.

2. The **Recovery Plan** contains a concise overview of the recovery strategy for the species (indicating how its recovered state will achieve redundancy, resiliency, and representation), as well as the statutorily required elements of recovery criteria, recovery actions, and estimates of the time and costs to achieve the plan's goals.

3. The **Recovery Implementation Strategy** (RIS) is the vehicle for implementing the recovery plan. The RIS is a short-term, flexible operational document focused on how, when, and by whom the recovery actions from the recovery plan will be implemented. This document may be updated as needed based on new information, allowing it to be adapted to changing circumstances with greater flexibility and efficiency. The RIS will be developed and maintained in cooperation with our conservation partners, and will focus on the period of time and activities that work best for our partners to achieve recovery goals.

EXECUTIVE SUMMARY

Species Status:

This draft recovery plan addresses 14 plants (7 threatened, 7 endangered), 1 endangered mammal, 1 endangered reptile, and 7 endangered invertebrates. These 23 species were proposed for listing on October 1, 2014 (USFWS 2014) and were listed October 1, 2015 (USFWS 2015). Critical habitat has not been designated for these species. All of these species are currently or historically known from the Mariana Islands; the Pacific sheath-tailed bat and *Cycas micronesica* also occur outside of the jurisdiction of the United States. Listed plants currently occur on 6 of the archipelago's 15 islands and listed animals currently occur on 10 islands; 4 islands do not support these listed species.

Species included in this recovery plan.

SPECIES	COMMON NAME	DISTRIBUTION[1]	STATUS
PLANTS			
Bulbophyllum guamense	wild onion, siboyas halumtanu [Ch], siboyan halom tano[Ca]	Guam, Rota, **Saipan**, **Pagan**	Threatened (USFWS 2015)
Cycas micronesica	fadang [Ch], faadang[Ca]	Guam, Rota, Tinian, Pagan[2], Palau[3], Yap[3]	Threatened (USFWS 2015)
Dendrobium guamense	No Common Name (NCN)	Guam, Rota, **Saipan**, Tinian, Aguiguan, **Agrihan**	Threatened (USFWS 2015)
Eugenia bryanii	NCN	Guam	Endangered (USFWS 2015)
Hedyotis megalantha	pao dedu [Ch], pao doodu[Ca]	Guam	Endangered (USFWS 2015)
Heritiera longipetiolata	ufa halumtanu [Ch], ufa halom tano[Ca]	Guam, Saipan, Tinian, Rota	Endangered (USFWS 2015)
Maesa walkeri	NCN	Guam, Rota	Threatened (USFWS 2015)
Nervilia jacksoniae	NCN	Guam, Rota	Threatened (USFWS 2015)
Phyllanthus saffordii	NCN	Guam	Endangered (USFWS 2015)
Psychotria malaspinae	aplokating palaoan [Ch/Ca]	Guam	Endangered (USFWS 2015)
Solanum guamense	tano [Ca]	Guam, **Rota**, **Saipan**, **Tinian**, **Asuncion**, **Guguan**, **Maug**	Endangered (USFWS 2015)
Tabernaemontana rotensis	NCN	Guam, Rota	Threatened (USFWS 2015)
Tinospora homosepala	NCN	Guam	Endangered (USFWS 2015)
Tuberolabium guamense	NCN	Guam, Rota, **Tinian**, **Aguiguan**	Threatened (USFWS 2015)

SPECIES	COMMON NAME	LOCATION	STATUS
MAMMAL			
Emballonura semicaudata rotensis	Pacific sheath-tailed bat (Mariana subspecies), payeyi [Ch], paischeey [Ca]	**Guam**, **Rota**, Aguiguan, **Tinian**, **Saipan**, **Anatahan**, **Maug**	Endangered (USFWS 2015)
REPTILE			
Emoia sleveni	Slevin's skink, Marianas Emoia, Mariana skink, gualiik halumtanu [Ch], gholuuf [Ca]	**Guam**, Cocos Island[4], **Rota**, **Aguiguan**, **Tinian**, Sarigan, Alamagan, Pagan, Asuncion	Endangered (USFWS 2015)
INVERTEBRATES			
Hypolimnas octocula marianensis	Mariana eight-spot butterfly, ababbang [Ch], Libweibwogh [Ca]	Guam, **Saipan**	Endangered (USFWS 2015)
Vagrans egistina	Mariana wandering butterfly, ababbang [Ch], Libweibwogh [Ca]	Guam, Rota	Endangered (USFWS 2015)
Ischnura luta	Rota blue damselfly, dulalas Luta [Ch], dulalas Luuta [Ca]	Rota	Endangered (USFWS 2015)
Partula gibba	humped tree snail, akaleha [Ch], denden [Ca]	Guam, Rota[5], **Aguiguan**, Tinian, Saipan, **Anatahan**, Sarigan, Alamagan, Pagan	Endangered (USFWS 2015)
Partula langfordi	Langford's tree snail, akaleha [Ch], denden [Ca]	Aguiguan	Endangered (USFWS 2015)
Partula radiolata	Guam tree snail, akaleha [Ch], denden [Ca]	Guam	Endangered (USFWS 2015)
Samoana fragilis	fragile tree snail, akaleha dogas [Ch], denden [Ca]	Guam, Rota	Endangered (USFWS 2015)

Ch = Chamorro name, Ca = Carolinian name. Translations courtesy of the Chamorro/Carolinian Language Policy Commission.
1 = Bolded islands indicate historical range (i.e., taxa have been extirpated from islands in bold).
2 = Unconfirmed occurrence.
3 = Range outside of the Mariana Islands.
4 = Cocos Island is an islet off the southern coast of Guam.
5 = A genetic study of snails on Rota found the species thought to be *Partula gibba* may be a different species.

Recovery Vision:

The overall recovery vision for the 23 species addressed in this draft recovery plan (hereafter, the 23 species) is to have multiple redundant, self-sustaining populations representing the genetic and ecological diversity of the species distributed across their historical ranges in habitats where threats are managed. A recovery vision for each species group or species is presented in the main body of the recovery plan.

Recovery Strategy:

The overall recovery strategy for the 23 species will require assessment of populations and their habitat, selection of sites for long-term conservation, control of threats, development of regulatory protections, species-specific research, and augmentation and reintroduction to maximize the species' resiliency, redundancy, and representation. A detailed recovery strategy for each species group or species is presented in the main body of this document.

Most of the plant species covered by this recovery plan (10 of 14) persist at very low numbers and are in rapid decline. To target and track recovery efforts for critically rare plants, the Hawaiʻi and Pacific Plants Recovery Coordinating Committee (HPPRCC), developed two interim recovery stages with the goal of minimizing the likelihood of extinction and to stabilize populations (HPPRCC 2011). While these two interim recovery stages are not required under the Act they are critical to the recovery of these species. Once these interim stages are achieved, additional criteria must be achieved to downlist or delist a species. Thus, recovery will be achieved through a series of conservation stages including: (1) preventing extinction, (2) interim stabilization, (3) downlisting, and (4) delisting.

The conservation measures recommended at these stages include genetic storage, controlling threats in the immediate vicinity of individual plants, and augmentation and reintroduction with the goal of protecting and/or creating a limited number of small populations of each species. The recovery of each species will follow from these initial efforts and include continued assessments of the distribution and condition of the 14 species and their habitat, selection of sites for their long-term conservation, management of threats, and development of regulatory protections to assure their long-term protection. Several species will also need protection from species-specific threats including military ordnance, vandalism, recreational vehicles, introduction of disease, and limited numbers. Detailed recovery strategies for individual species are presented in the body of this document.

The recovery strategies for the animal species share the following measures: survey the historical range of each species to assess their distribution; conduct research to evaluate the species' status; collaborate with stakeholders to protect habitat; develop management and monitoring frameworks for habitat; manage threats; maintain the biosecurity of islands with extant populations to prevent the introduction of potential predators or habitat altering invasive species; and evaluate conservation translocation as a tool to reestablish populations. Detailed recovery strategies for individual species and species groups are presented in the body of this document.

Interim Recovery Stages:

Plant Species

Preventing Extinction

To meet the preventing extinction goals, surveys must be completed throughout each species' historical range and all major threats must be controlled in the immediate vicinity of the three populations (see below). Studies of plant reproductive biology are completed as needed to inform management. Each species has a minimum of 3 self-sustaining populations comprised of 25 to 100 sexually mature (mature) individuals per population with evidence of natural reproduction (i.e., viable seeds, seedlings, saplings). Genetic storage is achieved with at least 50 individuals per population, or the total number of individuals if fewer than 50 remain, are secured in a well-managed *ex situ* collection.

Interim Stabilization

To meet the interim stabilization goals, all preventing extinction targets must be achieved and 3 self-sustaining populations comprised of 100 to 600 mature individuals per population are conserved. Species known from multiple islands must be represented by at least one population on each historically occupied island, as long as appropriate stock is available for planting within the species known range. All major threats must be controlled around the target populations and each population is naturally reproducing.

The following tables summarize the downlisting and delisting criteria for the 23 species covered in this recovery plan. See the body of the recovery plan for a detailed explanation of each of the criteria.

Recovery Criteria:

Plant Species

Downlisting and Delisting Criteria – 14 species of plants, having met preventing extinction and interim stabilization goals.

	Criterion 1	Criterion 2	Criterion 3
Downlisting Criteria	5 populations including at least 3 on each island within species' historical range are stable for 10 years, each with at least 200 individuals	Monitoring in place; PVA completed	Threats managed, management plan completed that identifies actions needed to control threats to long-term persistence of habitat for all species
Delisting Criteria	10 populations including at least 3 on each island within species' historical range are stable for 20 years, each with at least 200 individuals	Threats including ungulates controlled, with land protections in place	Genetic analyses completed for all species

Animal Species

Downlisting and Delisting Criteria – Pacific sheath-tailed bat.

	Criterion 1	Criterion 2	Criterion 3	Criterion 4
Downlisting Criteria	3 stable populations on at least 2 islands each with at least 500 individuals	Roosts and habitat supporting Downlisting Criterion 1 are protected	All threats managed	None
Delisting Criteria	6 stable populations on at least 3 islands each with at least 500 individuals	Roosts and habitat supporting Delisting Criterion 1 are protected	All threats managed, management/monitoring plan completed; agreements to maintain habitats are in place	A management plan (or plans) is developed and implemented to ensure the long-term protection of the habitat that supports the 6 populations

Downlisting and Delisting Criteria – Slevin's skink.

	Criterion 1	Criterion 2	Criterion 3	Criterion 4
Downlisting Criteria	Stable populations on 4 islands	Suitable habitat supporting Downlisting Criterion 1 is protected	Islands are free of invasive predators or predators are controlled	None
Delisting Criteria	Stable populations on 6 islands, 1 must be on Guam, Rota, Tinian, Saipan, or Pagan	Suitable habitat supporting Delisting Criterion 1 is protected	All threats managed, management/monitoring plan completed; agreements to maintain habitats in are in place	A management plan (or plans) is developed and implemented to ensure the long-term protection of the habitat that supports the 6 populations

Downlisting and Delisting Criteria – Mariana eight-spot butterfly and Mariana wandering butterfly.

	Criterion 1	Criterion 2	Criterion 3	Criterion 4
Downlisting Criteria	At least 14 stable populations	Habitat and host plants supporting Downlisting Criterion 1 are protected	Populations are free of predators or predators are controlled	None
Delisting Criteria	At least 20 stable populations	Habitat and host plants supporting Delisting Criterion 1 are protected	Populations are free of predators or predators are controlled, management/monitoring plan completed, agreements to maintain habitats are in place	A management plan (or plans) is developed and implemented to ensure the long-term protection of the habitat that supports the 20 populations

Downlisting and Delisting Criteria – Rota blue damselfly.

	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5
Downlisting Criteria	At least 3 stable populations in at least 3 Talakhaya Watershed streams on Rota or in suitable habitat on other islands	Suitable habitat supporting Downlisting Criterion 1 is protected	Stream habitat is protected; turbidity, pollution, overharvesting of water is minimized; introduction of predators/competitors is managed	None	None
Delisting Criteria	At least 5 stable populations in at least 3 Talakhaya Watershed streams on Rota or in suitable habitat on other islands	Native and secondary forest in the Sabana plateau is preserved	Stream habitat is protected, management/monitoring plan completed, agreements to maintain habitats are in place	A captive breeding population has been established to ensure survival of the species	A management plan (or plans) is developed and implemented to ensure the long-term protection of the habitat that supports the 5 populations

Downlisting and Delisting Criteria – Four species of tree snails.

	Criterion 1	Criterion 2	Criterion 3	Criterion 4
Downlisting Criteria	At least 10 stable populations each with at least 400 individuals	Suitable habitat supporting Downlisting Criterion 1 is protected	Biosecurity measures are in place, risk evaluation indicates that occupied habitat is free of predators or that predation will not have population-level effect	None
Delisting Criteria	At least 20 stable populations each with at least 400 individuals	Suitable habitat supporting Delisting Criteria 1 is protected, management/monitoring plan completed; agreements to maintain habitats are in place	Biosecurity measures are in place; predation does not threaten the long-term viability of any population; and at least 5 of the 20 populations must occur in areas without predatory snails and the New Guinea flatworm	A management plan (or plans) is developed and implemented to ensure the long-term protection of the habitat that supports the 20 populations

<u>Recovery Actions and their Costs</u>:

Recovery actions and cost estimates for all 23 species are shown in the table below. Cost estimates are preliminary. Project-level details of recovery action implementation will be developed with partners in the RIS, which will supplement this draft recovery plan. Implementation is subject to availability of funds and is at the discretion of partners.

<u>Recovery Actions common to all 23 species and their estimated sost (in Fiscal Year 2022 dollars).</u>

Recovery Actions	Action #	Estimated Costs
Determine population status and current distribution	1.0	**$6,620,000**
Conduct research to clarify life history information, identify limiting factors and/or threats to population viability, and develop solutions	2.0	**$333,570,000**
Conserve and enhance populations	3.0	**$304,000,000 – $7,600,000,000**
Develop regulations and policy essential to recover the species and conserve their habitats	4.0	**$3,000,000**
Improve stakeholder awareness and engagement	5.0	**$340,000**
	TOTAL:	**$647,530,000 - $7,943,530,000**

<u>Date of Recovery</u>:

If all actions are fully funded and implemented as outlined, including cooperative efforts by all partners needed to achieve recovery, we estimate the earliest that the delisting criteria could be met would be between 2052 and 2117 for the listed plant species, 2062 for the sheath-tailed bat, 2052 for Slevin's skink, 2047for the Mariana eight-spot butterfly, 2052 for the Rota blue damselfly, and 2047 for the humped tree snail, Guam tree snail, and fragile tree snail. The year of recovery of the Mariana wandering butterfly and Langford's tree snail cannot be estimated unless these species are rediscovered, but in any scenario, recovery is unlikely to be achieved before 2062.

ACRONYMS AND ABBREVIATIONS

CNMI	Commonwealth of the Northern Mariana Islands
DLNR	Commonwealth of the Northern Mariana Islands Department of Lands and Natural Resources
DFW	Commonwealth of the Northern Mariana Islands Division of Fish and Wildlife
GPEPP	Guam Plant Extinction Prevention Program
IPCC	Intergovernmental Panel on Climate Change
PIFWO	Pacific Islands Fish and Wildlife Office
RIS	Recovery Implementation Strategy
USFWS	U.S. Fish and Wildlife Service

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I. INTRODUCTION

The Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act) protects species of wildlife and plants that are listed as endangered or threatened. Recovery is defined as "the process by which listed species and their ecosystems are restored and their future is safeguarded to the point that protections under the [Act] are no longer needed," according to the 2018 updated National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (Service or USFWS) Interim Recovery Planning Guidelines, Version 1.4 (NMFS and USFWS 2018, entire).

Recovery plans are guidance documents developed to provide recommendations to reduce or alleviate threats to the species (includes distinct population segments [DPS], subspecies, species groups) and ensure self-sustaining, wild populations. The Act (section 4(f)(1)) requires that recovery plans include: (1) a description of site-specific management actions necessary to conserve the species; (2) objective, measurable criteria that, when met, will allow the species to be removed from the Federal Lists of Endangered and Threatened Wildlife and Plants (Lists); and (3) estimates of the time and cost required to achieve the plan's goals and intermediate steps.

Table 1 summarizes the status, within the Mariana Islands, of the 23 species addressed in this recovery plan (hereafter, 23 species). The species addressed in this recovery plan were proposed for listing in 2014 (USFWS 2014, entire) and listed under the Act in a final rule published in October 2015 (USFWS 2015, entire). The Recovery Outline for the Mariana Islands was published on February 3, 2020, and covers all 23 species (USFWS 2019). Critical habitat is scheduled to be designated these 23 species.

The Mariana Islands are comprised of 15 islands located west of Hawai‘i and south of Japan (Figure 1). The islands were the first settled by humans in Remote Oceania prior to Polnesian settlement of the rest of the Pacific islands. The Chamorro people colonized the islands between 1500 – 1400 BC. A second migration followed from the Caroline Islands by the first millennium AD and a third likely from the Philippines or eastern Indonesia by 900 AD. The native people of the Mariana Islands are of Chamorro (Indonesian, Spanish, Filipino [with language based on Tagalog]) and Carolinian (from the Caroline Islands) descent (Chamorro-Carolinian Language Policy Commission, 2020 in litt.). After World War II, the United States administered the Pacific islands formerly held by Japan pursuant to the United Nations Trust Territory of the Pacific Islands (United Nations 1946 p. 124-125 and United Nations 1947). The Guam Organic Act of 1950 established Guam as an unincorporated organized territory of the United States and granted citizenship to residents. In 1975, the Commonwealth of the Northern Mariana Islands (CNMI), the 14 northernmost islands excluding Guam, was designated a U.S. territory. The CNMI adopted its constitution in 1977, and its first constitutional government took office in 1978. Many of the 15 islands comprising the archipelago are remote and difficult to access. This combined with the archipelago's challenging terrain (Table 2) have limited natural history studies of the 23 species and their native habitats.

Table 1. Species covered by this recovery plan, including the number of populations, number of individuals, their recovery priority number, distribution, and current listing status.

Species	Common Name	Number of Known Populations	Number of Individuals in the Wild in the Marianas	Recovery Priority Number	Distribution[1]	Listing Status
PLANTS						
Bulbophyllum guamense	wild onion, siboyas halumtanu [C], siboyan halom tano[Ca]	12	<511	8	Guam, Rota, **Saipan, Pagan**	Threatened (USFWS 2015)
Cycas micronesica	fadang [Ch], faadang[Ca]	25	~ 175,133-590,133	5	Guam, Rota, Tinian, Pagan [2], Palau[3], Yap[3]	Threatened (USFWS 2015)
Dendrobium guamense	NCN	21	~ 1,250	8	Guam, Rota, Saipan, Tinian, Aguiguan, **Agrihan**	Threatened (USFWS 2015)
Eugenia bryanii	NCN	8	929-2,311	8	Guam	Endangered (USFWS 2015)
Hedyotis megalantha	pao dedu [Ch], pao doodu[Ca]	Unknown	<800	8	Guam	Endangered (USFWS 2015)
Heritiera longipetiolata	ufa halumtanu [Ch], ufa halom tano[Ca]	17	1,687 mature	5	Guam, Saipan, Tinian, Rota	Endangered (USFWS 2015)
Maesa walkeri	NCN	5	786	8	Guam, Rota	Threatened (USFWS 2015)
Nervilia jacksoniae	NCN	8	708	8	Guam, Rota	Threatened (USFWS 2015)
Phyllanthus saffordii	NCN	>17	Several thousand	8	Guam	Endangered (USFWS 2015)
Psychotria malaspinae	aplokating palaoan [Ch/Ca]	3	12	2	Guam	Endangered (USFWS 2015)
Solanum guamense	tano [Ca]	None known	None known	2	Guam, **Rota, Saipan, Tinian, Asuncion, Guguan, Maug**	Endangered (USFWS 2015)
Tabernaemontana rotensis	NCN	14	15,549	8	Guam, Rota	Threatened (USFWS 2015)
Tinospora homosepala	NCN	3	30 males, 0 females	2	Guam	Endangered (USFWS 2015)
Tuberolabium guamense	NCN	11	26,906	8	Guam, Rota, **Tinian, Aguiguan**	Threatened (USFWS 2015)

Species	Common Name	Number of Known Populations	Number of Individuals in the Wild in the Marianas	Recovery Priority Number	Distribution[1]	Listing Status
MAMMAL						
Emballonura semicaudata rotensis	Pacific sheath-tailed bat (Mariana subspecies), payeyi [Ch], paischeey [Ca]	1	359 to 466	6	**Guam, Rota,** Aguiguan, **Tinian, Saipan, Anatahan, Maug**	Endangered (USFWS 2015)
REPTILE						
Emoia slevini	Slevin's skink, Marianas Emoia, Marianas skink, gualiik halumtanu [Ch], gholuuf [Ca]	4	Unknown	8	**Guam,** Cocos Island[4], **Rota, Aguiguan, Tinian,** Sarigan, Alamagan, Pagan, Asuncion	Endangered (USFWS 2015)
INVERTEBRATES						
Hypolimnas octocula marianensis	Mariana eight-spot butterfly, ababbang [Ch], libweibwogh [Ca]	6	Unknown	6	Guam, **Saipan**	Endangered (USFWS 2015)
Vagrans egistina	Mariana wandering butterfly, ababbang [Ch], libweibwogh [Ca]	Unknown	Unknown	5	Guam, Rota	Endangered (USFWS 2015)
Ischnura luta	Rota blue damselfly, dulalas luta [Ch], dulalas luuta [Ca]	1	Unknown	5C	Rota	Endangered (USFWS 2015)
Partula gibba	humped tree snail, akaleha [Ch], denden [Ca]	7	Unknown	8	Guam, Rota[5], **Aguiguan,** Tinian, Saipan, **Anatahan,** Sarigan, Alamagan, Pagan	Endangered (USFWS 2015)
Partula langfordi	Langford's tree snail, akaleha [Ch], denden [Ca]	Unknown	Unknown	5	Aguiguan	Endangered (USFWS 2015)
Partula radiolata	Guam tree snail, akaleha [Ch], denden [Ca]	50+	Unknown	5	Guam	Endangered (USFWS 2015)
Samoana fragilis	fragile tree snail, akaleha dogas [Ch], denden [Ca]	3	Unknown	5	Guam, Rota	Endangered (USFWS 2015)

Ch = Chamorro name, Ca = Carolinian name. Translations courtesy of the Chamorro/Carolinian Language Policy Commission.
1 = Bolded islands indicate historical range (i.e., taxa have been extirpated from islands in bold); 2 = Tentative occurrence.
3 = Range outside of the Mariana Islands; 4 = Cocos Island is an islet off the southern coast of Guam; 5 = A genetic study of snails on Rota found that the species thought to be *Partula gibba* may be a different species.

