



Photo Credit: Mike Richardson

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#### **EXECUTIVE SUMMARY**

The Mariana eight-spot butterfly (abbabang [Chamorro], libweibwogh [Carolinian], Hypolimnas octocula marianensis), is a butterfly in the Nymphalidae (brush-footed butterfly) family, endemic to the island of Guam and possibly Saipan (Schreiner and Nafus 1996, p. 2; Schreiner and Nafus 1997, p. 26; Rubinoff and Holland 2018, p. 218). Described in 1912, the Mariana eight-spot butterfly is a narrow endemic found in native limestone forests on Guam. Prior to the arrival of humans and feral ungulates to the Mariana Islands, the Mariana eight-spot butterfly likely occurred across a much larger range of habitat than its current distribution on Guam. On Guam alone, the native limestone forest that supports the butterfly's host plants has experienced at least an 85 percent reduction from its historical distribution. Currently, the Mariana eight-spot butterfly is indirectly threatened by habitat loss and degradation due to impacts from feral ungulates, nonnative plants, and herbivory by slugs. The primary direct stressors to the butterfly include high egg mortality and predation from native and nonnative insects including ants and parasitic wasps. Conservation actions have included limited management of ungulates in some habitat areas and experimental out-planting of its host plants. The overall current viability of this subspecies is low due to low to moderate resiliency and representation and moderate redundancy. The U.S. Fish and Wildlife Service expects conservation measures that include ungulate control and eradication as well as strong biosecurity to provide the greatest future potential benefit to the Mariana eight-spot butterfly.

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# **INTRODUCTION**

The Mariana eight-spot butterfly (abbabang [Chamorro], libweibwogh [Carolinian], *Hypolimnas octocula marianensis*), a butterfly in the Nymphalidae (brushfooted butterfly) family, endemic to the island of Guam and possibly Saipan (Schreiner and Nafus 1996, p. 2; Schreiner and Nafus 1997, p. 26; Rubinoff and Holland 2018, p. 218). Described in 1912, the Mariana eight-spot butterfly is a narrow endemic found in native limestone forests on Guam. This species is indirectly threatened by habitat loss and degradation due to impacts from feral ungulates, nonnative plants weeds, and herbivory by slugs. The primary direct stressors to the butterfly itself include predation from both native and nonnative insects including ants and parasitoid wasps. Conservation actions have included limited management of ungulates in some habitat areas and experimental host plant out-planting techniques.

Prepared by the Pacific Islands Fish and Wildlife Office, this Species Report provides an indepth review of Mariana eight-spot butterfly's biology, factors influencing viability (threats and conservation actions), and an evaluation of its current status and viability. The intent is for the Species Report to be easily updated as new information becomes available, and to support the functions of the Service's Endangered Species Program. As such, the Species Report will be a living document upon which the Service will base other documents such as recovery plans and 5year reviews.

## **Regulatory History**

After spending 18 years as a candidate species for Federal listing, the Mariana eight-spot butterfly was finally listed as endangered under the Endangerd Species Act (ESA) in 2015 (USFWS 2015, 73 pp.) (80 FR 59423). The Mariana eight-spot butterfly is included in the Draft Recovery Plan for 23 Species in the Marianas Islands, published on November 8, 2022 (USFWS 2022, entire). To date, the Service has not designated critical habitat for the species.

This document is one portion of a larger Pacific Islands Office-wide effort to assess the current and future viability of several listed species in the Mariana Islands as well as the main habitat types found within the archipelago including marine, forest, stream, and wetland habitats. To streamline this effort, we attempted to include the most relevant and recent information in this species report regarding the specific habitat and stressors pertaining to the Mariana eight-spot butterfly. For general information including geography, climate, geology, demographics, and an historical overview of human-caused impacts to the Mariana Islands, we will direct the reader to our 2015 final listing rule for the Mariana eight-spot butterfly (USFWS 2015) and the recently completed biogeography assessment for the Mariana Islands (Harrington et al. 2019, entire). Likewise, for a general overview of the forest habitat in the Mariana Islands including its historical and current stressors, we refer the reader to Willsey et al. (2019, entire).

### Methodology

In preparing this Species Report, we used the best scientific and commercial data available to us, including peer-reviewed literature, grey literature (government and academic reports), and expert elicitation. This Species Report assesses the ability of the Mariana eight-spot butterfly to maintain viability over time, i.e., the species ability or likelihood to maintain populations over time, and thus avoid extinction. To assess the viability of the Mariana eight-spot butterfly, we used the three conservation biology principles of resiliency, redundancy, and representation, or the "3Rs" (**Figure 1**; USFWS 2016, entire). We evaluated the viability of this species by describing what it needs to be resilient, redundant, and represented, and compared that to the status of the Mariana eight-spot butterfly based on the most recent information available to us.

### Resiliency

Resiliency is the capacity of a population or a species to withstand the more extreme limits of normal year-to-year variation in environmental conditions such as temperature and rainfall extremes, and unpredictable but seasonally frequent perturbations such as fire, flooding, and storms (i.e., environmental stochasticity). Quantitative information on the resiliency of a population or species is often unavailable. However, in the most general sense, a population or species that can be found within a known area over an extended period of time (e.g., seasons or years) is likely to be resilient to current environmental stochasticity. If quantitative information is available, a resilient population or species will show enough reproduction and recruitment to maintain or increase the numbers of individuals in the population or species, and possibly expand the range of occupancy. Thus, resiliency is positively related to population size and growth rate, and may also influence the connectivity among populations.

### Redundancy

Redundancy is the inherent ability of particular species that avoid extinction through existence as multiple resilient populations across a landscape. Such species occur across a geographic range that exceeds the area of impact of any given catastrophic event that would otherwise overwhelm the resilient capacity of individual populations of a species. In this Species Report, catastrophic events are distinguished from stochastic events-in that they are relatively unpredictable and infrequent and exceed the more extreme limits of normal year-to-year variation in environmental conditions (*i.e.*, environmental stochasticity). Because catastrophic events expose populations to an elevated extinction risk within a respective area of impact, redundancy exists when the geographic range of a species exceeds that area of impact. In general, a wider range of habitat types, greater geographic distribution, and connectivity across the geographic range will increase the redundancy of a species and its ability to survive a catastrophic event.

### Representation

Representation exists when one or more populations of a species occurs across the full range of habitat types used by the species. Alternatively, representation can be viewed as maintaining the

breadth of genetic diversity within and among populations, in order to allow the species to adapt to changing environmental conditions over time. Because the historic biogeographical range of a species is tied to a species' current habitat and genetic diversity, conservation of a species' range should take into account both current and historic latitudinal and longitudinal ranges, elevation gradients, climatic gradients, soil types, habitat types, seasonal condition, etc. Connectivity among populations and habitats is also an important consideration in evaluating representation.