Figure 1. The 15 islands comprising the Mariana Archipelago in the western Pacific Ocean.

Table 2. The area of each island in the Mariana Archipelago along with their percentage of total archipelago land mass, maximum elevation, and predominant substrate.

Island	**Land area square kilomers (square miles)**	**% of land area of Mariana Archipelago**	**Maximum elevation (meters (feet))**	**Substrate**
Guam	540.0 (208)	53.3	407 (1,335)	limestone
Rota	85.1 (32.9)	8.4	496 (1,627)	limestone
Aguiguan	7.0 (8.7)	0.7	57 (187)	limestone
Tinian	101.2 (39.1)	10.0	187 (614)	limestone
Saipan	119.0 (45.9)	11.7	474 (1,555)	limestone
Farallon de Medinilla	0.7 (0.3)	>0.1	25 (82)	limestone
Anatahan	33.9 (13.1)	3.3	788 (2,585)	volcanic
Sarigan	4.5 (1.7)	0.4	538 (1,765)	volcanic
Guguan	4.2 (1.6)	0.4	287 (942)	volcanic
Alamagan	13.0 (5.0)	1.3	744 (2,441)	volcanic
Pagan	47.8 (18.4)	4.7	570 (1,870)	volcanic
Agrihan	44.1 (17.0)	4.3	965 (3,166)	volcanic
Asuncion	7.9 (3.0)	0.8	857 (2,812)	volcanic
Maug	2.1 (0.8)	0.2	227 (745)	volcanic
Farallon de Pajaros	2.3 (0.9)	0.2	360 (1,181)	volcanic
Total Land Area	**1,012.71 (391)**			

A. BACKGROUND

Basic Species Information

Species descriptions, life history, status, and historical and current range and distribution are included in the proposed listing rule (USFWS 2014, entire) and final listing decision (USFWS 2015, entire). Habitat status and species biological reports detail the habitat, biology, distribution, resiliency (the ability of a species to recover from periodic disturbance), redundancy (the number of populations of a species distributed across the landscape), and representation (the range of variation found within a species) of each of the species addressed in this draft recovery plan (Table 3). These reports are available https://ecos.fws.gov/ecp/species-reports and will be updated as new information informs the conservation status of the species and the habitats on which they rely.

Table 3. Species and the corresponding Species Biological Reports and Habitat Status Reports used in this draft recovery plan.

Species	Species Report	Habitat Status Report
PLANTS		
Bulbophyllum guamense	USFWS 2020a	Willsey et al. 2019
Cycas micronesica	USFWS 2020b	Willsey et al. 2019
Dendrobium guamense	USFWS 2020c	Willsey et al. 2019
Eugenia bryanii	USFWS 2020d	Willsey et al. 2019
Hedyotis megalantha	USFWS 2020e	Frager et al. 2019
Heritiera longipetiolata	USFWS 2020f	Willsey et al. 2019
Maesa walkeri	USFWS 2020g	Willsey et al. 2019
Nervilia jacksoniae	USFWS 2020h	Willsey et al. 2019
Phyllanthus saffordii	USFWS 2020i	Frager et al. 2019
Psychotria malaspinae	USFWS 2020j	Willsey et al. 2019
Solanum guamense	USFWS 2020k	Willsey et al. 2019
Tabernaemontana rotensis	USFWS 2020l	Willsey et al. 2019
Tinospora homosepala	USFWS 2020m	Willsey et al. 2019
Tuberolabium guamense	USFWS 2020n	Willsey et al. 2019
MAMMAL		
Emballonura semicaudata rotensis	USFWS 2020o	Willsey et al. 2019
REPTILE		
Emoia slevini	USFWS 2020p	Willsey et al. 2019
INVERTEBRATES		
Hypolimnas octocula marianensis	USFWS 2020q	Willsey et al. 2019
Vagrans egistina	USFWS 2020r	Willsey et al. 2019
Ischnura luta	USFWS 2020s	Polhemus and Richardson 2019
Partula gibba	USFWS 2020t	Willsey et al. 2019
Partula langfordi	USFWS 2020u	Willsey et al. 2019
Partula radiolata	USFWS 2020v	Willsey et al. 2019
Samoana fragilis	USFWS 2020w	Willsey et al. 2019

Plants

All the plants with the exception of *Cycas micronesica* are endemic to the Mariana Islands, with five being found only on Guam (see Table 2). The status of habitats supporting these plant species is summarized in the Habitat Status Reports listed in Table 3.

Bulbophyllum guamense
Bulbophyllum guamense is an epiphyte in the orchid family (Orchidaceae) now restricted to the native forests of Guam and Rota (Ames 1914, p. 13; Raulerson and Rinehart 1992, p. 90; Costion and Lorence 2012, pp. 54, 66; Global Biodiversity Information Facility [GBIF] 2019, entire; Zarones et al. 2015a, in litt). As of 2020, there were 3 populations with a total of fewer than 250 individuals on Guam and 9 populations, with at least 261 individuals on Rota. On Rota, the presence of multiple age classes indicates successful reproduction (USFWS 2020a, entire).

Cycas micronesica
Cycas micronesica is a gymnosperm in the cycad family (Cycadaceae) native to Guam, Rota, and tentatively Pagan, Palau (Republic of Palau) and Yap (Federated States of Micronesia) (Hill et al. 2004, p. 280; Keppel et al. 2008, p. 1,006; Cibrian-Jaramillo et al. 2010, pp. 2,372-2,375; Marler 2013, p. 1). *Cycas micronesica* used to be the most common understory tree in the region's limestone forests (Stone 1970, p. 65; Raulerson and Rinehart 1991, p. 4; Donnegon et al. 2004, p. 19) and it can also be found in coastal strand habitat (Marler 2013, p. 1). It was the most abundant tree on Guam forest inventory surveys in 2002 with over 1.5 million trees (Donnegan et al. 2004, entire) and was similarly common on Rota. Their numbers are declining rapidly; a significant percentage of the cycads observed on Guam and Rota are in poor health or dying. In 2015, there were an estimated 15 to 20 populations with 900,000 to 950,000 individuals on Guam, Rota, Yap, and Palau. Estimates from the Forest Inventory and Analysis Program on Guam indicate an 8.1 percent average annual rate of decline, most likely due to the cycad *Aulacaspis* scale (*Aulacaspis yasumatsui*; Donnegan et al. 2004, p. 29; Lazaro et al. 2020, p.l 15, JRM 2020, p. 106). By applying this rate of decline to the most recent estimates of individuals on Guam and Rota, we estimate that in 2020, there were 344,000 (123,000 to 538,000) individuals in 21 populations on Guam and fewer than 52,133 in 4 populations on Rota (USFWS 2020b, entire).

Dendrobium guamense
Dendrobium guamense is an epiphyte and occasional lithophyte in the orchid family (Orchidaceae) known from native forests on Guam, Rota, Saipan, Tinian, and Aguiguan (Ames 1914, p. 14; Raulerson and Rinehart 1992, p. 98; Raulerson 2006, in litt.; Costion and Lorence 2012, p. 66; Zarones et al. 2015a, in litt.; Zarones et al. 2015b, in litt.). In 2020, there were at least 21 populations with approximately 1,250 individuals distributed across the 5 islands. On Rota, the presence of multiple age classes indicates that the species' status on Rota is better than previously known (USFWS 2020c, entire).

Eugenia bryanii
Eugenia bryanii is a perennial shrub in the myrtle family (Myrtaceae) endemic to Guam, where it historically occurred on windy, exposed cliff lines along the western and eastern coasts of the island and in forest along the Pigua River (Costion and Lorence 2012, p. 82). When listed in 2015, there were fewer than 420 known individuals (USFWS 2015, entire); however, due to increased survey efforts, as of 2020 there were between 929 and 2,311 known individuals in 8 populations distributed across the island (USFWS 2020d, entire).

Hedyotis megalantha

Hedyotis megalantha is a perennial herb in the coffee family (Rubiaceae) endemic to savannas on Guam. As of 2020, *H. megalantha* was known to occur in one large scattered population with fewer than 800 individuals on southern Guam (Costion and Lorence 2012, pp. 54, 86; Gawel et al. 2013, in litt.; USFWS 2020e, entire).

Heritiera longipetiolata

Heritiera longipetiolata is a tree in the hibiscus family (Malvaceae) endemic to the native forest on Guam, Rota, Saipan, and Tinian (Stone 1970, p. 420; Raulerson and Rinehart 1991, p. 94; GBIF 2019). In 2020, there were 11 known populations on Guam with 1,075 mature and 151 immature plants, and over 11,800 seedlings (SWCA 2011 pp. 21 and 30; JRM 2016, DoN 2018, GPEPP 2015, Demeulenaere et al. 2018, USFWS 2017, and GPEPP 2019). There are 2 known populations on Tinian, with 558 mature plants and 204 seedlings, but seedling survival appears low, likely due to ungulates, and few immature plants were found (DoN 2018, *in litt.*). In 2020, 3 populations with at least 53 mature individuals and several hundred seedlings occurred on Saipan (Camacho and Micronesian Environmental Service 2002 pp. 38-39); 1 tree remains on Rota (USFWS 2020f, entire).

Maesa walkeri

Maesa walkeri is a shrub or small tree in the primrose family (Primulaceae) endemic to native forests of Guam and Rota (Fosberg and Sachet 1979, pp. 368-369; M & E Pacific, Inc. 1998, pp. 31, 79; Raulerson and Rinehart 1991, p. 67; Costion and Lorence 2012, p. 84; GBIF 2019; Wagner et al. 2012). In 2020, an estimated 786 individuals were known from 5 populations. On Guam in the late-1990s, there were 3 populations consisting of 52, 43, and 7 individuals and evidence of some recruitment (M & E Pacific, Inc. 1998, pp. 31 and 79). On Rota, there were at least 684 individuals throughout the Sabana Plateau, with multiple age classes indicating successful reproduction (Harrington et al. 2012, in litt.; Gawel et al. 2013, in litt.; Liske-Clark et al. 2015).

Nervilia jacksoniae

Nervilia jacksoniae is a small herb in the orchid family (Orchidaceae) endemic to Guam and Rota. As of 2020, there were an estimated 8 populations with at least 708 individuals in native limestone forest, mixed forest, and ravine forest (Harrington et al. 2012, in litt. and Zarones et al. 2015c, in litt.). On Guam, *N. jacksoniae* remains in 3 populations totaling 388 individuals (M & E Pacific, Inc. 1998, p. 58; McConnell 2012, pers. comm., USFWS 2020h p. 31). On Rota, *N. jacksoniae* persists in 5 scattered populations with at least 320 individuals (Rinehart and Fosberg 1991, pp. 81-85; Raulerson and Rinehart 1992, p. 118; Costion and Lorence 2012, p. 67; Consortium Pacific Herbarium 2020; GBIF 2020; McConnell 2012, pers. comm.; Zarones et al. 2015c, in litt.; USFWS 2020h, p. 31).

Phyllanthus saffordii

Phyllanthus saffordii is a short-lived shrub in the Phyllanthaceae family endemic to low-growing grass and shrub communities in ecotones between forests and savannas, and between savannas and barrens, in southern Guam. Although there have been no surveys focused on the distribution and abundance of *P. saffordii*, as of 2020, there were at least 17 populations with several thousand individuals (Demeulenaere 2020 in litt.). *Phyllanthus saffordii* is often found in clusters of up to 20 individuals, depending on the available habitat (Demeulenaere 2020, in litt.).

Psychotria malaspinae

Psychotria malaspinae is a shrub or small tree in the coffee family (Rubiaceae) endemic to Guam. Historically, *P. malaspinae* was known from scattered populations in the forests of northeastern and southwestern Guam (Merrill 1914, pp. 148-149; Stone 1970, pp. 554-555; Raulerson and Rinehart 1991, p. 83; Fosberg et al. 1993, pp. 111-112; Costion and Lorence 2012, pp. 54, 85-86; Wagner et al. 2012). The most recent surveys indicate 12 individuals remained in 3 populations with 3, 5, and 4 individuals each (Guam Plant Extinction Prevention Program 2015, in litt.; USFWS 2020j, p. 8).

Solanum guamense

Solanum guamense is a small shrub in the nightshade family (Solanaceae) endemic to Guam, Rota, Saipan, Tinian, Asuncion, Guguan, and Maug (Merrill 1914, pp. 139-140; Stone 1970, p. 521; Costion and Lorence 2012, p. 89). The species may be extinct; it was last documented in 1994. The last known individuals occurred on cliffs or outcrops inaccessible to ungulates in Guam's limestone forest (Perlman and Wood 1994, pp. 135–136; Stone 1970, p. 521). In recent decades the species was only known from Guam although it may still occur on Asuncion, Guguan, Maug, and/or Farallon de Pajaro (USFWS 2020k).

Tabernaemontana rotensis

Tabernaemontana rotensis is a small- to medium-sized tree in the dogbane family (Apocynaceae) known from limestone forests on Guam and Rota (Stone 1970, p. 485). As of 2020, an estimated 15,510 naturally-occurring (as opposed to outplanted) plants remain within eight populations on Guam and as scattered individuals across Rota (USFWS 2020 l, p. 1-15). On Rota in 2015, 9 remaining naturally-occurring individuals (CNMI DLNR 2015, in litt.) were distributed across the western, southern, and eastern parts of the island and by 2020, 30 outplanted individuals were scattered across the island (Manglona 2019, pers. comm.; USFWS 2020l, p. 1, 13, 15).

Tinospora homosepala

Tinospora homosepala is a vine in the moonseed family (Menispermaceae) historically known from forests on Guam (Merrill 1914, p. 83; Stone 1970, pp. 27, 277; Costion and Lorence 2012, pp. 92-93). The most recent surveys indicate there were 3 populations with 30 males; no female plants are known (Yoshioka 2008, p. 15; Gawel et al. 2013, in litt.; USFWS 2020m).

Tuberolabium guamense

Tuberolabium guamense (*Trachoma guamense* is a synonym) is an epiphyte in the orchid family (Orchidaceae) endemic to the forests of the Mariana Islands. The most recent surveys indicate there were 4 populations in southern Guam with 12,647 individuals, 5 populations in northern Guam with 14,020 plants, and an estimated 239 plants on Rota (Gawel et al. 2013, in litt.; Harrington et al. 2012, in litt.; Zarones et al. 2015d, in litt.; University of Guam 2019). On Rota, individuals were documented along 6 of 18 transects surveyed in the Sabana and their population structure indicated recent successful reproduction (USFWS 2020n, p. 20-23).

Animals
The nine animal species are endemic to the Mariana Islands, with the Rota blue damselfly known only from Rota, Langford's tree snail known only from Aguiguan, and Guam tree snail known only from Guam (see Table 1). The status of habitats supporting these animal species is summarized in the Habitat Status Reports listed in Table 3.

Pacific sheath-tailed bat
The Mariana Island subspecies of the Pacific sheath-tailed bat is a small insectivore in the old-world family *Emballonuridae* with an extensive tropical distribution. Historically, the Pacific sheath-tailed bat occurred on Guam, Rota, Aguiguan, Tinian, and Saipan, and possibly on Anatahan and Maug (Steadman 1999, p. 321; Wiles and Worthington 2002, pp. 1-3; Wiles et al. 2011, p. 299; Lemke 1986, pp. 743-745). Surveys in 2002–2013 confirmed it was restricted to a single population on Aguiguan withan estimated 359 to 466 individuals in a few colonies (Wiles and Worthington 2002, p. 15; Wiles 2007, pers. comm.; O'Shea and Valdez 2009, pp. 2-3; Wiles et al. 2011, p. 299; Oyler-McCance et al. 2013, p. 1,030). The species is nocturnal, forages in native forest habitats, and roosts during the day under or in overhanging cliffs, limestone solution caves, crevices, and lava tubes (hereafter caves; Grant et al. 1994, pp. 134-135; O'Shea and Valdez 2009, pp. 105-108; Craig et al. 1993, p. 51; Wiles and Worthington 2002, p. 13; Wiles et al. 2011, pp. 301-303).

Slevin's skink
Slevin's skink is a small lizard in the family Scincidae and is the only lizard endemic to the Mariana Islands. Historically, the species has been recorded from Guam, Rota, Aguiguan, Tinian, Sarigan, Alamagan, Pagan, and Asuncion; it is currently extant on Sarigan, Alamagan, and Asuncion, and was recently rediscovered on Cocos Island off southern Guam. The species is found in leaf litter and tree debris in several forest types including native limestone, mixed-native, *Casuarina equisetifolia* (ironwood), and coconut (*Cocos nucifera*) forests (Brown and Falanruw 1972, p. 110; McCoid et al. 1995, p. 72; Berger et al. 2005, p. 175; Vogt in litt. 2007; Lardner in litt. 2013; Mathies pers comm. 2019).

Mariana eight-spot butterfly
The Mariana eight-spot butterfly in the family Nymphalidae is endemic to the forests of Guam and Saipan (Schreiner and Nafus 1996, p. 2; Schreiner and Nafus 1997, p. 26), although it may be extirpated from Saipan (Schreiner and Nafus 1997, p. 26). The species' habitat is closed-canopy native limestone forest with an abundance of their host plants, *Procris pedunculata* and *Elatostema calcareum* (Schreiner and Nafus 1996, p. 1); caterpillars are restricted to both species. Despite surveys between 2011 and 2013 on Rota, Tinian, and Saipan, the butterfly has recently only been known from Guam (Schreiner and Nafus 1996, p. 2; Schreiner and Nafus 1997, p. 26; Rubinoff and Haines 2012, in litt.; Rubinoff 2013, in litt.). Recent surveys across Guam confirmed the presence of the species in six areas (Lindstrom and Benedict 2014, p. 9), but did not provide an estimated number of individuals per population (USFWS 2020q, entire).

Mariana wandering butterfly
The Mariana wandering butterfly in the family Nymphalidae is endemic to native limestone forests of Guam and Rota that support the species' host plant, *Maytenus thompsonii,* a small tree endemic to the Mariana Islands (Vogt and Williams 2004, p. 121; Schreiner and Nafus 1996, p.

1). The species has not been observed on Guam since 1979 and is likely extirpated from the island (Schreiner and Nafus 1996, pp. 1-2; Rubinoff 2013, in litt.). During surveys on Rota in 1995, the butterfly was recorded at only one location among the six sites surveyed (Schreiner and Nafus 1996, pp. 1-2). However, comprehensive surveys for the species have not been conducted since 1995, so its current status on Rota is unknown. This species possibly occurs on the northern islands of the archipelago where its host plant is found (Rubinoff 2013, in litt.), although no historical records exist (USFWS 2020r, entire).

Rota blue damselfly

The Rota blue damselfly is a small, blue-colored stream-obligate damselfly in the family Coenagrionidae endemic to the island of Rota where it is only known from Okgok Stream, a perennial stream, in the southern part of the island. Okgok Stream occurs in a forested area known as Talakhaya that encompasses all the available stream habitat on Rota. The presence of several dry stream beds and intermittent streams located to the east of Okgok Stream suggests that the range of the damselfly may have been historically larger (USFWS 2020s, entire).

Humped tree snail

The humped tree snail in the family Partulidae is endemic to the forests of the Mariana Islands where it historically occurred on Guam, Rota, Saipan, Tinian, Aguiguan, Anatahan, Sarigan, Alamagan, and Pagan. The species occurs in cool, shaded forests (Crampton 1925, pp. 31, 61), with high humidity and reduced air movement. Based on the most recent information, the humped tree snail is extant on Guam, (Hopper and Smith 1992, p. 81; Smith et al. 2009, pp. 10, 12, 16), Saipan (Hadfield 2010, pp. 20-21), Tinian (NavFac, Pacific 2014, pp. 5-5—5-7), Sarigan (Hadfield 2010, p. 21), Alamagan, (Bourquin 2002, p. 30), and Pagan (Hadfield 2010, pp. 8-14); the species appears to be extirpated from Aguiguan and Anatahan. Recent surveys on Rota found that individuals thought to be the humped tree snail are genetically distinct and should be considered a different species (Sischo and Hadfield 2017, p.1), although as of 2022 this taxomomic change has not been made.

Langford's tree snail

Langford's tree snail in the family Partulidae is endemic to the forests of Aguiguan and may be extinct. Although little is known about the species, like other partulid snails in the Marianas, it presumably occurred in cool, shaded forests (Crampton 1925, pp. 31, 61), with high humidity and reduced air movement. It has not been observed in the wild since 1992, when one individual was observed on the island's northwestern terrace (Berger et al. 2005, p. 154). Surveys conducted in 2006 and 2008 found only shells of *P. langfordi* (Smith 2013, p. 14) (USFWS 2020u, entire).

Guam tree snail

The Guam tree snail in the family Partulidae is endemic to the forests of Guam and prefers shaded forests with high humidity and reduced air movement. Prior to its listing in 2015, there were approximately 20 known populations but extensive surveys in 2019 identified more than 50 populations. While some may support only a few individuals, others likely number in the thousands (Fiedler pers. comm. 2019 and USFWS 2020v, entire).

Fragile tree snail

The fragile tree snail in the family Partulidae is known from the forests of Guam and Rota and prefers shaded forests with high humidity and reduced air movement. Historically, the fragile tree snail was known from 13 populations on Guam and 1 population on Rota (Crampton 1925, p. 30; Kondo 1970, pp. 86-87). As of 2019, only six populations are known from Guam (Fiedler pers. comm. 2019) and most are small and narrowly distributed. On Rota, the only known population located on the Sabana was converted to agricultural fields, and no living snails were found during surveys in 1995; in 1996, a previously unknown population was discovered in a different location roughly 1 mile south in the Talakaya area (Bauman 1996, pp. 18, 21).

Threats

Section 4 of the Act (16 U.S.C. 1533) and its implementing regulations (50 CFR part 424) set forth the procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants (Lists). A species may be determined to be an endangered or threatened species due to one or more of the five factors described in section 4(a)(1) of the Act: (1) The present or threatened destruction, modification, or curtailment of its habitat or range; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) the inadequacy of existing regulatory mechanisms; and (5) other natural or manmade factors affecting its continued existence.

The most important threats to the 23 species are habitat loss and degradation due to development, invasive animals, invasive plants, typhoons, climate change driven increases in typhoon frequency and intensity, and loss of habitat due to changes in precipitation and temperature (USFWS 2015, Willsey et al. 2019, Frager et al. 2019, Polhemus and Richardson 2019, USFWS 2020a - USFWS 2020w). In addition, 8 of the 14 listed plants and 8 of the 9 listed animals are threatened by predation or herbivory by invasive animals. Inadequate regulatory mechanisms affect the conservation of all 23 species and all but 4 plant species face species-specific threats. Inadequate regulatory mechanisms allow development, human-caused wildfires, ungulate presence across landscapes, and the inadvertent and purposeful movement of invasive species (USFWS 2015, Willsey et al. 2019, Frager et al. 2019, Polhemus and Richardson 2019, USFWS 2020 a - USFWS 2020 w). Species-specific threats include herbivory by introduced ungulates and invasive invertebrates, predation by invasive animals, competition with invasive introduced species, as well as an increase in vulnerability to threats because of small numbers of individuals and/or populations (USFWS 2020a-n). Threats are summarized and organized in Table 4 by the five factors and discussed in detail below. The distribution of introduced animals across the archipelago (Table 5) illustrates the complexity of conserving species across islands with different threats. Additional information about specific threats are in the final listing rules (USFWS 2015; USFWS 2020 Recovery Outline) and Species Biological Reports for each species (USFWS 2020 a-w).

Table 4. Summary of habitats used by the 23 Mariana Islands species addressed in this recovery plan as well as their threats[1] organized by the five listing factors[2].

Species	Habitat	Listing Factor A						Factor B	Factor C		Factor D	Factor E
		Agricultural and urban development, military training	Invasive animals	Invasive plants		Typhoons	Climate change	Over-utilization	Predation or herbivory by invasive vertebrates	Predation or herbivory by invasive invertebrates	Inadequate existing regulatory mechanisms	Other species-specific threats
				Invasion of intact habitat	Invasion after wildfire							
PLANTS												
Bulbophyllum guamense	Native Forest	✓✓	U (✓✓), R, BTS, A(P)	✓	✓	✓	✓			S	✓✓	
Cycas micronesica	Native Forest	✓✓	U (✓✓), R, BTS, A(P)	✓	✓	✓	✓		U	CAS and others ✓✓	✓✓	ORD
Dendrobium guamense	Native Forest	✓✓	U (✓✓), R, BTS, A(P)	✓	✓	✓	✓			S	✓✓	
Eugenia bryanii	Native Forest	✓✓	U (✓✓), R, BTS, A(P)	✓		✓	✓		R, U		✓✓	RUST(P)
Hedyotis megalantha	Savanna	✓	U, R, BTS, A(P)	✓	✓✓	✓	✓				✓✓	REC
Heritiera longipetiolata	Native Forest	✓✓	U (✓✓), R, BTS, A(P)	✓		✓	✓		U		✓✓	ORD
Maesa walkeri	Native Forest	✓✓	U (✓✓), R, BTS, A(P)	✓	✓	✓	✓				✓✓	BTS(P)
Nervilia jacksoniae	Native Forest	✓✓	U (✓✓), R, BTS, A(P)	✓	✓	✓	✓			S	✓✓	
Phyllanthus saffordii	Savanna	✓	U, R, BTS, A(P)	✓	✓✓	✓	✓				✓✓	REC
Psychotria malaspinae	Native Forest	✓✓	U (✓✓), R, BTS, A(P)	✓	)	✓	✓		U		✓✓	LN (✓✓), BTS(P)
Solanum guamense	Native Forest	✓✓	U (✓✓), R, BTS, A(P)	✓		✓	✓		U		✓✓	LN (✓✓)
Tabernaemontana rotensis	Native Forest	✓✓	U (✓✓), R, BTS, A(P)	✓	✓	✓	✓				✓✓	V, BTS(P)
Tinospora homosepala	Native Forest		U (✓✓), R, BTS, A(P)	✓		✓	✓				✓✓	LN (✓✓)
Tuberolabium guamense	Native Forest	✓✓	U (✓✓), R, BTS, A(P)	✓	✓✓	✓	✓			S	✓✓	

Species	Habitat	Listing Factor A						Factor B	Factor C		Factor D	Factor E
		Agricultural and urban development, military training	Invasive animals	Invasive plants		Typhoons	Climate change	Over-utilization	Predation or herbivory by invasive vertebrates	Predation or herbivory by invasive invertebrates	Inadequate existing regulatory mechanisms	Other species-specific threats
				Invasion of intact habitat	Invasion after wildfire							
MAMMAL												
Pacific sheath-tailed bat (*Emballonura semicaudata rotensis*)	Native Forest, Cave	✓✓	U (✓✓), R, BTS	✓		✓	✓		R, BTS, ML		✓✓	P, LN (✓✓), D
REPTILE												
Slevin's skink (*Emoia slevini*)	Native Forest	✓✓	U (✓✓), R, BTS, A$^{(P)}$	✓		✓	✓		R, BTS (✓✓), Sh	A$^{(P)}$	✓✓	LN✓✓
INVERTEBRATES												
Mariana eight-spot butterfly (*Hypolimnas octocula marianensis*)	Native Forest	✓✓	U (✓✓), R, BTS, S, A$^{(P)}$	✓		✓	✓			A✓✓, W✓✓	✓✓	LN ✓✓
Mariana wandering butterfly (*Vagrans egistina*)	Native Forest		U (✓✓), BTS, R, S, A$^{(P)}$	✓		✓	✓			A, W,	✓✓	LN ✓✓
Rota blue damselfly (*Ischnura luta*)	Stream	✓	U (✓✓), BTS	✓	✓$^{(P)}$	✓	✓✓		Fi, Am		✓✓	LN (✓✓), WE (✓✓)
Humped tree snail (*Partula gibba*)	Native Forest	✓✓	U (✓✓), R, BTS, A$^{(P)}$	✓	✓	✓✓	✓✓		R	F (✓✓), PS (✓✓), A$^{(P)}$	✓✓	LN ✓✓
Langford's tree snail (*Partula langfordi*)	Native Forest	✓✓	U (✓✓), R, BTS	✓		✓	✓		R	F (✓✓), PS (✓✓), A$^{(P)}$	✓✓	LN ✓✓
Guam tree snail (*Partula radiolata*)	Native Forest	✓✓	U (✓✓), R, BTS, A$^{(P)}$	✓	✓	✓✓	✓✓		R	F (✓✓), PS (✓✓), A$^{(P)}$	✓✓	LN ✓✓
Fragile tree snail (*Samoana fragilis*)	Native Forest	✓✓	U (✓✓), R, BTS, A$^{(P)}$	✓		✓✓	✓✓		R	F (✓✓), PS (✓✓), A$^{(P)}$	✓✓	LN ✓✓

[1] A = ants, Am = predatory amphibians, BTS = brown treesnake (includes indirect effects), CAS = cycad *Aulacaspis* scale (*Aulacaspis yasumatsui*) , an introduced cycad specialist armored scale insect, D = roost disturbance, F = Manokwari flatworm (*Platydemus manokwari*), Fi = predatory fish, LN = limited numbers, ML = Monitor lizard, ORD = ordnance, P = pesticide, PS = predatory snails, R = rats, REC = recreational vehicles, RUST = *Austropuccinia psidii* (myrtle rust, pathogen), S = slugs, Sh = shrew, U = ungulates, V = vandalism, W = parasitic wasps, WE = municipal and agricultural water extraction from groundwater and diversion and harvesting directly from streams.

[2] Listing Factors: A = The present or threatened destruction, modification, or curtailment of the species' habitat or range. B = Overutilization for commercial, recreational, scientific, or educational purposes. C = Disease or predation. D = Inadequacy of existing regulatory mechanisms. E = Other natural or manmade factors affecting the species' continued existence.

✓✓ indicate most pressing threats to the species, based on currently available information.

$^{(P)}$ = potential threat, ✓$^{(H)}$ = historical threat

Table 5. Animal species that threaten some or all of the 23 species, or their habitat, by island.

Island	Pigs (*Sus scrofa*)	Goats (*Capra aegagrus hircus*)	Cattle (*Bos primigenus*)	Water buffalo (*Bubalus bubalis*)	Deer (*Rusa marianna*)	Rats (*Rattus spp.*)	Monitor lizard (*Varanus tsukamotoi*)	Brown treesnake (*Boiga irregularis*; BTS)	Invertebrates [1]
Guam	✓			✓	✓	✓	✓*	✓	A, W, F, S, CAS
Rota		✓			✓	✓	✓*		A, W, F, S, CAS
Aguiguan		✓				✓	✓*		F
Tinian			✓			✓	✓*		F
Saipan						✓	✓*	✓**	A, W, F, S
Farallon de Medinilla						✓			
Anatahan						✓	✓*		
Sarigan						✓	✓*		F
Guguan						✓			F
Alamagan	✓	✓	✓			✓	✓*		F
Pagan	✓	✓	✓			✓	✓*		F
Agrihan	✓	✓				✓	✓*		
Asuncion						✓			
Maug						✓			
Farallon de Pajaros						✓			

[1] A = ants, CAS = cycad *Aulacaspis* scale (*Aulacaspis yasumatsui*), an introduced cycad specialist armored scale insect, F = Manokwari flatworm (*Platydemus manokwari*), S = slugs, W = parasitic wasps

* Threat affects only listed animals.

** Confirmed sightings of BTS have occurred on Saipan; however, a BTS population is not known to be established.

The following sections summarize the listing factors still affecting the species and contain updated information as available since the final listing rule.

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

The 23 species are threatened by habitat loss and degradation from development, typhoons, invasive animals, invasive plants, pesticide use, and climate change. Habitat clearing for development is among the greatest threat to the recovery of the 23 species. The archipelago's native habitats have been lost and degraded by residential, urban, and military development, ranching, clearing for agriculture, military training activities, and bombing and ground combat during World War II (Ohba 1994, pp. 17, 28, 54–69; Mueller-Dombois and Fosberg 1998, p. 242; Berger et al. 2005, pp. 45, 105, 110, 218, 347, 350). More than 20% of Saipan and Guam and approximately 6% of Tinian and Rota are developed (Spies et al. 2019, p. 7). The total loss of native forest on Guam and Rota since human settlement is estimated to be 83 and 53 percent, respectively (Willsey et al 2019, pp. 13-18).

The Mariana Islands occur in the world's most active typhoon basin, the western Pacific, and typhoons are a major threat to the 23 species. Typhoons have direct and indirect effects to native species and the habitats on which they depend. Intense typhoon winds defoliate and uproot trees and/or break their primary branches and trunks. Forests can take several years to recover and during this time are susceptible to encroachment from invasive trees, shrubs, and vines (Marler 2001, p. 1). After typhoons, more light penetrates forests because of damage to or loss of vegetation, which benefits invasive plant species, which in turn alter basic soil hydrology and nutrient cycling (Willsey et al. 2019, p. 18; Polhemus and Richardson 2019, pp. 3-4, Kerr, 2020, entire). "Dry" typhoons, which are characterized by very little rainfall, carry salt spray inland, which causes many tree species to drop their leaves within 2 days of a storm and can result in tree mortality (Kerr 2000, p. 895). Tree mortality when followed by a drought can increase the likelihood and intensity of wildfires (Aydlett 2017, pp. 5-6). Such catastrophic events can lead to the direct loss of a listed species or degradation/loss of the habitats needed for their conservation. Species with small populations or those with narrow distributions are particularly vulnerable to such catastrophic events.

Invasive animals including ungulates, the brown treesnake (*Boiga irregularis*), rodents, and invasive ants degrade native forest, savanna, and stream habitats, which provide habitat for the 23 species. Many native plants and animals from the Mariana Islands, as well as other Pacific islands, lack competitive and predator avoidance mechanisms because they evolved in the absence of invasive plants and animals (Fritts and Rodda 1998 p. 115). With few exceptions, invasive species are non-native and have been introduced to the Mariana Islands by humans.

Ruminant ungulates including Philippine deer (*Rusa marianna*), goats (*Capra aegagrus hircus*), cattle (*Bos primigenus*), and water buffalo (*Bubalus bubalis*) degrade habitat on Pacific Islands by preventing regeneration of native plants via browsing, grazing, and trampling (Stone et al. 1992, p. 666-702; Leopold and Hess 2016, entire; Latham et al. 2017, entire; Gawel et al. 2018, entire; Manglona pers. comm. 2019, 2021). Mortality of palatable native plants increases availability of habitat for colonization by invasive plants and can lead to barren land and extensive soil erosion (Diong 1982, LaRosa 1992, Stone et al 1992, Tep and Gaines 2003, and Liddle et al. 2006, in JRM 2019, p. 4-30). In the Mariana Islands, browse lines are visible where palatable native tree and understory vegetation is removed as high as these invasive animals can reach (Bruns 2019, pers. comm; Rieffanaugh 2021, pers. comm.). On Guam, centuries of deer browsing preferences have shaped species composition of forests (Gawel et al. 2018, p. 9). Ungulates also facilitate the spread of invasive plants by transporting seeds and plant parts (Cuddihy and Stone 1990, pp. 63–64) although on Guam, pigs (*Sus scrofa*) may be aiding in the dispersal of native seeds where native seed dispersers have been extirpated by the brown treesnake (Gawel et al. 2018, pp. 5-10). As of 2020, only 458 hectares (1,132 acres) of native forest on Guam are fenced to exclude ungulates and ungulates have been removed from only an estimated 20 percent of this area (Mizerek pers comm., 2020). On Rota, individual *Serianthes nelsonii* and *Osmoxylon mariannensis* trees are fenced to prevent ungulates from impacting them and their seeds and seedlings (Manglona 2019 and 2021) and fencing is used to minimize the threat of domestic goats and cattle escaping and establishing feral populations (Bruns pers. comm. 2019).

The invasive brown treesnake threatens the persistence of native habitats indirectly via the elimination of vertebrate seed dispersers and pollinators. Introduced to Guam in approximately 1949, it caused the extinction of a majority of Guam's endemic birds. The brown treesnake poses an ongoing threat to the persistence of the habitats needed for the recovery of the 23 species (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, Wandrag et al. 2015, p. 4-6). Almost three quarters of Guam's native trees depend on birds to eat their fruits and disperse their seeds (Rogers et al. 2009, in litt.). Seeds falling under parent trees experience reduced germination and survival due to conspecific competition and increased exposure to pathogens and herbivores (Rogers et al. 2017, p. 3; Nathan and Muller-Landau 2000, p. 278-283; Muller-Landau 2001, p. 165-178). In addition, germination of some seeds is reduced unless seed coats are digested by passing through the gut of a bird (Rogers et al. 2009, in litt.). On Guam, the only remaining native avian frugivore is the Micronesian starling (*Aplonis opaca*); 86% of species in the seedbank on Guam had a conspecific adult plant nearby compared to 33% on Rota and 39% on Saipan, which still supports a relatively intact avian frugivore community (Wandrag et al 2015, p. 6). In the absence of avian seed dispersers on Guam, 94% of *Psychotria* seeds and 95% of *Premna* seeds fall beneath the parent's canopy compared with 26% and 40% on islands with avian seed dispersers (Rogers et al 2017, p. 3). On Saipan, the median distance of the seeds of 15 tree species dispersed by 5 bird species was 56 meters (184 feet) (Rehm et al. 2018, pp. 1, 5). On Guam, the extirpation/extinction of native seed dispersers due to the brown treesnake is reducing recruitment and forest regeneration, the spatial distribution of native tree species and species richness (Rogers et al. 2017, entire). The potential introduction of the brown treesnake to other islands poses an ongoing threat to all native habitats addressed in this recovery plan.

Rats have caused plant and animal extinctions across Pacific islands directly through predation and indirectly by altering native habitats by reducing native plant reproduction and vigor by eating fruits, seeds, flowers, stems, leaves, roots, and other plant parts (Cuddihy and Stone 1990, p. 69, Campbell and Atkinson 1999, in Atkinson and Atkinson 2000, pp. 23-24; Shiels et al. 2014, pp., 152-159; Shiels and Drake 2015, p. 1; Duron et al 2017, p. 764). Three rat species are found throughout the Mariana Islands: the Polynesian (*Rattus exulans*), the Norway (*R. norvegicus*), and a new southeast Asian *Rattus* species, originally thought to be *R. diardii* (synonymous with *R. tanezumi*) (Kuroda 1938 in Wiewel et al. 2009, p. 208; Wiewel et al. 2009, pp. 210, 214–216). One or more of these species are present on all 15 islands of the Mariana archipelago (Wiewel et al. 2009, pp. 205– 222; Kessler 2011, p. 320). At the same time, rats may serve an important seed disperser role where native seed dispersers have been extirpated (Shiels 2005, p. 142-145). Rodent populations may be suppressed by the brown treesnake on Guam, and threats to listed species from rats are expected to increase as brown treesnake suppression is implemented.