The viability of a species is an assessment derived from a combined analysis of the 3Rs. A species is considered viable when there are a sufficient number of self-sustaining populations (resiliency) distributed over a large enough area across the range of the species (redundancy) and occupying a range of habitats to maintain environmental and genetic diversity (representation) to allow the species to persist indefinitely when faced with annual environmental stochasticity and infrequent catastrophic events. Common ecological features are an integral part of each of the 3Rs. This is especially true of connectivity between habitats across the range of the species. Connectivity sustains dispersal of individuals, which may affect genetic diversity within and among populations. Connectivity also sustains access to the full range of habitats normally and historically used by the species and is essential for re-establishing occupancy of habitats following severe environmental stochasticity or catastrophic events (see Figure 1 for more examples of overlap among the 3Rs).

Population resiliency is the foundation of the 3Rs principles. While redundancy and representation are assessed at the species level, resilient populations are the necessary foundation to attain sustained or increasing representation and redundancy within the species. For example, a species cannot have high redundancy if the populations have low resiliency. This assessment of viability is not binary, in which a species is either viable or not, but measured rather on a continual scale of degrees of viability, from low to high. The health, number and distribution of populations were analyzed to determine "the three Rs" and the viability of the Mariana eight-spot butterfly. In broad terms, the more resilient, represented, and redundant a species is, the more viable the species is. The current and future understanding of factors, including threats and conservation actions, will influence how the "the three Rs" and viability are interpreted for the butterfly. While this report focuses on the Mariana eight-spot butterfly in particular, we direct the reader to a more general discussion regarding the current and future scenarios for the Marianas forest habitat in Willsey et al. (2019, entire) and Miller (2019, entire) respectively.



Figure 1. The three conservation biology principles of resiliency, redundancy, and representation, or the "3Rs"

# **SPECIES NEEDS / ECOLOGY**

### **Species Description**

The Mariana eight-spot butterfly is one of seven butterflies of the Nymphalidae family found within the Mariana Islands. Comprised of over 6,000 species worldwide, the Nymphalidae is the largest family of butterflies. Nymphalid male butterflies possess very reduced and clawless forelegs and their dense covering of scales has resulted in the common name of "brush-footed butterflies" (New 1997, pp. 17-18). Butler described the original parent species, *Hypolimnas* 

*octocula*, in 1869, while Frushstorfer (1912) described the Mariana eight-spot subspecies. It was recognized as a distinct taxon in Swezey (1942, p. 35), the most widely accepted taxonomy for this subspecies.

Like most nymphalid butterflies, orange and black are the two primary colors exhibited by this subspecies. The males are smaller than the females by at least a third or more in size. Males are predominantly black with an orange stripe running vertically on each wing. The stripe on the hindwings exhibits small black dots in a vertical row. Compared to the males, females appear duller with less contrast between the colors. Additionally, the orange stripes on both sets of wings are larger and black bands occur across the apical-most (top) margins of both pair of wings (Schreiner and Nafus 1997, pp. 15, 26–27). Similar to many nymphalid butterflies, the bottom of the wings, visible when folded up, appear much duller and leaf-like in color thereby providing the species some protection by camouflage. The larval stage caterpillar of this species is black in color with reddish-orange spikes, and its black head differentiates it from similar appearing caterpillars (Schreiner and Nafus 1996, p. 10; Schreiner and Nafus 1997, p. 26). As the caterpillar grows and sheds successive skins, it becomes more colorful, darker with bright orange spines.



**Figure 2.** Photograph of an adult male Mariana eight-spot butterfly showing the top of the wings (Photo by Curt Fiedler)



Figure 3. Photograph of an adult male Mariana eight-spot butterfly showing the undersides of the wings (Photo by Curt Fiedler)

![](_page_10_Picture_3.jpeg)

**Figure 4.** Photograph of a Mariana eight-spot butterfly caterpillar feeding upon its host plant, *Procris pedunculata*, near Asiga Cave, southern Guam (Photo by Curt Fiedler)

#### Life History

The majority of life history and biological information available regarding the Mariana eightspot butterfly comes from an unpublished report of rare butterfly surveys by Schreiner and Nafus (1996), conducted in the early to mid-1990s in the Mariana Islands. As part of the endeavor, Schreiner and Nafus also conducted a yearlong study of a population of the Mariana eight-spot butterfly located near the University of Guam. According to their surveys, Mariana eight-spot butterflies were most abundant between December and February. These months include the end of the wet season and the beginning of the dry season on Guam and correspond to expected growth of the host plant species. Conversely, population levels were very low in July and August, the beginning of the wet season. Like most nymphalid butterflies, the adults use a long, proboscis to feed on a variety of ephemeral food sources including primarily nectar of dayblooming flowers, as well as rotting fruit, and occasionally dead animals. More recently, Fiedler et al. (2023, entire), conducted a months-long captive rearing study to establish some baseline information about the capacity for the species to be reared in captivity. In addition to recording new data and observations regarding the species egg to adult lifespan and captive rearing challenges, the research showed that the Mariana eight-spot butterfly actually has a relatively high potential for fecundity with one female laying over 300+ eggs.

The caterpillars of the Mariana eight-spot butterfly feed on two native plants, *Procris* pedunculata (no common name) and Elatostema calcareum (tapun ayuyu) (Schreiner and Nafus 1996, p. 1). Both of these vine-like forest herbs (family Urticaceae) grow on rocky and karst substrate within native limestone forests. Recorded on Guam, Rota, and Tinian, and Saipan, both species grow draped over karst spires, boulders, and small cliffs which offer protection from grazing ungulates (see further discussion below regarding host plant suppression by nonnative feral ungulates) (Schreiner and Nafus 1996, p. 1; Rubinoff in litt. 2013; Rubinoff in litt. 2014; Demeulenaere et al. 2018). During an intensive survey of transects within Andersen AFB on northern Guam 2016-2017, Demeulenaere et al. (2018, p. 1) noted that Elatostema calcareum appeared more widely dispersed than *Procris pendunculata*, while more mature plants were recorded for the latter. The number of eggs, larvae, and adult butterflies recorded at clusters of the hostplants varies according to the literature. However, consistently across the literature, researchers generally observe adult butterflies in proximity to its larval stage host plant species (Rubinoff and Kawahara in litt. 2011; Rubinoff 2013, p. 1; Demeulenaere et al. 2018). Similarly, Schreiner and Nafus (1996) noted an association in occurrence of the adult butterflies with the presence of host plants and with host plants occupied by the egg and caterpillar stages. During their 2022 captive rearing study, Fiedler et al. (2023, entire), noted challenges rearing a large number of eight-spot larvae from a possibly limited number of Procris pendunculata plants and recommended that additional research take a look at host plant preferences and capacity.

While the length of time spent as a pupa and the adult butterfly's longevity remain inadequately studied (Moore 2013, p. 7), Schreiner and Nafus (1996, pp. 3-4), recorded developmental times

for both the eggs and caterpillars they examined during their yearlong study of a population near the University of Guam in the mid-1990s. Caterpillars hatched after approximately six days and then required approximately 20 days to complete their development through six instars (an increment of the larval stage between molts) before pupating. Schreiner and Nafus (1996, p. 3) also noted that the number of pupae found within a given patch of host plants did not correspond to the prior number of large and conspicuous late-instar caterpillars within that same patch of host plants. They suggested that many of the caterpillars likely sought out a different and hidden location to begin the pupal stage (as opposed to predators consuming them). More recently, during a 2022 captive rearing study, Fiedler et al. (2023, p. 4) recorded two adult butterflies reared from laboratory hatched eggs and isolated for study of longevity, surviving for 146 and 74 days, respectively.

![](_page_12_Picture_2.jpeg)

**Figure 5.** *Procris pedunculata* host plants growing on limestone cliffs at Haputo Point. Note the cascading nature of the plants stems. (Photo by Daniel Rubinoff)

![](_page_13_Picture_1.jpeg)

Figure 6. *Elatostema calcareum* host plant near Hilaan Point, Lost Pond, Guam. (Photo by Daniel Rubinoff)

## **Individual Needs**

Other than the limited amount of information available in the literature and as presented above, we lack very specific details regarding the Mariana eight-spot butterfly's individual needs. Like all butterfly species, the caterpillar life stage requires a sufficient amount of host plant material to feed upon to complete its development to the adult stage. During their study, Schreiner and Nafus (1996, pp. 3-4) noted that caterpillars would typically begin feeding on the same plant upon which they hatched and then migrate to a second, larger host plant after the fourth instar. However, no estimate was provided regarding the actual amount of plant consumed. Competition with cohorts and a suitable amount of host plant relative to larval density may also be an important factor as observed by Fiedler et al. during their 2022 captive rearing study (2023, p. 8). As noted above, the Mariana eight-spot butterfly may also require a safe place to pupate (like most lepidoptera), but the parameters for this requirement remain unknown. After the caterpillar's successful pupation and metamorphosis into a butterfly, the individual requires abundant adult food resources including flower nectar and possibly rotting fruit and animals.

# **Population Needs**

Very little information is available regarding the structure and size of Mariana eight-spot butterfly populations including the number of adults and caterpillars. Females lay a relatively small number of eggs on the bottom of the host plant leaves, along the margins (Demeulenaere et al. 2018, p. 10). Across the literature, researchers have typically measured host plant clusters supporting caterpillars by the number of host plant stems, varying between 2 and 285 stems (Schreiner and Nafus 1996, p. 7). The number eggs, caterpillars, and adult butterflies recorded at any one host plant cluster or 'population site' has also varied widely, but often includes no more than a handful of individual larvae and even fewer adults. Recorded numbers of eggs appear much more numerous, up to 180 at one site on a given day (Schreiner and Nafus 1996, p. 7; Demeulenaere et al. 2018, p. 22). During a study within limestone forest in northern Guam conducted between 2016 and 2017, Demeulenaere et al. (2018, p. 18), recorded the highest numbers of observed Mariana eight-spot butterfly life stages to date at a given host plant site. In total from numerous surveys during the yearlong study of the 200-acre (ac) (81-hectare (ha)) site, researchers recorded 3,475 eggs, 115 larvae, 16 adults, and 12 chrysalids, thus providing new indication of the Mariana eight-spot butterfly's capacity at a particularly suitably location (see further discussion below regarding development).

Based upon the observed association of adults in proximity to caterpillar host plant populations (and the presence of other life stages including eggs and larvae), populations of the Mariana eight-spot butterfly likely require abundant adult food resources approximately within the same vicinity (Schreiner and Nafus 1996; Rubinoff and Holland 2018; Demeulenaere et al. 2018). Based upon consistent observations of the species over time at a few survey sites containing larger aggregations of host plants, researchers have identified either the presence of pinnacle karst terrain or a relative absence of feral ungulates as a population need of the Mariana eight-spot butterfly (Rubinoff and Holland 2018, p. 224; Demeulenaere et al. 2018, p. 21).

## Species' Needs / Ecology

Unpredictable occupancy at many host plant population sites is among the few clear trends apparent from data gathered across the large number of surveys conducted for the Mariana eightspot butterfly beginning in 2010 (Rubinoff in litt. 2013; 2014; Rubinoff and Holland 2018; Demeulenaere et al. 2018). Although the species appears to consistently occupy several sites containing larger aggregations of host plants, particularly in northern Guam where the majority of the limestone forest remains, many sites lack butterflies, host plants, or both from survey to survey (Schreiner and Nafus 1996; Rubinoff and Holland 2018; Demeulenaere et al. 2018). Consequently, Rubinoff and Holland (2018 p. 223), has suggested that the species may exist as a metapopulation on Guam, which was our own assessment in a 2017 biological opinion for DOD projects on Guam (USFWS 2017; see further discussion below regarding development). Metapopulation is a term used to describe the specific population dynamics exhibited by butterflies and other highly mobile insects that occupy temporal and ephemeral habitats based upon the changing availability of larval stage host plants, adult food sources, climatic conditions, and other factors not entirely understood by science. Despite hundreds of research studies on tropical butterfly species to date, science actually understands very little about the dispersal capabilities of most tropical butterflies. This is both due to the difficulty in studying the butterfly population dynamics in tropical systems and the diverse behavior exhibited by tropical species (Bonebrake et al. 2010, p. 1,834). It is likewise accurate to state that we do not know whether the Mariana eight-spot butterfly exists as a large metapopulation or as a series of temporal and fluctuating populations on the island of Guam.