Invasive ants recently introduced to, or those at risk of being introduced to, the Mariana Islands are a potential threat to the habitat of the 23 species. Ant species such as the dwarf pedicel ants (*Tapinoma minutum*), tropical fire ants (*Solenopsis geminata*), white-footed ants (*Technomyrmex albipes*), bi-colored trailing ants (*Monomorium floricola*), and little fire ants (*Wasmannia auropunctata*) prey on vertebrates and invertebrate eggs, pupae, larvae, and adults (Wild 2014, p. 1). Little fire ants sting the skin and eyes of vertebrates causing blindness and they facilitate plant pests such as aphids, white flies and scale insects, which feed on plant sap and secrete sugar-rich sticky liquid that the ants eat (Hawaiʻi Invasive Species Council 2021 p. 1). Big-headed ants (*Pheidole megacephala*) and Argentine ants (*Linepithema humile*) eat a wide variety of plants and animals and are highly aggressive toward arthropods and other animals (Farmer 2017 p.1). Aggressive invasive ants, defending nectar, ward off, and may prey on, invertebrate and vertebrate plant pollinators (Lach 2008, entire; Hanna et al 2015, pp. 222-228; SWCA 2020, pp. 9, 11, and Appendix C; Fuster et al. 2020, pp. 957-966; Unmi et al. 2021, pp. 1-5). Where native invertebrate and vertebrate pollinators have dwindled, some non-native invertebrates may serve in some capacity as plant pollinators (Aslan et al. 2019, pp. 318-321). While not yet in the Mariana Islands, in Hawaiʻi, yellow crazy ants (*Anoplolepis gracilipes*) spray formic acid on nesting seabirds, causing deformities that affect vertebrate breathing and vision and cause seabirds to abandon the site (Plentovich et al 2018, pp. 1, 3-7). Several incipient populations of little fire ants occur on Guam and there is the potential for this species to be moved to other locations on Guam and to other islands via green waste and potted plants. Invasive ants are likely to directly or indirectly affect the 23 species; the 23 species and their habitats may not be able to persist in areas where ants disrupt ecosystem function by harassing, injuring, or killing native plant pollinators and vertebrates including seed dispersers.

The native flora of the Mariana Islands consists of approximately 500 taxa, 10 percent of which are endemic. Over 100 plant taxa have been introduced to the Mariana Islands and at least one-third of these are invasive (Stone 1970, pp. 18–21; Mueller-Dombois and Fosberg 1998, pp. 242–243, 249, 262–263; Costion and Lorence 2012, pp. 51–100). The greatest risk posed by invasive plant species is the displacement of native plants. Invasive plants indirectly affect the 23 species by degrading the habitat on which they depend and can directly outcompete the 14 listed plants. The establishment of invasive plants has led to significant changes to the native habitats in the Mariana Islands (Willsey, et al. 2019, p. 17) by reducing the availability of light, soil, water, and nutrients that native forest and savanna species require.

Because of rapid post-fire establishment of invasive grasses, wildfires in the Mariana Islands convert native forest and diverse native savanna to non-native grasslands and the grass provides fuel that increases the probability and intensity of subsequent fires (i.e., the grass-fire cycle) (Smith 1985, pp. 180–181 and 217-218; Cuddihy and Stone 1990, p. 74; D'Antonio and Vitousek 1992, p. 73; Ohba 1994, pp. 17, 28, 54– 69; Vitousek et al. 1997, p. 6-9; Mueller-

Dombois and Fosberg 1998, pp. 242–243, 249, 262–263; Berger et al. 2005, pp. 45, 105, 110, 218, 347, 350; Willsey, et al. 2019, p. 17). 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 land area of Guam (Minton 2006, p. 23; Dendy 2019 in litt., Trauernicht and Kunz 2019, p. 1); in comparison, only one percent of California's land areas burns annually (Chodosh, 2018, p. 1). Wildfires in the Mariana Islands are primarily human-caused (Minton 2006, p. 3; Dendy 2019 in litt.; Demeulenaere 2020 in litt.). During severe droughts, which typically occur from February through June and during El Niño years (Aydlett 2017), fires that are otherwise limited to grassy areas can burn into native forest and shrubland (Athens and Ward 2004, p. 18, Greenlee 2010, entire; Kunz 2018 p. 1, Dendy 2019, entire; Trauernicht and Kunz 2019 p. 1, Trauernicht and Chimera 2020, p. 1). Where native trees and shrubs are killed by fire, grasses can outcompete native plant seedlings for light, water, and nutrients (Fosberg 1960, p. 40; Stone 1970, p. 184; D'Antonio, and Vitousek 1992, p. 68-70; Minton 2006 p. 21, pp. 25-29; NRCS 2011, p. 1; Johnson 2012, p. 27; and Leary 2018, p. 3-4). Areas converted to grass facilitate the spread of future fires and reduce the area of remaining native forest each successive dry season (Fujioka and Fujii 1980 in Cuddihy and Stone 1990, p. 93; D'Antonio and Vitousek 1992, pp. 70, 73–74; Tunison et al. 2002, p. 122). The majority of fires on Guam occur in the southern half of the island where they are routinely set by humans (Minton 2006 pp. 3, 20) and steep slopes make controlling fires difficult. Southern Guam was historically dominated by native ravine forest but by 2020, the area of ravine forest was reduced by more than 50 percent due to human-caused fires (Minton 2006, p. 23-30; Greelee 2010, entire; Camacho Fejeran 2021, p. 22).

Pesticides, when used in or adjacent to native habitat, can reduce pollinators needed for native plant reproduction (Kearns et al. 1998, entire). Where typhoons defoliate and topple native forest, invasive vines can grow in dense patches, smothering regeneration of the native forest by outcompeting native plants (Marler, 2001, p. 264, Liske-Clark 2015, in litt.; Willsey, et al. 2019, p. 17).

Factor B (*Overutilization for Commercial, Recreational, Scientific, or Educational purposes*)

At present, overutilization is not known to be a threat to any of the 23 species. *Partulid* snail shells were used historically as jewelry and decorations by the Chamorro people (Crampton 1925 p. 1) but this practice appears to have ceased around the time of World War II.

Factor C (*Disease and Predation*)

Eight of the 14 plants and 8 of the 9 animals are directly threatened by herbivory or predation by invasive animals including ungulates, rodents, the brown treesnake, ants, wasps, the New Guinea flatworm (*Platydemus manokwari*), predatory snails, and slugs (Table 4). The 23 species did not evolve with these herbivores and predators so they lack defense mechanisms against these introduced species. Invasive species are the primary driver of island extinctions; they have been implicated in 86% of extinctions of island species since 1500 A.D. and in 2017, significantly reduced populations of 596 species of birds, mammals, and reptiles (Spatz et al 2017, p. 1).

Introduced ungulates trample and crush individual plants and animals. Ungulates damage or kill listed plants by eating seedlings, shoots, or young plants before they can become established or tolerate herbivory.

Invasive rodents and shrews have caused declines, and in many cases extirpation of island plant and animal species (Cuddihy and Stone 1990, pp. 68-70). Rats eat seeds, flowers, stems, leaves, roots, and other plant parts (Atkinson and Atkinson 2000, p. 23) and can significantly affect regeneration. Introduced rats are responsible for the loss of vast lowland palm forests throughout Hawaiʻi and on Rapa Nui (Easter Island) because rats ate the flowers, seeds, and seedling palms, preventing them from regenerating (Hawaiʻi DLNR 2020 p. 1 and Hunt 2006, p. 416-419). Rodents and the Asian house shrew are known predators of *Partulid* snails and may depredate Slevin's skinks.

The introduction of the brown treesnake caused significant ecological damage to Guam including the extirpation/extinction of many of the island's birds and other small animal species (see above). *Maesa walkeri*, *Psychotria malaspinae*, and *Tabernaemontana rotensis* have fleshy fruit that may rely on dispersal by now-extirpated frugivores and the spatial distribution of these species may be affected by by the brown treesnake. Survey data gathered between 1976 and 1998 indicated that the brown treesnake had severely affected 2 native bat species, 4 native lizard species, and 13 (59 percent) of Guam's 22 native bird species (Wiles et al. 2003, p. 1,358; Rodda and Savidge 2007, p. 307). The brown treesnake also likely contributed to the extirpation of Slevin's skink on Guam (Wiles et al. 2003, p. 1,358). The snake is also a potential predator of the Pacific sheath-tailed bat (Service 2020o).

Insects including ants and wasps are a known or a potential threat to the nine animal species. Ant predation is a known threat to the Mariana eight-spot butterfly and Mariana wandering butterfly and is a potential threat to all but the Pacific sheath-tailed bat. Ants eat butterfly eggs (Schreiner and Nafus 1996, p. 3; Rubinoff in litt. 2014) and possibly caterpillars. Dwarf pedicel ants, tropical fire ants, white-footed ants, bi-colored trailing ants, and little fire ants all feed on vertebrate and invertebrate eggs, pupae, larvae, and adults (Wild 2014, p. 1). In the Mariana Islands, ants commonly occur in large, potentially high-density colonies (Schreiner and Nafus 1996, pp. 3-4). Wasps parasitize native insects, laying their eggs inside the native insect's egg or caterpillar where the hatching wasp will feed on and kill the native insect. Schreiner and Nafus (1996, p. 3) found rates of Mariana eight-spot butterfly egg parasitization as high as 86 percent of all eggs layed.

The New Guinea flatworm and introduced predatory snails are considered the most significant threat to the *Partulid* snail species (USFWS 2020t, p.15). The flatworm can climb trees when they are wet and locate arboreal snails via scent and has contributed to the extirpation of several snail populations (Sugiura and Yamaura 2009, p. 737). The introduced rosy wolf-snail (*Euglandina rosea*) and the giant African snail (*Achatina fulica*) also depredate *Partulid* snails (Hopper and Smith 1992, p. 77).

Slugs are a threat to the plant species addressed herein as well as to their native habitats. Herbivory by slugs can result in the death of individual plants, especially seedlings. In addition to the direct effects to the listed plant species, slugs feed on the two host plants on which Mariana eight-spot butterfly larvae depend. The Cuban slug (*Veronicella cubensis*) has been known on Rota since 1996, occurs in large numbers, and is a pest to agricultural and ornamental crops (Badilles et al. 2010). This species is known to forage on orchids and thus they may threaten the four species of orchids addressed herein.

Egg parasitism by wasps is a significant threat to the Mariana eight-spot butterfly. Two species of parasitoid wasp, *Telenomus* sp. (NCN) and *Ooencyrtus* sp. (NCN), have been documented emerging from Mariana eight-spot butterfly eggs. Both are apparently native to Guam, thus the butterfly is likely adapted to this parasitism (Moore 2013, p. 9). However, parasitism rates as high as 86 percent have been recently observed, which may be higher than historical levels and is likely inhibiting the recovery of the species (Rubinoff and Holland 2018, p. 222).

Although predator dynamics for the Rota blue damselfly are unknown, many damselfly groups found on Pacific islands are naïve to predatory fish and insects due to their lack of evolutionary history with these predators. Therefore, the introduction and/or proliferation of an invasive predator on Rota could severely affect the recovery of the Rota blue damselfly.

Factor D (*Inadequacy of existing regulatory mechanisms*)

Inadequate local regulatory mechanisms, which allow development and degradation of habitats occupied by the 23 species and do not address biosecurity and the spread of invasive species, threaten the 23 species and the habitats on which they depend. Although these species are federally listed, Commonwealth and Territorial laws have not been updated to include all of the 23 species, so under local law, take is not prohibited during development and other activities. In addition, laws do not prohibit intentional introduction of ungulates or intentional ignition of wildfires.

Factor E (*Other natural or manmade factors affecting the species' continued existence*)

Twelve of the 23 species are especially vulnerable to threats because of their small populations or limited distributions, 2 plant species are threatened by use of military ordnance, 1 plant is threatened by vandalism, 2 plants are threatened by off-road recreational vehicles, 1 plant is vulnerable to a non-native rust pathogen, the Pacific sheath-tailed bat is directly threatened by disturbance of roosting caves as well as being vulnerable to pesticide use, and the Rota blue damselfly is vulnerable to streamflow alterations from water harvesting for human use (Table 4) (Service 2020s).

Three of the plant species *Solanum guamense*, a species with no known individuals; *Tinospora homosepala*, a species with no known females; and *Psychotria malaspinae* and all of the animal species are especially vulnerable to demographic and environmental stochastity due to their limited numbers (see Table 1). All else being equal, species with small populations are at greater risk of extinction than species with larger populations for the following reasons: (1) reduced reproduction due to lack of reproductive opportunities (e.g., reduced likelihood an insect pollinator will encounter multiple plants of the same species, reduced amount of pollen available for wind-pollinated species, for animals, the low probability of encountering conspecifics) or inbreeding depression (Darwin 1859 Chapter 3, p. 1; Lacy 1997, entire; Crnokrak and Roff 1999, pp. 262-263; Frankham 1998, entire; Frankham et al. 2002, pp. 24-38; and Frankham 2005 p.133); (2) reduced genetic variability or allele loss due to bottlenecks, which can lead to reduced resiliency, especially in changing environments (Stebbins 1950, entire); and (3) extirpation of all remaining individuals of the species by a single catastrophic event such as a typhoon, drought, flood, or wildfire.

A potential threat to *Eugenia bryanii* would be the introduction of *Austropuccinia psidii* myrtle rust pathogen to the Mariana Islands. This rust fungus infects species in the Myrtaceae family. It is wind dispersed and has spread throughout the Pacific, including Hawaiʻi, Japan, Indonesia, New Caledonia, New Zealand, and Australia (Carnegie and Giblin, 2019 entire; Pegg et al. 2014, entire). It can also be introduced through the shipment of infected plants (Loope 2010, entire). After arrival to Hawaiʻi in 2005, all populations and trees of the endangered *Eugenia koolauensis* were infected by 2006, and damage was evaluated as severe to lethal. All *E. koolauensis* populations are currently in decline, with several populations with less than 10% of the population remaining and a couple more populations that have been extirpated (OANRP 2014, p. 275). If *A. psidii* becomes established on Guam, it could result in mortality of *E. bryanii* individuals and drastically reduce the resiliency of the species.

Human activity near or in roost sites used by the Pacific sheath-tailed bat has contributed to the species' decline throughout its range. Recreation and guano mining are examples of human activities that disturb roosting bats (Grant et al. 1994, p. 135; Tarburton 2002, p. 106; Wiles and Worthington 2002, p. 17; Palmeirim et al. 2005, pp. 63, 66; Malotaux 2012a in litt.; Malotaux 2012b in litt.). Feral goats use caves on Aguiguan for shelter, which disturbs colonies of the endangered Mariana swiftlet (*Aerodramus vanikorensis bartschi*) and likely disturbs roosting Pacific sheath-tailed bats (Wiles and Worthington 2002, p. 17; Cruz et al. 2008, p. 243; Scanlon 2015b, in litt.). Roosts facilitate complex social interactions, provide protection from inclement weather, help bats conserve energy, and minimize predation risk (Kunz and Lumsden 2003, p. 3). Thus, any disturbance, especially that which results in bats leaving their roosts, likely cause bats to incur elevated energetic costs, physiological stress, and potentially increased predation. Pesticide use in the vicinity of bat foraging and roosting habitat may have been one factor leading to the decline and eventual extirpation of the Pacific sheath-tailed bat on Rota and other islands in the Marianas; in other bat species, pesticides result in secondary poisoning or reduced insect availability (USFWS 2020o).

II. RECOVERY

A. RECOVERY VISION AND STRATEGY

Recovery Vision

A recovery vision is an explicit expression of recovery in terms of species resiliency, redundancy, and representation. It builds on the description of viability for the species and defines what recovery looks like for the species. The recovery strategy provides a recommended approach for achieving the recovery vision, and ultimately, the down- and delisting criteria.

Our overall recovery vision for the 23 species is to have redundant populations of each species, representing the remaining genetic diversity distributed throughout their historical range in areas where threats to individuals and their habitats are managed to support resilient populations. Habitat needed for recovery will be protected from development, invasive animals and plants, and other human activities which degrade habitat quality. Species-specific threats will be sufficiently managed to assure the long-term persistence of healthy populations of each species (see below).

Our recovery vision for the 14 plant species entails having redundant populations of each species distributed throughout their historical range in the Mariana Islands (see Table 1). Populations will be self-sustaining, resilient, and represent the remaining genetic and ecological diversity of the species. Habitat required to support each of the populations needed for recovery will be protected from development, invasive animals and plants, and other human activities. Species-specific threats, including invasive species and disease, will be sufficiently managed. To be downlisted and/or delisted, each species will need a minimum number of populations with a minimum population size that remain stable for 10 or 20 years as an indication that they can withstand repeated typhoons and the effects of climate change.

Our recovery vision for Pacific sheath-tailed bat entails having multiple self-sustaining populations on the islands in the Mariana archipelago within their historical range, which function as one or more viable metapopulations. The population must have stable or increasing numbers, with sufficient resiliency and redundancy to withstand foreseeable short- and long-term threats. Populations should be well-distributed on islands to provide adequate genetic representation and to facilitate their recovery from catastrophic events such as typhoons. To facilitate resilient populations, adequate areas of high-quality forest for foraging will be maintained or restored near suitable roosting sites. Threats should be managed such that the Pacific shealth-tailed bat maintains stable to growing populations throughout its range.

Our recovery vision for the Slevin's skink entails having multiple self-sustaining populations on several islands in their historical range. The range-wide population must have stable or increasing numbers, with sufficient resiliency to withstand foreseeable, long-term threats. The populations should be well distributed on islands on which they occur to provide adequate genetic representation of the species. Threats should be managed such that the Slevin's skink maintains stable to growing populations throughout its range.

Our recovery vision for the Mariana eight-spot butterfly and the Mariana wandering butterfly entails having multiple self-sustaining populations on the islands in their historical range in the Mariana Islands. The populations must have stable or increasing numbers, with sufficient resiliency to withstand foreseeable, long-term threats. The populations should be well distributed on the islands on which they occur to provide adequate genetic representation of the species and to facilitate their recovery from catastrophic events such as typhoons. Threats should be managed such that Mariana eight-spot butterfly and the Mariana wandering butterfly maintain stable to growing populations throughout their range.

Our recovery vision for the Rota blue damselfly entails having multiple self-sustaining populations in multiple watersheds to increase redundancy and genetic representation. The populations must have stable or increasing numbers, with sufficient resiliency to withstand foreseeable long-term threats such as drought and typhoons. Threats should be managed such that Rota blue damselfly maintains stable to growing populations throughout its range.

Our recovery vision for the four listed *Partulid* tree snails entails having multiple self-sustaining populations on the islands in their historical range. The populations must have stable or increasing numbers, with sufficient resiliency to withstand foreseeable long-term threats. Populations should be well distributed on the islands on which they occur to provide adequate genetic representation of the species and to facilitate their recovery from catastrophic events such as typhoons. Threats should be managed such that *Partulid* tree snails maintain stable to growing populations throughout their range.

Recovery Strategy

General Recovery Strategy

Recovery of the 23 species will require surveys of remaining populations and their habitat, selection of sites for their long-term conservation, control of threats in areas needed for their recovery, development of regulatory protections, initiation of species-specific research, and augmentation and reintroduction to improve the resiliency of each population and increase the redundancy and representation of each species.

Recovery of the 23 listed species will require thorough surveys of their historical range to locate remnant populations, identify availability of suitable occupied and unoccupied habitat, evaluate the health of existing populations, and assess site-specific threats. These surveys are a crucial first step in the development of durable long-term conservation plans for these species.

Research into the life history and species-specific threats will need to be completed for a number of the species where knowledge gaps exsist and to ensure that management continues to be informed by the best available science. The impacts of invasive predators and the specific microclimate needs of each species should be studied to inform their management. Modeling is needed to examine how climate change will affect the 23 species' distributions, including whether it will exacerbate the effects of invasive predators/herbivores. Once the overall condition of each species is known, as well as their potential future condition and distribution, sites for their long-term conservation must be established. Well-designed conservation programs, including adaptive management and monitoring, will need to be established to manage each species and its habitat.