In an extensive review of the studies on tropical butterflies, Bonebrake et al. (2010, entire) found very little consistency in the response of butterflies to habitat disturbance. However, the study identified a consistent pattern in that butterflies limited to narrow ranges of habitat were the most vulnerable to habitat loss and required natural forest to survive (Bonebrake et al. 2010, p. 1,834). In the case of the Mariana eight-spot butterfly, already restricted to a narrow range of forest habitat suitable to its two patchy host plants species, all remaining such limestone forest may be a species need. Although poorly studied in general, the effects of habitat fragmentation on tropical butterfly species, including nymphalid spp., are less likely to fly through open areas, and therefore forest habitat connectivity between the specific Mariana eight-spot butterfly larval stage host plant sites may be equally important (Scriven et al. 2015, p. 420; Scriven et al. 2017, pp. 206, 212; Rubinoff and Holland 2018, pp. 223, 224).

individual needs	population needs	species needs
• sufficient amount of	<ul> <li>closed canopy limestone forest</li> </ul>	At the current species level,
caterpillar plant to	located on karst terrain	the Mariana eight-spot
complete development	• pinnacle karst terrain or absence of	butterfly requires the entirety
<ul> <li>egg and larvae parasites</li> </ul>	feral ungulates	of the remaining 11,759 ac of
and predators below a	<ul> <li>sufficiently large aggregations of</li> </ul>	limestone forest on the island
certain threshold	caterpillar host plants	of Guam with the existing
• safe place to pupate	<ul> <li>abundant butterfly food resources</li> </ul>	system of forest connectivity
inside a chrysalis	within proximity	between caterpillar host plant
<ul> <li>abundant food</li> </ul>		population sites
resources for the adult		
butterfly		

Table	1.	Summary	of	individual,	population,	and	species	needs	of	the	Mariana	eight-spot
butterf	ly											

# FACTORS INFLUENCING VIABILITY

# **Direct Stressors – Predation**

Schreiner and Nafus (1996, pp. 2–5) were the first to document possible impacts to the Mariana eight-spot butterfly from insect predators and parasites. During their year-long study of a population located near the University of Guam, they noted and recorded high mortality of the

eggs in particular at greater than 90 percent. More recently, researchers continue to observe high rates (72 to 86 percent) of parasitized eggs, and occasionally, a parasitized chrysalis (Rubinoff and Holland 2018, p. 222; Demeulenaere et al. 2018, p. 10; Fiedler et al. 2023, pp. 4, 8).

### Predation by ants or wasps

Ants commonly occur in dense numbers on both host plant species (Schreiner and Nafus 1996, p. 3-4) and four species of nonnative ant species are recorded preying upon the Mariana eight-spot butterfly (Schreiner and Nafus 1996, p. 3), including dwarf pedicel ants (*Tapinoma minutum*); tropical fire ants (*Solenopsis geminata*); white-footed ants (*Technomyrmex albipes*); and bicolored trailing ants (*Monomorium floricola*). These ants eat the butterfly eggs (Schreiner and Nafus 1996, p. 3; Rubinoff in litt. 2014) and, possibly, the caterpillars. Capable and efficient predators, ant species prey on all immature stages of Lepidoptera and can completely exterminate populations particularly they are not a native component of the ecosystem (Zimmerman 1958). During their study, Schreiner and Nafus (1996, pp. 3–4) noted predation by nonnative ants and suggested that it, and parasitization by wasps, was the cause of the high mortality they observed for the Mariana eight-spot butterfly, however they did not provide actual numbers of eggs or larvae predated by ants. Micronesia contains at least 45 species of ants (Clouse 2007, entire; antwiki 2019), however the list includes many native species and many known to be present on Guam since at least 1911 (Nafus 1993, p. 267).

### Predation by parasitic wasps

As noted above, researchers continue to observe consistently high rates of Mariana eight-spot butterfly egg parasitization during field surveys for the species, easily identified as the eggs turn to a black color when parasitized by the small developing wasp inside. First reported by Schreiner and Nafus (1996, p. 3), the trend continues more recently with observed rates of egg parasitization in the field as high as 86 percent (Rubinoff and Holland 2018, p. 222). From their samples, Schreiner and Nafus identified two different species of parasitoid wasps that emerged from the parasitized eggs, *Telenomus* sp. (no common name) and *Ooencyrtus* sp. (no common name), both apparently native to Guam, implying that the butterfly evolved with this specific pressure (Moore 2013, p. 9). More recently, identification of wasp species emerging from Mariana eight-spot butterfly eggs and chrysalids have not been conducted, although the literature identifies this as research need (Rubinoff and Holland 2018, pp. 222, 224; Demeulenaere et al. 2018, p. 10; Fiedler et al. 2023, p.8). Although nonnative wasp species are not implicated in the high rates of observed egg parasitization to date, the possibility is certainly plausible given biosecurity concerns worldwide and the documented introduction to Guam of over 27 biocontrol agents specifically for control of moths and butterflies (Nafus 1993, p. 265).

## **Predation summary**

During a mid-1990s study of two related butterfly species, *Hypolimnas anomala* and *H. bolina*, Nafus (1993, p. 267), noted very high egg parasitization and predation of both species by ants. The role of this impact on the Mariana eight-spot butterfly is therefore uncertain when

considering that *H. bolina* is presently among the most commonly observed butterflies on Guam and assuming that egg parasitization and predation on the species has remained the same (Moore 2013, p. 9). However, Demeulenaere et al. (2018, pp. 9-11) point out that female *H. anomala* and *H. bolina* both guard their eggs and *H. anomala* lays a large number of eggs. In contrast, the Mariana eight-spot butterfly lays relatively few eggs in the field (2 to 10) per plant and does not guard them, highlighting a potential susceptibility of the species to predation and parasitization, identified in the literature as a research need (Rubinoff and Holland 218, pp. 218, 224). In a more recent study, Fiedler et al. (2023, p. 8), noted that female Mariana eight-spot butterflies have the capacity to lay a large number of eggs. During their 2022 captive rearing study, Fiedler et al. (2023), observed one female laying over 300 eggs in its enclosure. It is possible that Mariana eight-spot females are laying large numbers of eggs in the field but spend substantial time searching for suitable host plants to spread out their brood (Fiedler et al. 2023, p. 8).

### Indirect Stressors - habitat loss and alteration

Many different stressors have historically affected forest habitat within the Mariana Islands, including development, wildfire, nonnative feral ungulates, nonnative plants, and climatic events such as typhoons (USFWS 2015; Willsey et al. 2019). Many of these same stressors continue to affect the limestone forest habitat necessary for the Mariana eight-spot butterfly. Some stressors, including nonnative plants, alter and degrade native forests slowly and incrementally, while development for example, completely removes forest habitat and connectivity between habitat sites.

## Habitat loss and alteration – host plant suppression by nonnative feral ungulates

All available scientific literature regarding the Mariana eight-spot butterfly identifies habitat degradation by nonnative ungulates, particularly feral pigs (*Sus scrofa*) and Philippine deer (*Cervus mariannus*), as the primary stressor threatening the current and future viability of the species (Schreiner and Nafus 1996; Moore in litt. 2013, p. 10; Rubinoff and Holland 2018; Demeulenaere et al. 2018, pp. 8, 20). Introduced to Guam in the 1600s and 1700s respectively, both species have spread island-wide and expanded their populations to densities among the highest in the world (Conry 1988, pp. 26-27; Wiles et al. 1999, p. 200).

Feral pigs and deer indirectly degrade and alter limestone forest habitat through their activities, including grazing and trampling, and by facilitating the invasion of nonnative plants into these areas. They also facilitate erosion, change in forest understory, and altered canopy cover (Wiles et al. 1999, entire), and most importantly, feral pigs and deer on Guam graze on the butterfly's two host plants (*Procris pedunculata* and *Elatostema calcareum*), both which evolved in the absence of grazing ungulates. On Andersen AFB, researchers estimated densities of Philippine deer and feral pigs at 0.8 deer per acre (ac) and 0.2 pigs per ac, which are some of the highest densities recorded in the world (NAVFAC 2012, p. 18)). Andersen AFB also contains a largest

percent of Guam's remaining limestone forest and butterfly host plant populations (**Figure 7** and **Figure 8**).

According to the literature, the Mariana eight-spot butterfly's two host plants are entirely restricted to closed canopy (moist) native limestone forest habitat. Within these areas, strong grazing pressure by feral pigs and deer further restricts the host plants to a smaller subset limestone forest habitat that includes cliff edges and particularly jagged karst terrain commonly known as pinnacle karst or karren (Demeulenaere et al. 2018, pp. 4-6; Rubinoff and Holland 2018, p. 223). The ideal requirements (e.g., soil, moisture, canopy cover, etc.) of the two host plants remain unknown (Demeulenaere et al. 2018, p. 26). However, researchers have observed both host plant species (and the butterfly) in some areas of limestone forest habitat of Guam, including Hilaan, Pagat, Asiga, growing on flat ground or on top of boulders (Demeulenaere et al. 2018, p. 25). Perhaps due to greater hunting pressure on some sites outside of DOD-owned lands, the host plants are not restricted to locations out of reach of pigs or deer. In contrast, even in pinnacle karst terrain where feral ungulate abundance and activity are high, researchers surveying for the butterfly consistently observe grazing damage on both host plant species as they begin to grow within reach of pigs and deer (Rubinoff in litt. 2013; Lindstrom and Benedict 2014, pp. 29, 32-35; Rubinoff in litt. 2014).

Currently, we lack information to indicate how much of Guam's remaining 11,759 ac (4,759 ha) of limestone forest (**Figure 8**) may be categorized as pinnacle karst or similarly rugged to preclude ungulate grazing on the host plants. However, based upon researchers' observations and surveys of limestone forest and LiDAR imagery of Guam, it is likely a much smaller subset of limestone substrate and primarily occurs in a few areas near at the edge of cliff lines (Fiedler pers comm. 2019).

Feeding damage on both host plants caused by the invasive Cuban slug (*Veronicella cubensis*), is another frequent observation by researchers during surveys for the butterfly (Demeulenaere et al. 2018, pp. 8, 20). Apparently introduced to Guam around 1993 (Robinson and Hollingsworth 2009, p. 4), this worldwide pest to agriculture and biodiversity is now incredibly invasive in Micronesia with the highest densities in the world recorded in the Mariana Islands. During a 2018 effort to test out-planting of the host plants for the butterfly, Cuban slugs caused the majority of observed mortality rates ranging between approximately 45% for *Elatostema calcareum* and 73% for *Procris pedunculata* (USFWS 2019, p. 3). While it is difficult to estimate the full impact from this stressor, it is likely much less serious than feral ungulate grazing pressure. Also notably, their contribution to the reduced viability of the host plant species highlights the very plausible threat of future nonnative species introductions to Guam including new serious insect pests or pathogens that could further affect the host plants.

### Habitat loss and alteration - DOD development of limestone forest habitat

Primary (original and not cleared) limestone forest likely covered most if not all of the limestone substrate on Guam, approximately 78,769 ac (31,877 ha) or 58.5 percent of the island's surface area. A mix of limestone forest now covers approximately 11,759 ac (4,759 ha), a reduction of 84 percent from historical condition. However, primary limestone forest is now largely restricted to northern Guam on undeveloped, rugged karst terrain on cliff-edge plateaus (Taborosi 2013, pp. 14-16; Demeulenaere et al. 2018, p. 9), where these areas have to date escaped the centuries-long development that altered much of Guam's original limestone terrain. This largely undevelopable, steep, rugged terrain, along cliff edges, or on DOD lands, supports the majority of the primary native limestone forest where Mariana eight-spot butterfly habitat occurs.

As part of a large effort to realign and balance U.S military forces in the Asia-Pacific region, the Department of the Navy (Navy) is in the process of relocating U.S. Marine Corps (USMC) personnel from Okinawa, Japan to Guam, which includes related infrastructure construction and military training activities. Project activities for this relocation include the construction of a main cantonment area, family housing, a live fire training range complex and a variety of other training activities on DOD property on Guam. Post-completion of the project, the population on Guam will increase by approximately 7,400 people according to official estimates.

Specific to the Mariana eight-spot butterfly and its habitat, this relocation project permanently modified (developed) approximately 1,219 ac (493 ha) of limestone forest and 613 ac (248 ha) of herbaceous scrub. Due to the large project footprint on limestone forest, in particular (**Figure 7**), and the potential to affect a variety of threatened and endangered species on Guam, the Department of the Navy proposed a number of conservation measures to reduce the impacts to such species and habitats. For example, the Navy proposed that contractors would relocate all life stages of the Mariana eight-spot butterfly onto appropriate host plants prior to construction.

Construction within limestone forest habitat for this Navy project began in 2019 and as translocation efforts are ongoing, the success of these efforts are not yet determined. Therefore, this species report does not assess the individuals recently translocated as part of the current (or future) conditions and assumes no individuals remain within the affected project footprint. Consequently, the resulting number of individuals removed as a result of this project are identified as historic populations, and we will evaluate the success of the translocations in future versions of this species report.

Meanwhile, we expect the Navy relocation project reduced the viability of the Mariana eightspot butterfly due to the permanent destruction of 1,219 ac (493 ha) of limestone habitat on Guam, which was approximately 11 percent of the total remaining on the island (**Figure 8**) prior to commencement of the project. In addition to the actual project footprint within Guam's limestone forest, it is reasonable to assume additional impacts to the butterfly will occur by the time the project is completed. These impacts include increased fragmentation of habitat, increased amounts of edge (vs. contiguous) habitat, and decreased canopy cover and habitat connectivity in addition to impacts from increased levels of DOD activity in northern Guam (USFWS 2017, pp. 113-119).