Sites for the long-term conservation of each species will need to be selected. Regulatory and land conservation designations or landowner agreements will need to be established and/or augmented to facilitate protection of the 23 species and their habitat from development, invasive species, and species-specific threats. The 23 species should be designated as endangered or threatened under Guam's and CNMI's Endangered Species Acts and regulatory mechanisms developed and implemented to reduce threats to the 23 species from biosecurity limitations, introduced ungulates, habitat loss, and wildfire. Habitats needed to support the 23 species must have long-term recovery conservation status (e.g., conservation purchase, conservation easements, landowner conservation agreements) such that they cannot be developed and on-site management (e.g., invasive species control, reintroduction and reinforcement of populations) can be accomplished.

Invasive species degraded the habitat required by the 23 species and also directly affect many of the species. Thus, controlling invasive plants and animal threats (Table 4) will be necessary. Biosecurity measures to prevent the transport of new invasive species to the archipelago and among the islands in the archipelago are critical to the recovery of the 23 species. Improving biosecurity should include public outreach, coordination and inspection at ports of entry, and Commonwealth and Territorial biosecurity legislation.

Recovery of the 23 species will require ungulate-free habitats. Five of the 14 plant species and 8 of the 9 animal species (all but the Pacific sheath-tailed bat) are vulnerable to ungulate trampling, grazing, browsing, or rooting (Table 4, Table 5). In addition, native habitat, which is essential to the recovery of all 23 species, is degraded by ungulates (see Threats section above). Where ungulates are not eradicated from the entire island, sites selected for the long-term conservation of these species must be protected from ungulates via construction and maintenance of ungulate-proof enclosures or exclusion of ungulates from the area through lethal control. To prevent extinction, short-term management of remnant populations at sites where ungulates will not be removed may be necessary while the permanent sites for the long-term conservation and recovery of the species are secured and protected from threats.

Recovery of the 23 species will require control of rodents, brown treesnakes, invasive invertebrates, diseases and pathogens and programs to prevent spread and introduction of such pests. Rodent control or eradication programs and implementation are needed to increase reproduction, recruitment, and survival of the 23 plant and animal species as well as to ensure the long-term persistence of their habitat. Almost three-quarters of the native tree species on Guam rely on birds to disperse their seeds (Rogers 2009; Rogers 2011, pp. 1–75). To facilitate the long-term persistence of the native habitats needed to conserve Guam's listed species, landscape-scale control of the brown treesnake is necessary to allow the recolonization of the island's frugivorous birds and fruit bats. Without effective brown treesnake control and recolonization by effective seed dispersers, these species may be unable to persist on Guam without human-assisted dispersal. The brown treesnake, rodents, and invasive invertebrates also depredate the nine listed animals and directly or indirectly affect the listed plants and the habitats needed by the 23 species. Thus, recovery of the 23 species also will require site-specific invasive vertebrate and invertebrate control programs. Control of invasive ants that interfere with native pollinators and feed on vertebrate and invertebrate eggs, pupae, larvae, and adults, may be necessary to conserve plant pollinators and seed dispersers needed for the persistence of native habitat. Control of invasive slugs may be necessary to protect the plant species addressed herein as well as the native habitats that all 23 species rely upon.

Recovery of most of the 23 species will require management of invasive plant species. Control or eradication of habitat-modifying invasive plants, wildfire threat control, and interdiction to prevent introduction of new invasive plants will be necessary to conserve the listed species and the native habitat needed to support the listed species addressed herein. New tools and strategies to control or eradicate invasive plants and enhance native habitat to improve the survival of the 23 species may need to be developed. In addition to being a direct threat to listed plants and animals, wildfire facilitates the establishment of invasive grasses in burned native forest and savanna vegetation. Recovery of the listed species will require strategies to prevent wildfires from burning native forest habitats and directly killing listed individuals as well as ensuring that fire-return intervals in the savanna habitats needed for recovery are short enough to enable a diverse savanna plant community to persist.

Catastrophic events such as typhoons can degrade or destroy forest habitat, as well as the microhabitat conditions essential to the 23 species (USFWS 2020 a-w). While typhoons are a natural occurrence, the damage they cause can exacerbate the vulnerability of small or isolated populations. Typhoons and other catastrophic events tend to be spatially limited, thus the establishment of multiple populations on each island and on multiple islands is necessary to limit the species' vulnerability to catastrophic events. With all *ex situ* conservation and translocation efforts, all remaining genetic diversity must be preserved and removal of individuals for translocation should not harm donor populations (Sischo and Hadfield 2017, p. 1).

For the purposes of this document, conservation translocation (hereafter translocation) is defined as the deliberate movement of organisms from one site for release in another for conservation benefit and includes population restoration (reinforcement and reintroduction) and conservation introduction (assisted colonization and ecological replacement) as defined in IUCN (2013, entire). If part of a species' recovery strategy, translocations will follow the International Union for Conservation of Nature (IUCN)/Species Survival Commission guidelines (IUCN 2013, entire).

Population restoration is needed to establish a sufficient number of populations to allow each species to persist over the long term despite reoccuring catastrophic events such as typhoons. While having redundant and resilient populations distributed throughout a species' range is a hallmark of most recovery criteria, the periodic and extremely destructive potential of typhoons, which will likely increase with climate change, indicates that conservation translocations will be particularly important to the recovery of 23 species. Because the species and their habitats are vulnerable to typhoons, maintaining redundant, viable populations on multiple islands is needed to mitigate for lossess associated with typhoons. This strategy, in addition to having *ex situ* collections (i.e., captive propagation of animal, seed storage, and nursery collections of plants), increases the likelihood that the number of stable populations needed for recovery will persist over the long term. *Ex-situ* populations (e.g., botanical gardens, zoos, captive facilities) will be established within or outside of the species' historical ranges. These will serve as insurance populations as well as providing a source for conservation translocations. The development of micro-climate models to identify suitable current and future habitat will be needed to support the recovery of those species susceptible to the effects of climate change. The selection of sites for reinforcement or reintroduction will be prioritized based on threat and habitat suitability assessments, current and long-term conservation potential, population demography, genetics (Hoffmann et al. 2015, entire), and other site- and species-specific considerations. All populations created via translocation will incorporate the full genetic representation of the source population. Species-specific translocation plans will be developed for each species and include the genetic composition of the founders, number of founders to be used, number of individuals from each founder, the species' reproductive capacity as well as suitability and availability of habitat. Threats will be controlled or mitigated prior to any augmentation or reintroduction efforts. To achieve the required number of populations for recovery, assisted colonization may be needed to establish species outside of their known historical range.

In addition to the above general recovery actions, species-specific strategies and habitat needs are detailed below.

Recovery Strategy for Plants

In addition to the above outlined general strategies, the following specific strategies will be required to recover the 14 plant species. First, "preventing extinction" and "interim stabilization" measures (see below) must be taken to reverse the extinction trajectory and stabilize these species. These include genetic storage, controlling threats in the immediate vicinity of individual plants, and reinforcement and reintroduction to support and/or achieve a small number of relatively small populations. Of the 14 plant species, all but 4 (*Dendrobium guamense*, *Eugenia bryanii*, *Phyllanthus saffordii*, and *Tuberolabium guamense*) persist at very low numbers, are in rapid decline, or are thought to be extinct (see Table 2). Because of their low numbers, surveys will be especially important to the recovery of *Solanum guamense*, *Tinospora homosepala*, and *Psychotria malaspinae* to locate all individuals and closely track population status. Downlisting and delisting will require development and implementation of measures to protect the habitat needed for the long-term conservation of the species from threats including development, invasive animals, and invasive plants (including wildfire-mediated grass invasion). In addition to the measures needed to assure long-term persistence of their needed habitat, most plants will also require protection from direct impacts of herbivory by invasive vertebrates and invertebrates. On Guam, the brown treesnake has extripated most vertebrate seed dispersers. The recovery of *Maesa walkeri* (USFWS 2020g), *Psychotria malaspinae* (USFWS 2020i), and *Tabernaemontana rotensis,* which have fleshy fruits (USFWS 2020 l) that were likely dispersed by fruit-eating vertebrates, will require landscape-scale control of the brown treesnake or human-assisted seed dispersal to persist on Guam (Egerer et al. 2018, p. 655). Several species also need protection from military ordnance, vandalism, recreational vehicles, and the introduction of new diseases as well as increasing the number of individuals to ameliorate the suite of threats resulting from or exacerbated by limited numbers. New tools and methods to control and manage threats and limiting factors to enhance survival and reproduction may need to be developed and implemented. These may include micropropagation and the development of *ex situ* populations. Research pertaining to the detection and mitigation of threats, such as disease, should be initiated as needed to inform management. Reinforcement and reintroduction of plant populations to protected areas will be needed to recover the 14 plant species. To offset the risk from reoccurring typhoons, more protected populations than are typically required for recovery will be needed.

Recovery Strategy for the Pacific sheath-tailed bat

Recovery of the Pacific sheath-tailed bat will require surveys of historically occupied islands to identify remnant populations and suitable roosting and foraging habitat. To inform management, research on population structure and dynamics as well as life history is needed. The management and protection of remnant populations and the habitat that supports them is essential for the recovery of the subspecies. Currently the subspecies is known to occur only on Aguiguan and this population will be prioritized for management, unless surveys locate other, higher-priority populations. Islands such as Rota, however, where the species is extripated, also may offer management opportunities (e.g., reintroductions), especially given the island's size and infrastructure compared to the smaller and more difficult to access, uninhabited islands in the northern part of the archipelago.

In American Samoa, forest clearing around cave entrances has been associated with abandonment of Pacific sheath-tailed bat roosts (Service 2020o, Service 2020y). Therefore, protection of forests near roosting areas via ungulate removal, conservation agreements, and invasive plant control is necessary to maintain foraging habitat and ensure that caves provide adequate roosting habitat and are not abandoned. Both are critical to the restoration and recovery of bat populations.

Pacific sheath-tailed bat typically produce one pup annually (Wiles et al. 2011, p. 306). Their low reproductive potential makes the species vulnerable to events or threats that increase adult mortality as well as reproductive failure and results in a slow recovery from catastrophic events. Because cats and/or rats may opportunistically prey on roosting Pacific sheath-tailed bats (USFWS 2020o), predator control measures may be necessary to reduce this source of mortality.

Pacific sheath-tailed bats are nocturnal and roost in caves, and are vulnerable to daytime disturbance (e.g., entry of humans and/or goats). Therefore, where roost disturbance is an issue, public outreach, management, and fencing should be considered to minimize human disturbance and maintain the viability of existing roosts and/or aid in the reestablishment of abandoned roosts. Based on future surveys to assess the suitability of occupied and unoccupied caves, those with the most preferable characteristics for roosting and pup rearing should be protected as soon as possible.

Roosting caves and foraging habitat can be destroyed by typhoons and bats can be killed during storms (USFWS 2015). Climate change will likely increase the frequency and severity of typhoons. Thus, the Pacific sheath-tailed bat must be reestablished on multiple islands to limit its vulnerability to catastrophic events.

Pesticide use near forarging habitat or roosts is thought to have been one of the factors leading to the species' decline (Wiles and Worthington 2002, p. 17) and its extirpation on Rota and other islands in the archipelago. Pesticides are known to adversely affect bat population either by secondary poisoning from consuming contaminated insects or by reducing the availability of prey; however, the extent to which either mechanism has affected the subspecies in the Mariana archipelago remains uknown (Hutson et al. 2001, p. 138; Mickleburgh et al. 2002, p. 19). To avoid negatively impacting the species, pesticide use near current or potential roost and foraging sites will be avoided unless research determines pesticide use is not a threat to the species.

Historically this subspecies likely functioned as a metapopulation that facilitated gene flow among islands and natural recolonization after catastrophic events. If any inter-island dispersal currently occurs it is likely insufficient to re-establish extirpated island populations. Given the small populations restricted to Aguiguan, surveys throughout the subspecies' range are required to identify and protect all remnant populations as well as identify potential reintroduction sites.

If populations are not found outside of Aguiguan, reintroductions will be necessary to establish redundant populations necessary to buffer the subspecies from the effects of typhoons and other stochastic events. Surveys and modeling will be required to evaluate the Aguiguan population's capacity to serve as donors for translocation as would be genetic analyses to ensure that founders possess a significant percentage of the subspecies' remaining genetic diversity. Suitability of roosting and foraging habitat at reintroduction sites; protocols and logistical support for safe capture, transport, and release; and coordination and permitting all need to be conducted or be in place prior to any translocation efforts.

Recovery Strategy for Slevin's skink

Little is known about Slevin's skink; therefore, its recovery strategies are currently limited to those outlined above in the General Recovery Strategy section. Research will be conducted to determine the most significant threats to the species as well as research on population structure, population dynamics, and life history. This information will be used to refine the species' recovery actions.

Recovery Strategy for Mariana eight-spot butterfly and Mariana wandering butterfly

Little is known about either the Mariana eight-spot butterfly or Mariana wandering butterfly; therefore, its recovery strategies are currently limited to those outlined above in the General Recovery Strategy section and the paragraphs below. Research will be conducted to determine the most significant threats to the species as well as on population structure, population dynamics, and life history. This information will be used to refine the species' recovery actions.

Due to the dependence of both species on their respective host plants, ungulate and slug control or eradication are priority actions. The development of techniques to reduce or eliminate predation by native and non-native insects, mostly by ants and parasitic wasps, are also priority actions, with the following caveat: native parasitic wasp populations should not be reduced to the point where the ecosystem benefits they provide is diminished. Together, these actions would restore or enhance native forest habitat and improve the resiliency of butterfly populations.

Unless the Mariana wandering butterfly is rediscovered, no direct recovery actions can be implemented; however, management of appropriate habitat and host plants would improve conditions for any individuals that may still exist.

Recovery Strategy for the Rota blue damselfly

Little is known about Rota blue damselfly; therefore, its recovery strategies are currently limited to those outlined above in the General Recovery Strategy section and the paragraphs below. While we have some information regarding the life history and population dynamics of damselflies in Hawai‘i and other Pacific Islands, research (or a PVA) are needed to determine the most significant threats to the species as well as on population structure, population dynamics, and life history. This information will be used to refine the species' recovery actions.

The presence of several dry and intermittent stream beds located east of Okgok Stream suggest that the range of the Rota blue damselfly once included all of the Talakhaya watershed (USFWS 2020s). The species could potentially recolonize the watershed streams if conditions are improved. Comparing these streams to the Okgok will help determine whether the species' range could be expanded.

The protection of the remnant population in Okgok Stream and management of the threats that are degrading the watershed are essential to the recovery of the species. These include managing the forest on the Sabana Plateau to maintain water quality and preserving forest cover adjacent to the stream to prevent sediment runoff. The latter also will preserve the microhabitat conditions (i.e., temperature, and humidity) that are essential to the species. Excluding deer from stream habitat or reducing their population will likely be necessary to improve and maintain water quality. In addition, based on what is known of other island damselflies, preventing the introduction of potential predators is critical. Thus, bolstering the biosecurity of Rota is of particular importance to the recovery of this species.

Given the Rota blue damselfly's extremely limited range and number of populations as well as the limited amount of suitable habitat, captive propagation and reintroduction and/or assisted colonization to suitable stream habitat should be evaluated as potential tools to establish additional populations to improve the species' redundancy. The establishment of an insectary facility to propagate *Megalagrion xanthomelas*, a damselfly endemic to the Hawaiian island of O'ahu, has proven successful (Polhemus pers comm 2020). The success of this program suggests that captive propagation and release of the Rota blue damselfly could establish the species in additional watersheds.

Recovery Strategy for tree snails

Little is known about *Partulid* treesnails in the Marianas; therefore, recovery strategies are currently limited to those outlined above in the General Recovery Strategy section and in the paragraphs below. Although we do have some information regarding the treesnails in Hawai'i and other Pacific Islands, research is needed to determine the most significant threats to the species as well as population structure, population dynamics, and life history. This information will be used to refine the species' recovery actions.

Non-native predators are one of the most significant threats to tree snails in the Marianas (USFWS t-w). Development of effective tools to eradicate introduced predatory snails and/or New Guinea flatworm populations would benefit the Mariana tree snails as well as those on other Pacific islands. To date, no effective methods are available for controlling or eradicating established population of these predators; therefore, preventing their introduction to islands or areas of islands is essential for the recovery of tree snails in the Marianas.

Unless Langford's tree snail is rediscovered, no direct recovery actions can be implemented; however, management of appropriate habitat would likely improve conditions for any individuals that may still exist.

B. RECOVERY CRITERIA

Section 4(f)(1)(B)(ii) of the Act states that each recovery plan shall incorporate, to the maximum extent practicable, "objective, measurable criteria which, when met, would result in a determination that the species be removed from the List." Legal challenges to recovery plans (see Fund for Animals v. Babbitt, 903 F. Supp. 996 (D.D.C. 1995)) and a Government Accountability Audit (GAO 2006) also have affirmed the need to frame recovery criteria in terms of threats assessed under the five listing factors.

Recovery criteria serve as objective, measurable guidelines to assist in determining when an endangered species has recovered to the point that it may be downlisted to threatened, or that the protections afforded by the Act are no longer necessary and the species may be delisted. Delisting is the removal of a species from the Lists. Downlisting is the reclassification of a species from endangered to threatened. The term "endangered species" means any species (or distinct population segment [DPS], subspecies, or species group) that is in danger of extinction throughout all or a significant portion of its range. The term "threatened species" means any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Recovery criteria represent our best assessment, at the time the recovery plan is completed, of the conditions that would likely result in a determination that listing under the Act as threatened or endangered is no longer required. However, revisions to the Lists, including delisting or downlisting a species, must reflect determinations made in accordance with sections 4(a)(1) and 4(b) of the Act. Section 4(a)(1) requires that the Secretary of the Interior determine whether a species is an endangered or threatened species because of threats to the species, based on an analysis of the five listing factors in section 4(a)(1). Section 4(b) require that the determination be made "solely on the basis of the best scientific and commercial data available." Thus, while recovery plans provide important guidance to the Service, States, and other partners on methods of minimizing threats to listed species and measurable criteria against which to measure progress towards recovery, they constitute guidance and are not regulatory documents.

All classification decisions consider an analysis of the following five factors described under **Threats** (above). Thus, a decision to delist or downlist a species is informed by the recovery criteria but must ultimately be based on an analysis of threats using the best scientific and commercial data then available. When considering changing the status of a species, we first propose the action in the Federal Register to seek public comment and peer review, after which we announce a final decision in the Federal Register.

The species addressed in this recovery plan should be considered for downlisting and delisting when the following objective[s] and criteria have been met. Downlisting and delisting criteria are subject to change as additional information becomes available about species biology and threats.

1. Recovery Criteria - Plant Species

Objective - Establish multiple, self-sustaining populations of each species on multiple islands to increase population redundancy, preserve or enhance genetic diversity to maintain or increase representation, protect and manage suitable habitat, and manage threats to improve the resiliency of populations of all species.

Recovery will be achieved through a series of conservation stages based on the Hawaiʻi and Pacific Plants Recovery Coordinating Committee (HPPRCC) Revised Recovery Objective Guidelines (HPPRCC 2011, entire). These stages include preventing extinction, interim stabilization, downlisting, and delisting. At recovery, populations of each of the 14 species will be self-sustaining, resilient, and represent the remaining genetic diversity existing in the species. The species and the habitat on which they depend for recovery will be protected from threats including development and invasive animals and plants. Species-specific threats will be sufficiently managed so that each species maintains stable to positive population growth.

The HPPRCC, comprised of biologists from Federal and State agencies, private conservation organizations, botanical gardens, and universities, was established to advise the Service on the biology as well as management needed to recover listed plants. The HPPRCC outlined general actions and goals for a series of conservation stages which ultimately would lead to the recovery of listed plants in the Mariana Islands (HPPRCC 2011, entire). Current information is lacking for many of the 14 listed plant species with respect to the number of populations and their status and size, habitat requirements, breeding systems, genetics, and propagule storage options. We therefore adopted downlisting and delisting criteria for these 14 plants based on the revised general recovery objective guidelines developed by the HPPRCC (2011, entire). To assist in tracking progress toward recovery, we also developed conservation stages for preventing extinction and interim stabilization based on the recommendations of the HPPRCC. While these two interim recovery stages are not required under the Act, they are instrumental in the recovery of these species. The plant survey, genetic storage, site selection, and threat control criteria, as well as the minimum number of individuals and populations needed in each stage build upon previous stages; a stage is not considered complete unless goals of the previous stage has been achieved.