The aforementioned study conducted between 2016 and 2017 by Demeulenaere et al. (2018), determined that the 200 ac (81 ha) NW Field site, surveyed to assess the project's impacts, was particularly high in value to Mariana eight-spot butterfly. Largely comprised of primary limestone forest located on a mixture of karst and pinnacle karst terrain, the site included the highest recorded density and numbers of both host plants and observed butterfly life stages to date in any area of Guam. Approximately 338 ac (137 ha) of this same site is currently under development for the Navy relocation project. As we noted in our 2017 biological opinion for this project (USFWS 2017, pp. 113-119), this number only includes the direct project footprint and does not take into account the bisection and fragmentation of this important butterfly habitat (**Figure 7**). In addition to this population site, four other populations occur adjacent to forest habitat within this project's footprint and may experience impacts from the effects of fragmentation and increased activity (**Figure 8**).

To specifically offset the impacts to the Mariana eight-spot butterfly, the Navy has proposed several measures including, translocating host plants found within the project area, outplanting host plants in several other designated locations, and moving larvae or eggs found within the project area to suitable host plants nearby. To additionally offset and mitigate for impacts to both the butterfly and other affected species resulting from this project, the Navy proposed to set aside two areas on Andersen AFB for conservation and restoration. Located near Finegayan, the Navy proposed to enclose these two areas with ungulate proof fencing and manage them for feral ungulates (**Figure 8**).

![](_page_21_Figure_1.jpeg)

**Figure 7.** Map of Andersen AFB NW Field in northern Guam showing a portion of the Navy's USMC relocation project footprint where it overlaps with habitat containing dense observations of the Mariana eight-spot butterfly and its host plants identified by Demeulenaere et al. (2018).

As of this current version of the Mariana eight-spot butterfly SSA, we lack access to the GIS shapefile layers for the two conservation areas proposed for fencing and management of ungulates. Because we cannot analyze the type of habitat and quantity within the units, it is not possible for us to assess the potential level of net gain or net conservation loss to native limestone forest on Guam resulting from the Navy's USMC relocation project. Furthermore, we are unaware of any successful feral ungulate removal projects on Guam to date and lack information regarding longterm successful outplantings or translocations of the host plants. Therefore, the outcome of the offset efforts proposed by the Navy remains uncertain, including ongoing butterfly and host plant translocation efforts.

![](_page_22_Figure_1.jpeg)

**Figure 8.** Map of Guam indicating land cover by forest type, proposed project footprint for the Navy's USMC relocation, general butterfly population locations.

Stressor	Possible Impacts	Documented Impacts						
Habitat Stressors								
<b>Development</b> (urbanization and ongoing DOD projects and activities)	Loss of remaining limestone habitat (about 10% of Guam)	Currently ongoing DOD projects on Guam are removing 1,219 ac of limestone forest habitat – about 10% of the pre-project total of 12,900 ac remaining on Guam						
<b>Forest herbivores:</b> (deer, slugs, and pigs)	Grazing of native plants, trampling, opened understory results in forest alteration and facilitated spread of nonnative plants	Native limestone forest not occurring on extremely rugged terrain experiences disturbance and forest alteration including reduced canopy cover; Butterfly host plants now largely restricted to extremely rugged terrain						
		Cuban slugs eat the host plants and inhibit out- planting efforts						
Nonnative plants	Forest alteration and exacerbation of fire regime on Guam	Documented forest alteration and change in forest canopy						
Fire	Forest alteration and exacerbation of fire regime on Guam	Many areas on Guam are now grasslands or denuded and suffer from frequent fires (largely due to arson and hunting) and erosion with very little canopy cover remaining						
Activities associated with hunting by carefully implemented hunting programs could actually reduce deer and pig populations		Hunters frequent start fires on Guam to 'flush' deer and prompt new grass growth, leading to impacts (see fire above)						
Typhoons         Forest alteration include           Typhoons         Forest alteration include           Forest alteration include         Forest alteration include           Typhoons         Forest alteration include		Impacts documented in the Mariana Islands, but not specifically documented to affect the Mariana eight-spot butterfly or its habitat						
Host plant insects pest or pathogens	Could have dire effect on the butterfly's viability	Not documented – currently only a possible threat						
	Direct S	tressors						
	Reduced abundance							
Egg predation by ants and parasitic wasps	Possible exclusion from otherwise suitable habitat;	Egg mortality consistently high at 72-90%						
	a result of altered behavior							
Predation of other life stages by ants and parasitic wasps	Reduced abundance as a result of reduced fitness and loss of individuals	Impacts documented to affect the Mariana eight- spot butterfly, but levels unknown						

**Table 2.** Summary of possible and documented stressors to the Mariana eight-spot butterfly and its habitat.

### **Conservation Actions**

Since its listing in 2015, the primary conservation actions for the Mariana eight-spot butterfly, (not including DOD project related mitigation, see above regarding the USMC relocation and our 2017 biological opinion (USFWS 2017, entire)), include experimental efforts to grow and outplant the two host plant species, *Procris pedunculata* and *Elatostema calcareum*. Beginning in 2017, the USFWS and the National Park Service on Guam developed a collaborative partnership to recover the Mariana eight-spot butterfly on Park Service and Refuge lands. This partnership resulted in increased knowledge of host plant propagation methods and the out-planting of approximately 200 host plants on 9.5 ac (3.84 ha) on Park Service lands at Asan Beach and nearby Fonte Plateau where habitat for this endangered species did not previously exist (USFWS 2019, entire).

After determining the ideal greenhouse methods, soil medium, propagation methods (asexual stem cutting), etc., project partners tested out-planting at the two Park Service sites. Initial survival rates of the out-plantings after 2 months were approximately 45% for *E. calcareum* and 73% for *P. pedunculata*, with much of the mortality associated with slug damage (see discussion above regarding slugs). Although pests attacked *E. calcareum* in the nursery much more frequently and the species experienced greater out-planting mortality, survivors exhibited greater leaf flush, root growth, and flowering than did *P. pedunculata*. Of the nearly 200 host plants that were initially planted within the two Park Service sites, 156 remained as of April of 2018. In addition to the research and out-planting effort, project partners developed educational outreach materials and engaged the local community to educate them about the project. The Service expects that continued maintenance and monitoring of these two Park Service sites will further increase information on micro-habitat requirements and host plant population establishment for future conservation, including ongoing DOD mitigation efforts (see above discussion).