For many species, we do not have adequate data to determine the effective population size or the number of individuals contributing to the next generation. Thus, we used the number of reproducing individuals per population as a surrogate for effective population size. The number of sexually mature (mature) individuals per population required to meet the goals of the preventing extinction stage (greater than 25 to 100 individuals; Table 6) is based on the number of individuals needed to avoid immediate extinction due to demographic stochasticity as well as catastrophic events (HPPRCC 2011 p. 4-5). The number of mature individuals per population required to meet the goals of interim stabilization (greater than 100 to 500 individuals; Table 7) is based on the number of individuals needed to avoid inbreeding (HPPRCC 2011 p. 6), while the number of individuals required to meet downlisting and delisting criteria (approximately 5,000 mature individuals; Tables 8 and 9) is based on the estimated number of individuals needed to maintain evolutionary potential and resiliency (Reed et al. 2002, pp. 12-13; Traill et al. 2010, pp. 30, 32; HPPRCC 2011, p. 7-10).

For the purposes of recovery criteria in this plan, a plant population is a group of conspecific individuals in close proximity to each other (i.e., less than 1,000 meters [3,280 feet] apart) and presumed to be genetically similar and capable of sexual reproduction (HPPRCC 2011, p. 1). Species-specific life history and population characteristics used by the HPPRCC to set goals for the number of populations and the size of each of the 14 plants in this plan include life span, reproductive strategy, and population trend.

General distinctions made by the HPPRCC that are relevant to the 14 plants in this plan include the following:

- *Life span*: Long-lived perennials are defined as species with life spans greater than 10 years, short-lived perennials are those with life spans greater than 1 year but less than 10 years, and annuals are those with life spans less than or equal to 1 year. None of the 14 listed species are currently believed to be annuals. The HPPRCC recommends that populations of short-lived perennials have two to three times as many individuals as long-lived perennials to meet the goal of each stage (see Tables 6-9; referred to as "short" and "long," respectively). When a species' life span was unknown, we erred on the side of caution and considered the species short-lived. We currently do not have the data needed to determine the mean life span of most of these species; as more data is collected we will update species' life span categorizations.
- *Reproduction strategies*: Obligate outcrossers are species that either have male and female flowers on separate plants (i.e., dioecious plants) or otherwise require cross-pollination to fertilize seeds; hence not all individuals produce viable offspring. Therefore, for obligate outcrossers, the HPPRCC (HPPRCC 2011, p. 5, 6, 8, 10) recommends doubling the number of total reproductive individuals required per recovery stage compared to that necessary for species that are not obligate outcrossers. The majority of genetic varation in species that predominantly reproduce vegetatively or asexually (i.e., without seeds) is typically found among populations versus within populations (Frankham et al. 2002, pp. 414-415). While we currently are uncertain if this applies to any of the 14 listed plant species, if future data suggests otherwise, additional populations would be required. To maximize reproductive success and the maintenance of genetic diversity within each population where outplanting is conducted, founder (unique genetic lines) representation should be balanced among individuals (Falk et al 1996 p182-183) and, for dioecious plants, males and females should be planted near each other (Maschinski and Haskins 2012, p. 287).
- *Population size trends:* Species characterized by large fluctuations in the number of mature individuals or a known history of severe declines in the number of mature individuals in the population require a larger number of mature individuals (approximately 50 percent higher) than species without such fluctuations for the population to persist during, for example, drought years and to recover during typical years (HPPRCC 2011, p. 5-10). Our current understanding is that none of the 14 listed plants have populations that greatly fluctuate in size; should a species be identified as having this characteristic, the minimum number of mature individuals needed in each of the stages would be increased by 50 percent.

The following targets for the preventing extinction and interim stabilization stages and the downlisting and delisting criteria were determined based on known biology of the 14 plants addressed herein with consideration given to the above general guidelines.

Preventing Extinction

To meet the preventing extinction goal, several conditions must be satisfied. Surveys throughout each species' historical range are completed to document occurrences, and studies of plant reproductive biology are completed as needed to inform management. Each species has the minimum number of populations and reproducing individuals per population as shown in Table 6. All threats are assessed and controlled in the immediate vicinity of each population. Each population shows evidence of natural reproduction (i.e., viable seeds, seedlings, saplings). Finally, at least 50 individuals per population, or the total number of individuals if fewer than 50 remain, must be secured in a well-managed *ex situ* collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004, entire).

Table 6. Minimum number of plant populations and the number of individuals per population needed to meet preventing extinction goals.

Life Span	Population and Life History Characteristics	Minimum Number of Populations	Reproducing Individuals/ Population	Plant Species
Long	No specific characteristics known	3	25	*Eugenia bryanii*
		3	25	*Heritiera longipetiolata*
		3	25	*Maesa walkeri*
		3	25	*Psychotria malaspinae*
		3	25	*Tabernaemontana rotensis*
Long	Obligate outcrosser	3	50	*Cycas micronesica*
Short	No specific characteristics known	3	50	*Bulbophyllum guamense*
		3	50	*Dendrobium guamense*
		3	50	*Hedyotis megalantha*
		3	50	*Nervilia jacksoniae*
		3	50	*Phyllanthus saffordii*
		3	50	*Solanum guamense*
		3	50	*Tuberolabium guamense*
Short	Obligate outcrosser	3	100	*Tinospora homosepala*

Interim Stabilization

In addition to meeting all of the preventing extinction goals, to meet the interim stabilization goals, the minimum number of populations and reproducing individuals per population identified in Table 7 must be achieved. All major threats must be controlled around the target populations and each population must be naturally reproducing. Seedlings transitioning to mature individuals, a replacement regeneration, or an age-class distribution indicative of a stable population must be documented in all the populations. Once outplanted populations are producing viable seed or vegetatively reproducing they can count toward the population number criteria. Species known from multiple islands must be represented by at least one population on each historically occupied island, as long as appropriate stock is available for successful reintroductions. All populations are adequately represented in an appropriate *ex situ* collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004, entire) that is secure and well maintained.

Genetic analyses of wild, reintroduced, and *ex situ* populations of each species should be conducted to ensure maintenance of genetic variation within and between populations throughout controlled propagation efforts. The results of the genetic analyses will be used to develop translocation strategies to correct any genetic deficiencies and determine if translocation efforts should be from single or multiple wild populations. Finally, adequate monitoring is in place to assess individual plant survival, population trends, trends of major limiting factors, and the response of populations to threat management.

Table 7. Minimum number of plant populations and the number of individuals per population needed to meet interim stabilization goals.

Life Span	Population and Life History Characteristics	Minimum Number of Populations	Reproducing Individuals/ Population	Plant Species
Long	No specific characteristics known	3	100	*Eugenia bryanii*
		3	100	*Heritiera longipetiolata*
		3	100	*Maesa walkeri*
		3	100	*Psychotria malaspinae*
		3	100	*Tabernaemontana rotensis*
Long	Obligate outcrosser	3	200	*Cycas micronesica*
Short	No specific characteristics known	3	300	*Bulbophyllum guamense*
		3	300	*Dendrobium guamense*
		3	300	*Hedyotis megalantha*
		3	300	*Nervilia jacksoniae*
		3	300	*Phyllanthus saffordii*
		3	300	*Solanum guamense*
		3	300	*Tuberolabium guamense*
Short	Obligate outcrosser	3	600	*Tinospora homosepala*

<u>Recovery Criteria</u>

Downlisting

In addition to meeting all of the interim stabilization goals, the following criteria should be met to downlist the seven endangered plant species to threatened:

Downlisting Criteria

<u>Criterion 1:</u> The minimum number of mature individuals per population and the number of populations designated for downlisting detailed in Table 8 are stable, secure, and naturally reproducing for a minimum of 10 years. Species known from multiple islands within the archipelago, have at least three populations on each of the historically occupied islands, as long as suitable appropriate stock is available for successful reintroductions within the species' known range.

<u>Criterion 2:</u> Monitoring of the populations designated for downlisting is adequate to ascertain effectiveness and sufficiency of threat control and determine population size trend or growth. A PVA has been conducted to confirm the number of individuals needed to achieve a viable population and inform refinements to the recovery needs of the species. This analysis is based on data collected at intervals determined by the life history, threats, and management prescriptions of the species. The results of the PVA should not be given more weigth than other criteria in making a downlisting decision.

<u>Criterion 3:</u> Threats to each species and their habitat are managed to ensure that all populations meet downlisting Criterion 1. A species' management and monitoring plan is drafted and identifies actions necessary to control threats to the long-term persistence of

habitat supporting these (i.e., invasive animals including ungulates, invasive plants including grass invasion due to wildfire) populations. Species-specific management actions may be necessary to ensure stable populations even after species are downlisted. The plan also identifies monitoring procedures and schedules to track the response of species to management.

Table 8. Minimum number of plant populations and the number of individuals per population needed to meet downlisting Criterion 1.

Life Span	Population and Life History Characteristics	Minimum Number of Stable Populations	Reproducing Individuals/ Population	Plant Species Listed as Endangered
Long	No specific characteristics known	5	200	*Eugenia bryanii*
		5	200	*Heritiera longipetiolata*
		5	200	*Psychotria malaspinae*
Short	No specific characteristics known	5	500	*Hedyotis megalantha*
		5	500	*Phyllanthus saffordii*
		5	500	*Solanum guamense*
Short	Obligate outcrosser	5	1000	*Tinospora homosepala*

Delisting

To consider delisting the 14 listed plant species, the above downlisting criteria should be met for a 10-year period for the 7 endangered plant species, as well as the following criteria for all species.

Delisting Criteria

Criterion 1: At least 10 populations designated for delisting, with population sizes detailed in Table 9, are stable, secure, and naturally reproducing for a minimum of 20 years within secure and viable habitats to be considered for delisting. Species known from multiple islands within the archipelago, have at least three populations on each of the historically occupied islands, as long as suitable appropriate stock is available for reintroduction within the species' known range.

Criterion 2: Threats to the species and the habitat of plant populations conserved to meet recovery Criterion 1 are controlled. For example, on islands with ungulates all of the populations designated for delisting are within fenced areas free of ungulates, with funding and agreements from conservation partners to maintain fences and ungulate free status of fenced areas. Monitoring of the status and the threats to each population is ongoing. Population censuses and threat assessments are completed annually for at least 20 years prior to delisting. Species-specific management actions (e.g., hand-pollination, propagation, and translocation) should no longer be necessary, but habitat management will be necessary over the long term.

Table 9. Minimum number of plant populations and the number of individuals per population needed to meet delisting Criterion 1.

Life Span	Population and Life History Characteristics	Minimum Number of Stable Populations	Reproducing Individuals/ Population	Species
Long	No specific characteristics known	10	200	*Eugenia bryanii*
		10	200	*Heritiera longipetiolata*
		10	200	*Maesa walkeri*
		10	200	*Psychotria malaspinae*
		10	200	*Tabernaemontana rotensis*
	Obligate Outcrosser	10	400	*Cycas micronesica*
Short	No specific characteristics known	10	500	*Bulbophyllum guamense*
		10	500	*Dendrobium guamense*
		10	500	*Hedyotis megalantha*
		10	500	*Nervilia jacksoniae*
		10	500	*Phyllanthus saffordii*
		10	500	*Solanum guamense*
		10	500	*Tuberolabium guamense*
	Obligate outcrosser	10	1000	*Tinospora homosepala*

Rationale for Plant Recovery Criteria

The recovery criteria for the 14 plants are based on the currently known biology of each species as detailed in the latest listing rule, recovery outline, species reports, the Hawaiʻi and Pacific Plants Recovery Coordinating Committee's Revised Recovery Objective Guidelines, and expert opinion (HPPRCC 2011, entire; references in Tables 1 and 3). Rationale for the need to control threats to the listed plants and their habitats are detailed below in the "Recovery Strategy" section.

Life history traits have been used to infer minimum viable population numbers (Pavlik 1996, entire). We used each species' life span and reproductive strategy to determine the number of populations and the number of mature individuals per population needed to progress from the preventing extinction stage to delisting. Suitable habitat is required to maintain viable populations, and long-term habitat maintance and in some cases habitat restoration, will be necessary. Reinforcing existing populations and reintroductions to create new populations will be crucial to achieving recovery for many of the plant species; increasing the number of individuals will improve population resiliency and increasing the number of populations will improve species redundancy. All translocations will be informed by the genetic composition of the founders, number of founders used, number of individuals from each founder, and the species' reproductive capacity and habitat availability.

The number of populations and the number of individuals in each population needed to prevent extinction (and to achieve the preventing extinction goals) are based in part on models that demonstrate loss of genetic variation in populations of various sizes. For example, a population of 25 individuals will lose approximately 25 percent of its genetic variation over 10 generations. Vegetatively-reproducing and dioecious species are believed to possess less genetic variation compared to sexually-reproducing and hermaphroditic or monoecious species, and hence the number of populations (for vegetatively-reproducing species) or individuals per population (for dioecious species), needs to be higher to minimize the loss of genetic variation (see HPPRCC 2011 pp 5-10; Hartl and Clark 1989).

2. Recovery Criteria for Pacific sheath-tailed bat

Objective: Establish multiple, self-sustaining populations on multiple islands to increase population redundancy, establish metapopulation dynamics, enhance inter-population morphological and genetic diversity to maintain or increase representation, protect and manage suitable habitat, and manage threats to improve the resiliency of Pacific sheath-tailed bat populations.

Downlisting

To consider downlisting the Pacific sheath-tailed bat from endangered to threatened, the following criteria should be met.

Downlisting Criteria

Criterion 1: There are at least three stable or increasing populations of Pacific sheath-tailed bats with consistently occupied roosts on two or more islands. To be considered stable, a population must number at least 500 individuals over a 10-year period.

Criterion 2: Roosts that contribute to Downlisting Criterion 1 and the surrounding forest habitat are protected from development and habitat-altering invasive species including ungulates. Long-term management commitments are in place to maintain the quality and quantity of foraging and roosting habitat.

Criterion 3: Threats to the species, including predation, habitat alteration, and pesticides are eliminated or are being effectively managed such that populations meet targets in Downlisting Criterion 1.

Delisting

To consider delisting the Pacific sheath-tailed bat, the above downlisting criteria should be met, as well as the following criteria.

Delisting Criteria

Criterion 1: There are at least six stable or increasing populations of Pacific sheath-tailed bat with consistently occupied roosts on three or more islands. To be considered stable, a population must number at least 500 individuals over a 10-year period.

Criterion 2: Roosts that contribute to Downlisting Criterion 1 and the surrounding forest habitat are protected from development and habitat-altering invasive species including ungulates. Long-term management commitments are in place to maintain the quality and quantity of foraging and roosting habitat.

Criterion 3: Threats to the species including predation, habitat alteration, and pesticides are eliminated or are being effectively managed such that populations meet targets in Delisting Criterion 1.

Criterion 4: A management plan (or plans) is developed and implemented to ensure the long-term protection of the habitat that supports the six populations.

Rationale for Pacific sheath-tailed bat recovery criteria

Given a generation time of approximately 2.5 years, monitoring over a 10-year period will provide sufficient data to assess population trends over several generations and potentially allow the effects of catastrophic events to be tracked. Protecting and facilitating the growth of populations on Aguiguan is a necessary first step to restoring populations on other islands, as the Aguiguan populations will be the source for future reintroduction efforts. Establishing new populations on additional islands will improve the redundancy and representation of the species and hopefully re-establish a functioning metapopulation.

Based on the preference of the Mariana subspecies for foraging in forests adjacent to roosts, Wiles et al. (2011, p. 307) suggested that past deforestation in the Mariana archipelago was likely a principal factor in limiting the current population to Aguiguan, an island that retains significant forest cover. Overgrazing of the forest understory by ungulates results in little or no recruitment of canopy tree species, which inhibits or prevents forest recovery after catastrophic events such as typhoons. Protection of extant and extirpated roost sites from disturbance and management of adjacent forest habitat should preserve essential foraging habitat necessary to keep existing colonies viable and unoccupied roosts suitable for recolonization.

The most significant threats to the subspecies include predation by invasive mammals, disturbance at roost caves, habitat loss due to deforestation and overgrazing by ungulates, and stochastic events such as typhoons. In addition, pesticide use is thought to have contributed to the decline and eventual extirpation of bat colonies on Guam, Rota, Tinian, and Saipan. Although the magnitude and mechanism of these threats and their effect on population viability have not been extensively studied, managing these threats is expected to substantially improve the resiliency of populations.

Given the number of threats and the species' dependence on intact native forest for foraging, suitable habitat for this subspecies must be managed continuously. Developing and implementing a Pacific sheath-tailed bat management plan will ensure the species' needs are met and threats are managed to facilitate the eventual translocation or recolonization to islands or areas from which they were extirpated. Expanding populations to other islands will increase redundancy and resiliency and will enhance their ability to recover from catastrophic and stochastic events.

3. Recovery Criteria for Slevin's skink

Objective: Establish self-sustaining populations of Slevin's skink on six islands with threats adequately managed to increase redundancy, preserve inter-population morphological and genetic diversity to maintain or increase representation, protect and manage suitable habitat, and manage threats to improve the resiliency of Slevin's skink populations.

Downlisting

To consider downlisting the Slevin's skink from endangered to threatened, the following criteria should be met:

Downlisting Criteria

Criterion 1: There are stable or increasing populations of Slevin's skink on at least four islands. To be considered stable, populations must be reproducing and not decreasing in abundance for 10 years.

Criterion 2: Suitable habitat on the four occupied islands is effectively protected from development and habitat-altering invasive species including ungulates.

Criterion 3: Islands supporting the skink are free of invasive predators such as the brown treesnake, Asian house shrew, and black rat or populations are controlled to a level where the species is able to maintain stable to growing populations throughout its range.

Delisting

To consider delisting Slevin's skink, the above downlisting criteria should be met, as well as the following criteria.

Delisting Criteria

Criterion 1: Populations of Slevin's skink are stable or increasing on six islands. At least one population must occur on Guam, Rota, Tinian, Saipan, or Pagan, which have considerably more suitable habitat than the currently occupied islands. To be considered stable, populations must be reproducing and not decreasing in abundance for 10 years.

Criterion 2: Suitable habitat on the six occupied islands is effectively protected from development and habitat-altering invasive species including ungulates. Agreements from conservation partners to maintain protections are in place to ensure the habitat remains suitable.

Criterion 3: Habitat needed to support the skink is free of invasive predators such as the brown treesnake, Asian house shrew, and black rat, or populations are controlled to a level where the species is able to maintain stable to growing populations throughout its range.

Criterion 4: Management and monitoring plans are completed and identify the actions and procedures needed to control threats to habitat (i.e., ungulates and invasive plants) needed to support recovery of populations and to individuals. The monitoring plan identifies procedures and schedules to track the response of species to management.

Rationale for Slevin's skink recovery criteria

We did not include a specific number of populations in the recovery criteria because of the species' cryptic nature and the difficulty of surveying the northern islands. Instead, we rely on a target geographic distribution. Based on the most recent surveys, Slevin's skink populations occur on four islands. Although the skink was historically found on nine islands in the Marianas, as long as stable or increasing populations exist on four islands the species will have sufficient redundancy to protect them from catastrophic events. Three of the four islands, Sarigan, Alamagan, and Asuncion are presently not likely to be impacted by development pressure, have large areas of suitable skink habitat, and other threats are expected to remain at current levels due to the low likelihood of human disturbance in the Northern Islands. No life history studies of the skink have been conducted; however, a study of the related littoral skink (*Emoia atrocostata*), which also occurs in the Marianas, found that they have a life span of between 3 to 4 years. A 10-year period should be sufficient to differentiate seasonal and/or annual variation from long-term trends as well as document the effects of catastrophic events.

Although the skink persists on four islands, these islands are small compared to the size of the islands from which it has been extirpated. For the species to be delisted, it will need to be reintroduced to or rediscovered on at least one of the five larger islands in the archipelago: Guam, Rota, Tinian, Saipan, or Pagan. Each of these islands have substantially more suitable habitat than all the currently occupied islands combined. Populations of skinks on at least one of these islands in addition to the populations on the smaller islands would provide sufficient redundancy to allow it to recover from catastrophic events and warrant delisting.

Habitat loss and degradation are a significant factor in the decline of Slevin's skink (USFWS 2020p). Based on the area of forest habitat occupied by populations, the distribution of Slevin's skink has declined by 99 percent since the arrival of humans (Richardson and Amidon 2020). The islands from which the the skink has been extirpated (i.e., Guam, Rota, Aguiguan, Tinian, and Pagan) have a long history of human occupation including the introduction of ungulates. There is strong evidence linking the decline of Slevin's skink to the degradation of forest habitat by introduced ungulates, as illustrated by the fourfold increase in skink abundance following the eradication of ungulates on Sarigan (Vogt *in litt*. 2007, entire). The islands with extant skink populations (i.e., Cocos, Sarigan, Alamagan, Asuncion) have a high percentage of native or coconut forest cover, are relatively free from human disturbance, and all but Alamagan are ungulate-free. The species is apparently declining on Alamagan, likely due to decades of habitat degradation by ungulates, further supporting the need to manage and protect suitable habitat. Agreements with conservation partners to ensure these threats are controlled will be necessary to ensure the recovery of the long-term resiliency of all skink populations.