![](_page_25_Figure_1.jpeg)

**Figure 9.** Map of western-central Guam showing the location of 2017-2018 experimental partnership between the U.S. Fish and Wildlife Service and National Park Service to propagate and out-plant Mariana eight-spot butterfly host plants.

# **Historic Condition**

Prior to the arrival of humans and feral ungulates to the Mariana Islands, the Mariana eight-spot butterfly likely occurred across a much larger range of habitat than its current distribution on Guam. As noted above regarding the threat of development, we estimate that approximately 78,769 ac (31,877 ha) or 58.5 percent of the island was historically covered with limestone forest based upon the current distribution of limestone soils and substrate (**Figure 10**). Although we do not know with certainty that the butterfly's two host plants are not naturally restricted to cliff sides and pinnacle karst terrain, the limited available information regarding their distribution suggests otherwise. If the two host plants occurred within most the historical distribution of limestone forest at some unknown density, but at least similar to densities observed presently, we can suggest that historical range on Guam was 85 percent larger than its present size, estimated at approximately 11,759 ac (4,759 ha), or 8.7 percent of the island's surface area. With no geological or other known barriers of significance, we estimate that connectivity between all potential limestone forest habitats was also much greater than present conditions allow. Records exist of the Mariana eight-spot butterfly historically occurring on the island of Saipan, based on early 1900s labels for two type specimens (Schreiner and Nafus 1996, p. 10; Moore 2013, p. 2). Despite the existence of both host plant species and suitable habitat on Saipan, several surveys on the island have failed to detect the butterfly (Rubinoff and Holland 2018, pp. 218-220, 222). Assuming the accuracy of those early reports of the Mariana eight-spot butterfly occurring on Saipan, we estimate that its historical habitat range on that island was approximately 21,600 ac (8,741 ha), or 70 percent of the island (Figure 12) based upon the current distribution of limestone soils and substrate. Suitable limestone forest habitat and relatively abundant host plants also occur on the islands of Rota and Tinian (located between Guam and Saipan) (Figure 11 and Figure 12). Accordingly, researchers have suggested that the historical range of Mariana eight-spot butterfly may have also included both islands (Rubinoff and Holland 2018, pp. 218-220, 222). Subsequent surveys have revealed higher host plant densities in some areas, including portions of Tinian (Rubinoff and Holland 2018, p. 222), than comparable habitat on Guam. However, surveys have also failed to detect the butterfly on either island during recent years, and we, therefore, lack evidence to suggest the species' range included these islands historically or currently.

In addition to a larger habitat range and greater connectivity between habitat sites on at least Guam and Saipan, we expect that the Mariana eight-spot butterfly likely experienced lower historical predation pressure from nonnative insects established within the archipelago as a result of human activity. Based upon available information, we are unable to suggest a historical population abundance for the Mariana eight-spot butterfly.

![](_page_27_Figure_1.jpeg)

Figure 10. Map of Guam comparing potential historical and current distribution of limestone forest.

# **Current Condition**

The Mariana eight-spot butterfly occurs only on the island of Guam confined within primary (original and not cleared) limestone forest of an unknown amount. This habitat is a smaller subset of its estimated potential habitat on Guam represented by the total remaining limestone forest, approximately 11,759 ac (4,759 ha), or 8.7 percent of the island's surface area (**Table 3**). The majority of limestone forest habitat and known host plant populations of the butterfly occur in northern Guam on undeveloped, rugged karst terrain or the cliff-edges of limestone plateaus (Taborosi 2013, pp. 14-16; Demeulenaere et al. 2018, p. 9). These areas have to date escaped the centuries-long development that altered much of Guam's original limestone terrain due to their location in areas mostly steep, rugged, along cliff edges, or on DOD lands.

In total, the Mariana eight-spot butterfly is recorded from approximately fourteen locations on Guam. However, researchers estimate the species only consistently occurs at between 6 and 10 known locations that contain larger aggregations of the two host plant species. During the vast majority of the historical and recent observations, the butterfly only occurs within close proximity of its two host plant species. The majority of known host plant locations occur on extremely rugged karst terrain known as pinnacle karst that affords protection from feral ungulates, particularly Philippine deer. In only a few known locations, with apparently lower feral ungulate activity, do host plants grow on less extreme karst terrain. According to researchers familiar with the butterfly and our own analysis, it is possible that the primary occurrences of the host plant species represent distinct populations or that species exists as a meta-population on Guam taking advantage of the temporal and patchy distribution of its remaining habitat (USFWS 2017, p. 59-60; Rubinoff and Holland 2018, pp. 223-224).

As stated previously, we lack recorded evidence to show that the Mariana eight-spot butterfly has declined in abundance. Only by interpreting Swezey's single recorded happenstance observation of an adult butterfly foraging on hibiscus in 1936 near Piti, Guam (not near any presently known habitat sites), could one possibly interpret that the species was once more abundant than it is now. While we do know that its habitat has declined in recorded history, surveys for the butterfly in recent years have turned up several new locations for the species and its host plants including sites in both southeastern, west-central, and northern Guam (USFWS 2017, p. 60). Despite its narrow distribution, small amount of remaining habitat, and high mortality during the egg stage, these recent observations of the species outside of known range are hopeful and highlight the Mariana eight-spot butterfly's apparent capacity to survive to date under adverse conditions.

Guam Forest Cover	Historical Condition ac (ha) / percent of island cover	Current Condition** ac (ha) / percent of island cover	Percent reduction in native limestone forest from historical condition
Native limestone forest	78,769 ac	11,759 ac	85 0/2
cover*	(31.877 ha) / 58.5%	(4.759 ha) / 8.7 %	05 70

**Table 3.** Change in limestone forest habitat on Guam since historical condition (based upon the current distribution of limestone soils and substrate)

\*Based on XX and does not include mixed forest

\*\*Includes development of 1,219 ac (493 ha) of limestone forest as a result of the Navy's USCM relocation project

![](_page_30_Figure_1.jpeg)

**Figure 11.** Map of Guam depicting remaining limestone forest and general location of Mariana eight-spot butterfly observations and host plant populations on the island.

![](_page_31_Figure_1.jpeg)

**Figure 12.** Maps of Rota, Tinian, and Saipan showing remaining limestone forest and location of recorded Mariana eight-spot butterfly host plant populations on each island. (Maps may not depict all existing host plant populations, only those recorded during research surveys).