Despite no direct evidence of predation contributing to the decline of Slevin's skink, there is some correlation between the decline of Slevin's skink and predation. Researchers have identified the Asian house shrew, rats, and brown treesnake as potential predators (USFWS 2020 p). Therefore, to downlist and eventually delist the species, skink populations should exist on islands or habitats free from predators or where predators are controlled such that the species is able to maintain stable to growing populations throughout its range.

4. Recovery Criteria for Mariana eight-spot butterfly and Mariana wandering butterfly

Objective: Establish multiple, self-sustaining populations to increase redundancy, preserve morphological and genetic diversity to maintain or increase representation, and protect and manage suitable habitat and manage threats to improve the resiliency of the Mariana wandering butterfly and Mariana eight-spot butterfly populations.

Downlisting

To consider downlisting the Mariana eight-spot butterfly or Mariana wandering butterfly from endangered to threatened, the following criteria should be met.

Downlisting Criteria

> Criterion 1: There are at least 14 stable populations of each species within their historical range. To be considered stable, populations must be reproducing and not decreasing in abundance for 10 years.
>
> Criterion 2: Suitable habitat, including host plants, to support the 14 populations of each species is actively managed or protected from development, ungulates, and invasive plants. The host plants also must be protected from slugs.
>
> Criterion 3: Populations of butterflies occur in areas free of ants and parasitic wasps or they are controlled to a level where the species are able to maintain stable to growing populations throughout theirranges.

Delisting

To consider delisting the Mariana eight-spot butterfly or the Mariana wandering butterfly the above downlisting criteria should be met as well as the following criteria.

Delisting Criteria

> Criterion 1: There are at least 20 stable or increasing populations of each species within their historical range. To be considered stable they must be reproducing and not decreasing in abundance for 10 years.
>
> Criterion 2: Suitable habitat, including host plants, to support the 20 populations of each species is actively managed or protected from development, ungulates, and invasive plants. The host plants also must be protected from slugs.
>
> Criterion 3: All populations occur in areas free of ants and parasitic wasps or are controlled to a level the species is able to maintain stable to growing populations throughout its range.
>
> Criterion 4: A management and monitoring plan has been written identifying the actions and procedures that will be necessary to control predator threats and threats to habitat (i.e., ungulates, slugs, and invasive plants) at the sites occupied by recovery populations. A monitoring plan identifies procedures and schedules to track the response of species to management. Agreements from conservation partners to maintain protections are in place.

Rationale for Mariana eight-spot butterfly and Mariana wandering butterfly recovery criteria

The Mariana eight-spot butterfly is historically known from approximately 14 locations on Guam and occurred on Saipan; it can now be consistently found at only 6 locations on Guam that support large aggregations of its 2 host plant species (USFWS 2020q). The Mariana wandering butterfly has not been documented on Guam or Rota since 1979 and 1995, respectively. Without knowing if the species still persists, we used the criteria for the Mariana eight-spot butterfly, which shares similar habitat requirements and distribution, and also is dependent on the same host plants. We determined that 14 stable populations is appropriate as that is the number of known historical populations of the Mariana eight-spot butterfly and will provide redundancy for both butterflies as long as the species is broadly distributed through portions of its historical range. We also determined that for the species to have adequate redundancy to be delisted, there must be 20 butterfly populations distributed throughout its historical range. A 10-year period should be sufficient to differentiate seasonal or annual variation from long-term trends as well as to document the effects of catastrophic events.

The primary threat to the butterflies is habitat loss and host plant suppression by invasive plant species. Mariana eight-spot butterfly habitat is closed canopy, native limestone forest with an abundance of the host plants, *Procris pedunculata* (no common name) and *Elatostema calcareum* (no common name; Schreiner and Nafus 1996, p. 1). The host plant for the Mariana wandering butterfly, *Maytenus thompsonii* (Chamorro: luluhot), is a small shrub-like tree endemic to the Mariana Islands found primarily in the understory of closed-canopy native limestone forests (Vogt and Williams 2004, p. 121; Schreiner and Nafus 1996, p. 1). Development, invasive animals (including ungulates and slugs), and invasive plants all cause substantial damage to butterfly habitat by degrading forest habitat, inhibiting plant recruitment, and killing host plants. Therefore, for the butterflies to be downlisted and eventually delisted, these threats must be managed or mitigated such that they do not cause population-level effects to the butterflies nor to their habitat and host plants.

Predation by native and non-native ants as well as parasitic wasps is another significant threat to Mariana eight-spot butterfly and potentially the Mariana wandering butterfly (USFWS 2020q). Ants eat butterfly eggs (Schreiner and Nafus 1996, p. 3; Rubinoff in litt. 2014) and possibly caterpillars. In recent years, during surveys for the Mariana eight-spot butterfly, researchers consistently observed high rates of egg parisitization by wasps. The introduction and/or proliferation of these predators has the potential to reduce or extirpate populations of both species. To ensure adequate redundancy and representation in the Marianas, butterflies must occupy predator-free habitat or have predators controlled such that the species is able to maintain stable to growing populations throughout its range

5. Recovery Criteria for Rota blue damselfly

Objective: Establish multiple, self-sustaining populations to increase redundancy, preserve morphological and genetic characteristics to maintain representation, and protect and manage water quality, stream flow, and threats to improve the resiliency of the Rota blue damselfly.

Downlisting

To consider downlisting Rota blue damselfly from endangered to threatened, the following criteria should be met.

Downlisting Criteria

Criterion 1: There are at least three stable or increasing populations of the Rota blue damselfly in three or more streams in the Mariana Islands.To be considered stable a population must be reproducing and not decreasing in abundance for 10 years.

Criterion 2: The Sabana plateau and other areas supplying water to streams in the Talakaya watershed are managed to preserve existing native and secondary forest habitat to preserve suitable water quality and flow.

Criterion 3: On Rota, streams suitable for the damselfly are actively managed to preserve stream overstory cover as well as to prevent increased turbidity, pollution, and overharvesting of water.

Delisting

To consider delisting the Rota blue damselfly, the above downlisting criteria should be met, as well as the following criteria.

Delisting Criteria

Criterion 1: There are at least three stable or increasing populations of the Rota blue damselfly in five or more streams in the Mariana Islands. To be considered stable a population must be reproducing and not decreasing in abundance for 10 years and demonstrate resiliency against drought.

Criterion 2: The Sabana plateau and other areas supplying water to streams occupied by the damselfly will be managed to preserve existing native and secondary forest habitat to preserve suitable water quality and temperature.

Criterion 3: Streams suitable for the damselfly are actively managed to preserve stream overstory cover as well as to prevent increased turbidity, pollution, and overharvesting of water. In addition, biosecurity measures are in place that minimize the introduction of potential predators and competitors.

Criterion 4: A captive breeding population has been established to ensure the survival of the species in the event that a catastrophic event damages the Talakhaya Watershed and degrades the population at Okgok Stream.

Criterion 5: A management and monitoring plan has been completed that identifies the actions and procedures necessary to control predators, competitors, and threats to habitat (i.e., ungulates and invasive plants) at the sites occupied by recovery populations. A monitoring plan identifies procedures and schedules to track the response of species to management. Agreements from conservation partners to maintain protections are in place.

Rationale for the Rota blue damselfly recovery criteria:
Given the generation time of the damselfly, requiring a stable or increasing population for 10 years would allow monitoring to capture seasonal and yearly variation in population numbers. The presence of several dry and intermittent stream beds located east of Okgok Stream suggests that the Rota blue damselfly once had a larger distribution that may have included all of the Talakhaya. These streams may have been perennial prior to the increased withdrawal of water from the Talakhaya Watershed for human use (Golabi et al. 2018, p. 194). To ensure the species has sufficient redundancy and is able to recover from catastrophic events and be downlisted, the damselfly must occur in three or more streams.

To ensure the species remains viable and can meet delisting criteria, the damselfly must occur in additional streams on Rota and possibly on other islands if other streams on Rota are not suitable. The feasibility of assisted colonization of the species to Guam or Saipan must thus be evaluated. There are several perennial watersheds on Guam and one on Saipan that may be suitable sites for the damselfly. Confirming the suitability of these streams will require comparing the hydrology and water quality of Okgok stream to potential introduction streams as well as an understanding of the habitat needs of the species at all life stages. The success of propagating a damselfly species endemic to O'ahu suggests that captive propagation could facilitate the establishment of the Rota blue damselfly to other watersheds. The introduction of the damselfly to additional watersheds will increase the species' redundancy and increase its resiliency to stochastic and catastrophic events.

The species' dependence on freshwater streams makes it particularly vulnerable to drought. In the Mariana Islands, El Niño events contribute to severe droughts. Droughts result in the dessication of grasslands and forests, draw-down of streamflow and well-heads, and more severe and frequent wildfires, all of which impact water quantity and quality as well as essential damselfly habitat (USFWS 2020s). Therefore, for delisting, the 10-year monitoring period must include at least one drought year so that its effect on population viability as well as its ability to recover can be determined.

The loss and alteration of stream habitat and loss and degradation of forest habitat on the Sabana Plateau and in the Talakhaya Region are the main threats to the Rota blue damselfly. For the species to remain viable, there must be sufficient quantity and quality of forest habitat on the Sabana Plateau to enable natural filtration and precipitation to feed the streams in the Talakhaya Watershed. Although little is known about the water quality requirements of the Rota blue damselfly, for other odonates, particularly coenagrionid damselflies, they fall within a very narrow range (Córdoba-Aguilar and Rocha-Ortega 2019, pp. 1, 4-5). Generally, they are intolerant of high temperatures, pollutants, hypoxic conditions, and silted water. In addition, a reduction or loss of stream flow in conjunction with potential effects associated with climate change could eliminate or reduce the species' habitat (Polhemus and Richardson 2019). To downlist and eventually delist the species, the occupied watersheds and the forest habitat that supports the aquifer must be managed to limit unsustainable human withdrawal and sustain adequate water quality and quantity.

Sufficient forest cover along streams in the Talakhaya Region is essential to the survival and recovery of the species by contributing to cool water temperatures, refugia and shelter, and habitat for damselfly prey as well as sufficient stream flow to support all life stages. In addition to over-harvesting of water, if forest vegetation is converted to grassland, water flows are reduced by increased vegetation transpiration rates (USFWS 2020s). The most significant threats to stream habitat on Rota are Philippine deer, fire, and over harvesting of water. Deer degrade watersheds by causing erosion, spreading invasive plants, and decimating understory vegetation. Currently, deer are hampering ongoing efforts to revegetate the slopes of the Talakhaya to reduce soil erosion. Given the damselflies' dependence on cool stream water free of silt and pollution, deer and other ungulates must be managed to prevent the degradation of water quality. Fire is a human-exacerbated threat to native species and ecosystems throughout the Mariana Islands. On the Sabana Plateau and within the Talakhaya Watershed, deer hunters frequently burn areas to lure deer to new growth (Mattos et al. 2015, p. 13; Golabi et al. 2018, p. 198; CNMI-DCRM 2019, p. 1; NOAA 2019). When vegetation is destroyed or degraded by wildfire, water is not efficiently absorbed and surface flow can erode stream beds and deposit silt in the stream. Although fire has affected forest habitat on Rota, particularly within the Talakhaya, the impact of fire on the stream habitat of the Rota blue damselfly has not been quantified. Although the remote and relatively inaccessible location of the Rota blue damselfly population affords the species some protection from humans, the reduction or loss of stream flow due to increased interception for municipal use or reduced aquifer recharge on the Sabana could significantly diminish the damselfly habitat in Okgok Stream.

Given that the species is currently restricted to one watershed, it is vulnerable to extinction; thus, establishing additional populations would increase the probability the species would survive a catastrophic event. To facilitate the establishment of additional populations, a captive breeding facility must be established to house a captive population which will allow for the establishment of additional populations as suitable habitat is located and/or restored.

6. Recovery Criteria for humped tree snail, Langford's tree snail, Guam tree snail, and fragile tree snail

Objective: Establish multiple self-sustaining populations to increase redundancy, preserve inter-population morphological and genetic diversity to increase representation, protect and manage suitable habitat, and manage threats to improve the resiliency of the humped tree snail, Guam tree snail, Langford's tree snail, and fragile tree snail populations.

Downlisting

To consider downlisting the humped tree snail, Langford's tree snail, Guam tree snail, and/or fragile tree snail from endangered to threatened, the following criteria should be met.

Downlisting Criteria

Criterion 1: There are at least 10 stable populations of each listed *Partulid* snail species distributed across their respective historical ranges. To be considered stable, each population must number at least 400 individuals distributed across all age classes, and 6 of the 10 populations must maintain populations greater than 400 individuals for 3 years. If differences in morphology or genetics are determined to exist based on geography, each must be represented by at least 1 population.

Criterion 2: Each population in Downlisting Criterion 1 occurs in suitable habitat that is protected from development and invasive plants and animals (i.e., ungulate-free) and managed to protect native forest vegetation.

Criterion 3: Biosecurity measures are in place to prevent the introduction of new predators to the Mariana Islands as well as the spread of existing predators to new islands. The predation risk of each population in Downlisting Criterion 1 is evaluated and predators are absent or are controlled to a level where the species are able to maintain stable to growing populations throughout their ranges.

Delisting

To consider delisting the humped tree snail, Langford's tree snail, Guam tree snail, and/or fragile tree snail, the above downlisting criteria should be met, as well as the following criteria.

Delisting Criteria

Criterion 1: There are at least 20 stable populations of each listed *Partulid* snail species distributed across their respective historical ranges. To be considered stable, a population must number at least 400 individuals distributed across all age classes, and 15 of the 20 populations must maintain populations greater than 400 individuals for 5 consecutive years. If differences in morphology or genetics are determined to exist based on geography, each must be represented by at least 1 of the 20 populations.

Criterion 2: Each population in Delisting Criterion 1 occurs in suitable habitat that is protected from development and invasive plants and animals (i.e., ungulate-free) and managed to protect native forest vegetation.

Criterion 3: Biosecurity measures are in place to prevent the introduction of snail predators to new islands, and predation does not threaten long-term viability of all the populations in Delisting Criterion 1 because (1) non-native snail predators do not exist on the island where the population occurs; (2) effective predator control with long-term management commitments has successfully reduced predation pressure such that population viability is maintained; or (3) quantitative demographic data and predator/prey dynamics indicate that the population will maintain long-term viability without predator control.

Criterion 4: A management and monitoring plan has been completed that identifies the actions and procedures needed to control threats to habitat (i.e., ungulates and invasive plants) at the sites occupied by recovery populations. A monitoring plan identifies procedures and schedules to track the response of species to management. Agreements from conservation partners to maintain protections to needed habitat are in place.

Rationale for the tree snail recovery criteria

Due to the similarities in life history and habitat usage between *Partulid* snails of the Marianas and *Achatinella* snails on O‘ahu, we based the tree snail Recovery Criteria on the *Achatinella* criteria. Despite reaching reach maturity faster and produce young more frequently than *Achatinella* snails, *Partulid* snails are still considered K-selected (Cowie 1992, p. 174). The relative short time to first reproduction, high annual fecundity, and limited life span of *Partulid* snails, indicates that annual population surveys over a 3-year period are sufficient to capture population trends spanning several generations. The frequency of cyclones (i.e., typhoons in the Mariana Islands and hurricanes in the Hawaiian Islands) that destroy or degrade forest habitat is greater in the Mariana Islands than O‘ahu and projections of future cyclone activity indicate that typhoons are likely to increase in both frequency and severity in the Mariana archipelago. Consequently, to allow for the recovery of snail populations from stronger and more frequent typhoons, we established larger population thresholds for *Partulid* snails than those identified in the *Achatinella* Recovery Plan (USFWS 2019). Pending a detailed assessment of geographic variation and threats, 10 populations of 400 individuals should be sufficient to conserve the representation, and redundancy viability of the *Partulid* snail species. Requiring that 6 of the 10 populations have greater than 400 individuals for 3 consecutive years will provide a buffer against catastrophic events such as typhoons and allow for the recovery of the population once habitat has recovered.

To delist any of the *Partulid* snails, population monitoring over a 5-year period is required to track population status and trends over several generations. As described in the downlisting and delisting requirements, any documented inter- or intra-island genetic or morphological distinctions among populations will require that we differentiate among the populations and ensure each are represented in the 10 or 20 populations necessary for downlisting or delisting, respectively.

Recent genetic analysis of *Partula gibba* has shown that there is significant genetic variation among populations (Sischo and Hadfield 2017, p.1) making it essential that each genetically distinct, geographic unit is protected to ensure that all remaining genetic diversity is maintained.

One of the primary conservation concerns for *Partulid* snails is habitat loss and more specifically the alteration of the micro-habitat conditions on which they rely. *Partulid* snails require cool, shaded forest with high humidity and low air movement, which prevents excessive water loss in individual snails and stable temperature, humidity, and light are essential to the survival of juvenile snails. Feral pigs, goats, and Philippine deer degrade forest habitat, inhibit plant recruitment, and facilitate the spread of invasive plants. While *Partulid* snails currently persist in habitats occupied by feral ungulates on Guam, Rota, Tinian, Saipan and the northern islands, habitat degradation caused by ungulates is contributing to the decline and extirpation of *Partulid* snails in the Mariana Islands. Therefore, to downlist and eventually delist the species, snail populations must exist on ungulate-free islands or habitats.

To be delisted, snail populations must be able to expand their range and establish new populations through natural dispersal or captive propagation and reintroduction. Redundant populations will facilitate the species' ability to withstand catastrophic events.

The current and most serious threat to humped tree snails is predation by the New Guinea flatworm, as well as by rats and introduced predatory snails. Therefore, delisting will require a clear understanding of invasive predator distribution, abundance, and predator-prey dynamics. Although some *Partulid* snail populations appear to be persisting with predators, several populations have been extirpated or are rapidly declining. Given the extensive history of *Partulid* and *Achatinellid* snail extirpations on Pacific islands (Bick et al, p.508), we expect that establishing and maintaining snail populations on predator-free islands or within predator-free habitats will be needed to recover these species.

III. RECOVERY ACTIONS

This draft recovery plan identifies recovery actions, which will need to be implemented to meet the recovery criteria for the 23 species. Implementation of a recovery action will depend on its priority, availability of funds and resources, coordination with partners, complexity, and logistical constraints. A broad action may have multiple components developed as needed to best coordinate recovery implementation. Project-level implementation of these actions will be accomplished through shorter-term activities (collectively referred to as the Recovery Implementation Strategy) in coordination with the recovery partners interested and willing to work on implementing the activities. Activities are intended to be adaptable and guide partners to coordinate recovery implementation and further describe those responsible for each action described in the plan. Because these activities will be described in the RIS, they can be modified as needed without requiring future revision of the recovery plan, as long as they are consistent with the recovery plan.

As discussed in the Introduction, this recovery plan is a guidance document rather than being regulatory in nature. As such, implementation of recovery actions is voluntary and depends on the cooperation and commitment of numerous partners. All Federal agencies, however, have an obligation under section 7(a)(1) of the Act to carry out programs for the conservation of listed species.

The actions needed to alleviate threats to the species and achieve recovery criteria are organized into seven categories: (1) Determine population status and current distribution, (2) conduct research to clarify life history information, identify limiting factors and/or threats to population viability, and develop solutions, (3) conserve and enhance populations, (4) develop regulations and policy essential to recover the species and their habitats, and (5) improve stakeholder awareness and engagement.

Recovery Actions

1. **Determine the current distribution and status of the species and their habitats.**

   1.1. Develop survey methods for each of the 23 species and conduct range-wide surveys for listed plants, vertebrates, and invertebrates to determine their current distribution and status.

   1.1.1. Determine the current range and estimate the number and age class of individuals within each area and determine the number and genetic structure of populations on each island.

   1.1.2. Monitor the range-wide population, tracking trends and distribution at time intervals appropriate for each species.

   1.2. Map the remaining habitat for each species and assess the severity of threats to the persistence of these areas.

2. **Conduct research to clarify life history information, identify limiting factors and/or threats to population viability, and develop solutions.** Assess factors limiting population growth and stability to inform conservation actions.

   2.1. Habitat requirements – Identify and assess any potential factors limiting the species population growth and determine what constitutes high-quality breeding, feeding, and sheltering habitat for each plant and animal species, the distribution of this habitat, and threats to the sites with high-quality habitat.

   2.1.1. Monitor water quality and flow rates for Okgok stream and compare it to similar streams on Rota, Guam, and Saipan.

   2.1.2. Conduct research to determine if artificial roosts are suitable refugia for bats.

   2.1.2.1. Evaluate whether bats will use roost boxes placed in roost caves (to facilitate conservation translocations and minimize capture and handling stress).

   2.2. Population biology and breeding systems - determine where and when reproduction occurs, population structure, and factors limiting population stability.

   2.3. Food sources - determine preferred prey during different life stages.

   2.4. Identify potential predators, competitors, and habitat-modifying invasive animals on each island, quantify their effects, and develop effective control methods.

   2.4.1. Conduct research to determine the best way to control/eradicate the New Guinea flatworm and predatory snails from essential snail habitat.

   2.4.2. Conduct research to determine the best way to control/eradicate the brown treesnake, slugs, parasitic wasps, and predatory ants from listed plant and animal habitat.

   2.4.3. Conduct research to determine the best way to control/eradicate rodents from listed plant and animal habitat.

2.4.4. Determine whether other species compete for similar resources (i.e., food or shelter) used by the listed species.

2.5. Assess development, land designation, and zoning threats to the conservation of habitat needed for recovery.

2.6. Assess wildfire threat to each population and the habitats needed to achieve recovery.

3. **Conserve and enhance populations.** Once the overall condition of the 23 species is known (Recovery Actions 1 and 2), establish protected sites (hereafter sites) to be managed for the recovery of the species and develop well-designed conservation programs that incorporate consistent monitoring and adaptive management. Establish or augment populations within sites as needed to achieve the recovery criteria for each species.

3.1. Select sites to be managed for recovery of the 14 plants and 9 animals.

3.1.1. Select sites of sufficient number and size to support populations needed to achieve the recovery criteria of each species.

3.1.2. Prioritize site selection based on their conservation value to multiple species and likelihood of success of threat control efforts as well as other relevant factors.

3.1.3. Secure the long-term conservation status of sites through fee simple purchase, conservation easements, landowner agreements, and/or regulatory mechanisms, to protect and manage the sites from development and enable control of threats from invasive animals, invasive plants, and wildfire.

3.2. Protect listed animals, plants, and their habitats from invasive animal and plants.

3.2.1. Control habitat-modifying invasive plants and animals at all sites occupied by populations needed to achieve the recovery criteria for the 23 species (hereafter occupied recovery sites). Control or eradicate predators, herbivores, parasites, and diseases to minimize or eliminate affects to listed plant and animal populations needed to achieve recovery criteria.

3.2.1.1. Control or eradicate ungulates at all occupied recovery sites. Construct and maintain ungulate-proof fencing around all occupied recovery sites, eradicate ungulates from islands needed to achieve recovery of the 23 species, or otherwise prevent ungulates from degrading sites.

3.2.1.2. Control or eradicate habitat-modifying invasive plants at all occupied recovery sites.

3.2.1.3. Control or eradicate rodents and other habitat-modifying invasive animals at all occupied recovery sites.

3.2.1.4. Control the brown treesnake to protect listed species and their recovery habitat.

3.2.1.4.1. Prevent the introduction of the brown treesnake to other islands (i.e., outside of Guam) through appropriate interdiction efforts and have programs in place to detect and eradicate the brown treesnake should it be found on islands occupied by populations needed to achieve recovery.

3.2.1.4.2. Develop and implement landscape-scale control and suppression of the brown treesnake on Guam.

3.2.1.4.3. Eradicate the brown treesnake from all occupied recovery sites supporting listed vertebrates using snake exclusion fences or other means.

3.2.1.5. Control invasive invertebrates including slugs, ants, cycad blue butterflies, and cycad scale at all occupied recovery sites. Eradicate the little fire ant and any other ants from all occupied recovery sites.

3.2.1.6. Develop and implement biosecurity systems and measures to prevent the introduction or spread of habitat altering, invasive plants, animals, and pathogens to occupied recovery sites.

3.2.1.7. Develop and implement fire management plans, as needed, to minimize the likelihood that native forest at occupied recovery sites will burn, assure fire return intervals in savanna habitats are long enough to promote diverse native vegetation, and ensure the persistence of stream habitat needed for recovery of the 23 listed species.

3.3. Identify and implement additional site-specific and species-specific treatments at appropriate occupied recovery sites to control threats.

3.3.1. Ensure stream flow in Okgok stream is preserved, through conservation of forest to support recharge and management of water harvesting and diversion, to optimize Rota blue damselfly survival and productivity.

3.3.2. Manage unoccupied but suitable and occupied roost caves to minimize disturbance and reduce predation on Pacific sheath-tailed bats.

3.3.3. Develop and implement methods to control cycad *Aulacaspis* scale.

3.3.4. Control other threats, such as pesticides, to listed plant and animal populations and their pollinators and seed dispersers as appropriate.

3.4. Establish and conserve a sufficient number of populations of each of the 23 listed species within protected sites to achieve recovery criteria.

3.4.1. Increase the number of individuals in each population and the number of populations of each species to improve resiliency, redundancy, and representation.

3.4.1.1. Select populations for reinforcement and / or sites for reintroduction. Reintroduction sites must meet the same criteria as those supporting recovery populations (i.e., long-term protection is secured, threats are managed).

3.4.1.2. Prepare reinforcement and reintroduction sites. As needed, propagate and outplant common plants including host plants to improve habitat quality for listed animal and plant species.

3.4.1.2.1. In sites selected to benefit the recovery of the two butterflies, ensure sufficient numbers of host plants via protecting plants and/or through outplanting.

3.4.1.3. Reintroduce genetically appropriate individuals to sites; reinforcment or reintroduction must not be undertaken until threats have been controlled.

3.4.1.4. Consider assisted colonization for those with narrow ranges or when appropriate, as needed.

3.4.1.5. Monitor success of conservation translocation efforts and adapt management and/or protocols as appropriate.

3.4.2. Develop and maintain genetic storage and propagation facilities where needed.

3.4.3. Propagate genetically appropriate individuals for genetic storage and augmentation or reintroduction.

3.5. Monitor response of populations to recovery actions and adapt actions as appropriate.

4. Develop regulations and policy essential to recover the species and their habitats.

4.1. Facilitate or encourage regulations and policy to ensure protection of the listed species under Commonwealth or Territorial law.

4.1.1. Recognize the 23 species for protections under the Guam and CNMI's Endangered Species Act.

4.1.2. Facilitate or encourage regulations and policy to control the threats of ungulates and wildfire to occupied recovery sites.

4.2. Develop and support the implementation of biosecurity plans to prevent the arrival and spread of new invasive species into the Territory and Commonwealth and inter-island movement of invasive species already established in the archipelago.

4.3. Evaluate the utility of developing and implementing island-wide habitat conservation plans for key islands to protect the 23 species addressed herein.

5. Improve stakeholder awareness and engagement. Create and share outreach materials withpartners regarding the current and historical status of the 23 listed species, the conservation value of the listed species, and how we can work together to enhance populations and manage threats.

Table 10. Crosswalk relating threats, recovery criteria, and recovery actions for the 23 species.

Listing Factor	Threat	Downlisting and Delisting Criteria	Recovery Actions
14 listed plants			
A **Present or Threatened Destruction, Modification or Curtailment of its Habitat or Range**	Development (e.g., urbanization, agricultural, and military)	Downlisting and Delisting 2,	1, 2, 3, 4, 5
	Invasive animals (e.g., ungulates, rodents, brown treesnake, little fire ant)	Downlisting and Delisting 2	1, 2, 3, 4, 5
	Invasive plants (including wildfire-mediated)	Downlisting and Delisting 2	1, 2, 3, 4, 5
B **Overutilization**	Not applicable (N/A)		
C **Disease or Predation**	Seed predation by rats	Downlisting and Delisting 2	1, 2, 3, 4, 5
	Herbivory by invasive invertebrates	Downlisting and Delisting 2	1, 2, 3, 4, 5
D **Inadequacy of Existing Regulatory Mechanisms**	Regulations and policy needed to secure local protected status for species, protected status for recovery habitats, and control biosecurity, ungulate, and invasive plant threats	Downlisting and Delisting 2	3, 4, 5
E **Other Natural or Manmade Factors**	Typhoons	Downlisting and Delisting 2	1, 3, 4, 5
	Small population sizes and/or small number of populations	Downlisting and Delisting 1, Delisting 3	1, 2, 3, 4, 5
	Loss of genetic diversity	Downlisting and Delisting 1	1, 2, 3
Pacific sheath-tailed bat			
A **Present or Threatened Destruction, Modification or Curtailment of its Habitat or Range**	Development (e.g., urbanization, agricultural, and military), invasive animals (particularly goats), invasive plants	Downlisting and Delisting 2, Delisting 4	1, 2, 3, 4, 5
B **Overutilization**	N/A		
C **Disease or Predation**	Predation by invasive animals	Downlisting and Delisting 3	3.2, 3.4.3, 5
D **Inadequacy of Existing Regulatory Mechanisms**	Regulations and policy needed to secure local protected status for species, protected status for recovery habitats, and control biosecurity, ungulate, and invasive plant threats	Downlisting and Delisting 3, Delisting 4	3, 4, 5
E **Other Natural or Manmade Factors**	Human disturbance of roosts	Downlisting and Delisting 2	2, 3, 4, 5
	Typhoons	Downlisting and Delisting 1	1, 2, 3, 4, 5
	Small population sizes and/or small number of populations	Downlisting and Delisting 1	1, 2, 3, 4, 5
	Breakdown of metapopulation dynamics	Downlisting and Delisting 1	1, 2, 3, 4
	Pesticides (possible)	Downlisting and Delisting 3	3.3, 4, 5

Slevin's skink			
A **Present or Threatened Destruction, Modification or Curtailment of its Habitat or Range**	Development (e.g., urbanization, agricultural, and military)	Downlisting and Delisting 2, Delisting 4	1, 2, 3, 4, 5
	Invasive plants and invasive animals	Downlisting and Delisting 2	1, 2, 3, 4, 5
B **Overutilization**	N/A		
C **Disease or Predation**	Predation by invasive mammals and reptiles	Downlisting and Delisting 3	3.2, 3.3, 4.2, 5
	Predation by reptiles	Downlisting and Delisting 3	5
D **Inadequacy of Existing Regulatory Mechanisms**	Regulations and policy needed to secure local protected status for species, protected status for recovery habitats, and control biosecurity, ungulate, and invasive plant threats	Downlisting and Delisting 3	3, 4, 5
E **Other Natural or Manmade Factors**	Typhoons	Downlisting and Delisting 2	1, 3, 4, 5
	Small population sizes and/or small number of populations	Downlisting and Delisting 1	1, 2, 3
Mariana eight-spot butterfly and Mariana wandering butterfly			
A **Present or Threatened Destruction, Modification or Curtailment of its Habitat or Range**	Development (e.g., urbanization, agricultural, and military)	Downlisting and Delisting 2, Delisting 4	1, 2, 3, 4, 5
	Invasive plants	Downlisting and Delisting 2	1, 2, 3, 4, 5
	Invasive animals (i.e., ungulates)	Downlisting and Delisting 2	1, 2, 3, 4, 5
	Herbivory by slugs	Downlisting and Delisting 2	3.2, 3.3, 4.2, 5
B **Overutilization**	N/A		
C **Disease or Predation**	Predation by ants	Downlisting and Delisting 3	3.2, 3.3, 4.2, 5
	Predation by invasive wasps	Downlisting and Delisting 3	3.2, 3.3, 4.2, 5
D **Inadequacy of Existing Regulatory Mechanisms**	Regulations and policy needed to secure local protected status for species, protected status for recovery habitats, and control biosecurity, ungulate, and invasive plant threats	Downlisting and Delisting 3	3, 4, 5
E **Other Natural or Manmade Factors**	Typhoons	Downlisting and Delisting 1 and 2	1, 3, 4, 5
	Small population sizes and/or small number of populations	Downlisting and Delisting 1	1, 2, 3, 5

Rota blue damselfly			
A **Present or Threatened Destruction, Modification or Curtailment of its Habitat or Range**	Development (e.g., urbanization, agricultural, and military)	Downlisting and Delisting 2, Delisting 5	1, 2, 3, 4, 5
	Invasive plants, invasive animals (i.e., ungulates)	Downlisting and Delisting 3	1, 2, 3, 4, 5
B **Overutilization**	N/A		
C **Disease or Predation**	Predation by invasive fish or amphibians	Delisting and Dowlisting 3	NA
D **Inadequacy of Existing Regulatory Mechanisms**	Need for watershed planning	Downlisting and Delisting 2	3, 4, 5
	Regulations and policy needed to secure protected status for species, recovery conservation status for land, and to control biosecurity, ungulate, and invasive plant threats	Downlisting and Delisting 3	3, 4, 5
E **Other Natural or Manmade Factors**	Wildfire	Downlisting and Delisting 2	3, 4, 5
	Small population sizes and/or small number of populations	Downlisting and Delisting 1, Delisting 4	1, 2, 3, 5
***Partulid s*nails**			
A **Present or Threatened Destruction, Modification or Curtailment of its Habitat or Range**	Development (e.g., urbanization, agricultural, and military)	Downlisting and Delisting 2, Delisting 4	1, 2, 3, 4, 5
	Invasive animals (i.e., ungulates)	Downlisting and Delisting 2	1, 2, 3, 4, 5
	Invasive plants	Downlisting and Delisting 2	1, 2, 3, 4, 5
B **Overutilization**	Collection (historical threat)	Downlisting and Delisting 1	4, 5
C **Disease or Predation**	Predation by rats	Downlisting and Delisting 3	3.2, 3.3, 5
	Predation by invasive invertebrates	Downlisting and Delisting 3	3.2, 3.3, 5
D **Inadequacy of Existing Regulatory Mechanisms**	Regulations and policy needed to secure local protected status for species, protected status for recovery habitats, and control biosecurity, ungulate, and invasive plant threats	Downlisting and Delisting 3	3, 4, 5
E **Other Natural or Manmade Factors**	Typhoon impacts	Downlisting and Delisting 1	1, 2, 3, 4, 5
	Small population sizes and/or small number of populations	Downlisting and Delisting 1	1, 2, 3, 5
	Loss of local genetic diversity	Downlisting and Delisting 1	1, 2, 3

IV. TIME AND COST ESTIMATES

Achieving the recovery criteria is expected to require, at a minimum, approximately 30 to 95 years for the 14 listed plant species, 40 years for the sheath-tailed bat, 25 years for the *Partulid* snails and Mariana wandering and eight-spot butterflies, and 30 years for the damselfly and Slevin's skink.

The estimated costs of site-specific recovery actions projected to the estimated date of delisting are shown in Table 11. Estimated costs include only project specific contract, staff, or operations costs in excess of base budgets. They do not include budgeted amounts that support ongoing agency staff responsibilities. This recovery plan does not commit the Service or any partners to carry out a particular recovery action or expend the estimated funds.

Estimated costs incorporate planning, design, implementation, and research, monitoring, and evaluation associated with specific actions. The wide range in anticipated cost to conserve and enhance populations are primarily due to uncertainty regarding costs to control invasive plant and animal species including the brown treesnake and invertebrates. The cost of invasive species interdiction and control are expected to be significant. Costs may exceed the estimated costs (see Table 11) if invasive species interdiction fails. Adaptive management will ensure that management/conservation actions are effectively mitigating threats and meeting the objectives of this recovery plan. If actions are not effective, additional planning and scientific research may be necessary to inform and develop new conservation strategies.

Table 11. Estimated cost and priority of recovery actions (in fiscal year 2022 dollars).

Recovery Actions	**Recovery Action #**	**Priority[1]**	**Species Addressed**	**Estimated Costs**
Determine population status and current distribution	1.0	1	All	**$6,620,000**
Conduct research to clarify life history information, identify limiting factors and/or threats to population viability, and develop solutions	2.0	1	All	**$333,570,000**
Conserve and enhance populations.	3.0	1	All	**$304,000,000 – $7,600,000,000**
Develop regulations and policy essential to recovery the species and conserve their habitats	4.0	2	All	**$3,000,000**
Improve stakeholder awareness and engagement	5.0	2	All	**$340,000**
TOTAL: $647,530,000 - $7,943,530,000				

Priority 1 - an action that must be taken to prevent extinction or prevent the species from declining irreversibly in the foreseeable future.

Priority 2 - an action that must be taken to prevent a significant decline in species population or habitat quality.

Estimated cost through date of recovery (25 to 95 years by species, see below) is estimated to be between $647,530,000 and $7,943,530,000. Prorated by species based on estimated time to recovery, using the mid-point of cost and time to recovery, annual costs are estimated at just over $3,700,000.

Cost estimates are preliminary. Project-level details of recovery action implementation will be developed with partners in the RIS that will accompany this draft recovery plan. Implementation is subject to availability of funds and is at the discretion of partners.

Date of Recovery

If all actions are fully funded and implemented as outlined, including full cooperation of all partners, we estimate the earliest that the delisting criteria could be met would be between 2052 and 2117 for the listed plant species, 2062 for the Pacific sheath-tailed bat, 2052 for Slevin's skink, 2047 for the Mariana eight-spot butterfly, 2052 for the Rota blue damselfly, and 2047 for the humped tree snail, Guam tree snail, and fragile tree snail. The recovery timing of the Mariana wandering butterfly and Langford's tree snail cannot be estimated until the status of each species is determined. If populations of these species are rediscovered, recovery is unlikely to be achieved before 2062.

For all species, the time to delisting accounts for the time it will take to complete recovery actions in occupied recovery sites including developing and implementing species-specific threat control strategies, fencing and control/eradication of invasive animals, mitigating wildfire threat, controling of invasive plants and implementing conservation translocation programs to meet population goals.

For the 14 plant species, delisting is likely to require between 30 and 95 years depending on each species' life span and the challenges assocated with securing habitat against threats, propagating species with limited founders, and protecting the species from species-specific threats as well as each species' recovery potential (see the *Plant Recovery Criteria* section and Table 2). For each plant species, life span and biological requirements were factored into the estimated time to delisting. The delisting time for long-lived species is greater than for short-lived perennials due to their long generation time and the time required for individuals to become reproductively mature. The length of time needed to achieve downlisting and delisting is also dependent on each species' recovery potential. Plants with a low recovery potential will probably require additional effort to achieve recovery.

Reintroduction or natural recolonization of populations of the Pacific sheath-tailed bat from the remnant population on Aguiguan will likely require decades of active management. The small Aguiguan population will need to achieve substantial growth before it can be a source population for reintroduction efforts to other islands. For Pacific sheath-tailed bat, delisting criteria include a 20-year monitoring period.

Slevin's skink is extant on four islands with a moderate degree of threats and has a high recovery potential; however, not much is known about the species' life history. With a better understanding of its life history as well as habitat and threat management, recovery of the species could be achieved by 2052.

Recovery of the Mariana wandering butterfly and Langford's tree snail is contingent on locating populations; neither species has been observed since the 1990s. Thus, it is impossible to estimate a recovery timeline, but even if both species are rediscovered, recovery is unlikely to be achieved before 2062. For downlisting to occur, 14 and 10 populations of the butterfly and the snail respectively, are required. This will require significant habitat restoration and threat management as well as a source of individuals for reintroduction efforts. However, both species are relatively short-lived and have a relatively high rate of reproduction leading us to believe that the species could be delisted by 2052.

Very little is known about the life history of the Rota blue damselfly and it is currently restricted to one stream on the island of Rota making it susceptible to stochastic and catastrophic events. Without the establishment of additional populations, recovery cannot be achieved. Captive propagation of the species and conservation translocations to additional watersheds is essential to recovery of the species. Uncertainty associated with both captive propagation and introduction resulted in a long recovery period, but delisting of the species could be achieved by 2052.

The Guam tree snail appears widely distributed on Guam, although current survey data is needed as is a better understanding of how predators affect this species. Under an aggressive recovery implementation schedule, delisting could be achieved within 25 years. The humped tree snail and fragile tree snail are both found on more than one island and although some populations have been extirpated or are declining, the species has moderate resiliency and redundancy. A successful captive rearing program would further facilitate the recovery of the species by potentially increasing both resiliency and redundancy. With habitat and threat management recovery could be achieved within 25 years.

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