# **RESILIENCY, REPRESENTATION, AND REDUNDANCY OF THE SPECIES**

### **Resiliency of Current Populations: Low to moderate**

Resiliency is the capacity of a population to withstand stochastic disturbance events. Quantitative information on Resiliency is often unavailable for evaluating the status of a species. In the most general sense, a species showing good population growth is more likely to be resilient to an environmental perturbation. Additionally, occupying a larger landscape with viable migration corridors among habitats will greatly facilitate resilience, and sustain geographically dispersed populations.

Historically, records exist for the Mariana eight-spot butterfly from both the islands of Saipan and Guam (Schreiner and Nafus 1996, p. 10; Moore 2013, p. 2), so we will briefly examine the resiliency for each island's 'population'.

### Guam metapopulation

Prior to Schreiner and Nafus's mid-1990s surveys, only sporadic recorded observations of the Mariana eight-spot butterfly existed from Guam beginning with a 1936 observation in Piti (Swezey 1942). We, therefore, lack information to clearly show an actual decline in the abundance of the species on Guam. Despite an increase in surveys for the species beginning in the 2000s, we also lack information to suggest that population numbers on Guam are increasing. However, widespread feral pigs and deer populations now restrict both host plant species to a very narrow range of extreme karst habitat limited on Guam as a smaller subset of the estimated remaining 11,759 ac (4,759 ha) native limestone forest. All of the remaining forest habitat in which the host plants occur is susceptible to alteration and competition with invasive nonnative plants. Additionally, all available reports indicate that egg parasites and predators suppress Mariana eight-spot butterfly abundance within existing population sites. Based on the available information regarding forest habitat loss and alteration on the island, we estimate the resiliency of the Guam Mariana eight-spot butterfly metapopulation to be low to moderate due to a decline in available habitat.

### Saipan metapopulation

Researchers believe the Mariana eight-spot butterfly is extirpated from Saipan (Schreiner and Nafus's 1996, p. 10; Rubinoff and Holland 2018, p. 218). Therefore, this population has no resiliency.

## Species Representation: Low to moderate

Representation is having one or more populations of a species occupying the full range of habitat types used by the species. In general, conserving the biogeographic range occupied by populations of a species should take into account historic latitudinal and longitudinal ranges,

elevation gradients, climatic gradients, soil types, habitat types, seasonal condition, etc. Connectivity among populations and habitats is also an important consideration in evaluating representation.

With the Saipan population likely extirpated, we assessed only the Mariana eight-spot butterfly's representation on Guam. The total amount of pinnacle karst habitat where the host plants and the butterfly co-occur is limited, but widely distributed on Guam, particularly in the northern half of the island. Despite the species' ability to fly, we expect that connectivity between northern and southern Guam host plant populations is poor due to the distance and lack of suitable habitat in between the two regions. Connectivity between host plant sites in at least the northern half of Guam may be fair to good with possibly ample adult food resources between sites. However, the butterfly is often absent from many of its host plant sites during indicating that the species does not occupy its full range on Guam. Due to the extirpation of the Saipan population and because the host plants are largely restricted to a very narrow range of habitat within pinnacle karst terrain, we believe the representation exhibited by the Mariana eight-spot butterfly is low to moderate.

### **Species Redundancy: Low**

Redundancy is minimizing the risk of extinction of the species by establishing multiple populations across a landscape so some populations will always survive a catastrophic event. In general, a wider range of habitat types, a greater geographic distribution, and connectivity across the geographic range will increase the redundancy of a species and its ability to survive a catastrophic event.

It is unclear whether the Mariana eight-spot butterfly exists as a large metapopulation or as a series of temporal and fluctuating populations on the island of Guam. If the latter, the species is consistently observed in variable abundance at approximately ten different sites. These native limestone forest habitat sites contain the largest known aggregations of host plants and recorded butterfly observations since surveys began for the species in the 1990s. If viewed as multiple populations on Guam, the Mariana eight-spot butterfly is widely distributed on the island, albeit with greater density and abundance in northern Guam. As noted previously, connectivity between some populations is likely fair. Barring the introduction of some new plant pathogen or nonnative insect that aggressively attacks the host plants, we lack evidence to suggest that the species is at risk from any catastrophic event. Balancing this assessment with the fact that the species is extirpated on Saipan, we conclude that the Mariana eight-spot butterfly exhibits a low level of redundancy.

## **Current Species Viability Summary**

The Mariana eight-spot butterfly has low to moderate resiliency, low to moderate representation, and low redundancy compared to likely historic conditions, which would lead one to a

conclusion of low to moderate viability currently. However, it is necessary to balance this assessment within the context of a species is facing a moderate to high degree of threat from multiple stressors both currently unmanaged (feral ungulates) and some unmanageable (high levels of egg mortality). Without increased and improved feral ungulate control on Guam, the butterfly's viability may further decrease if the species remains restricted to the narrow range of its host plants within areas of pinnacle karst.

3Dc	Register Definition Application to the Mariana eight shot buttorfly					
3185	Application to the Mariana cight-spot butteriny					
Resiliency	Large, robust or growing populations able to withstand periodic and localized disturbance from stochastic events	The Mariana eight-spot butterfly has low to moderate resiliency because it is extirpated from Saipan and exists on Guam as a metapopulation of temporal populations restricted to a narrow range of habitat by ungulates and suppressed by egg predators and parasites. We lack evidence to suggest that any population is capable of growth.				
Representation	Interconnected populations that occupy a full range of historical ecological diversity maintaining adaptive potential	The Mariana eight-spot butterfly has low to moderate representation because despite the possibility for interconnectivity, its widely dispersed, ephemeral host plant populations on Guam are restricted to a narrow range of habitat by ungulates. Additionally, the species is extirpated from Saipan.				
Redundancy	Species exists as multiple, widely distributed populations capable of surviving extirpation due to catastrophic events	The Mariana eight-spot butterfly has low redundancy because it is extirpated from Saipan, and its temporal Guam populations are sporadically observed. However, the populations are widely distributed and the species as a whole does not appear to be vulnerable to catastrophic events.				

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I able 4.	Summary	of the	SKS analy	ysis toi	examining	Mariana	eigni-sp	ot butterily	viadility.

Even with documented habitat declines in recorded history, surveys for the butterfly in recent years have turned up several new locations for the species and its host plants including sites in southeastern, west-central, and northern Guam. Additionally, surveys have reconfirmed occupation of the species at sites on Navy lands un-surveyed for many years. Despite a narrow distribution, small amount of remaining habitat, and high rates of egg mortality, recent and continued observations of the species outside of known range are hopeful and highlight the Mariana eight-spot butterfly's capacity to survive to date under adverse conditions.

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