

# The Mariana Eight Spot Butterfly, *Hypolimnas octocula marianensis*

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*Hypolimnas octocula marianensis* Fruhstorfer 1912, commonly referred to as the Mariana eight spot butterfly or the Mariana forest flicker, is a subspecies of nymphalid butterfly recorded only from the islands of Guam and Saipan in the Mariana Islands. Because of its rarity and limited distribution, this subspecies became a candidate for listing under the United States Endangered Species Act in 1997. The objective of this article is to review what is currently known about this rare subspecies.

## 1 Taxonomy

*Hypolimnas octocula* is one of four species of nymphalid butterflies inhabiting the Mariana Islands including *H. bolina*, *H. anomola*, and *Vagrans egistina*. *H. bolina* and *H. anomola* are common. However, *V. egistina* is very rare, not having been observed since the 1970s (Schreiner and Nafus, 1997). As with *H. octocula marianensis*, *V. egistina* became a candidate for listing under the United States Endangered Species Act in 1997.

The subspecies *Hypolimnas octocula marianensis* was described by Fruhstorfer (1912). The parent species, *Hypolimnas octocula* was described under the name *Diadema octocula* by Butler in 1869. In addition to *H. o. marianensis*, there are several other subspecies occupying islands of Palau, Vanuatu, New Caledonia and the Loyalties, Fiji, Tonga, and Samoa (Samson 1986).

Samson (1986) revised the *Hypolimnas octocula* complex. He split the group into two species, *H. octocula* and *H. arakalulk*. In *H. arakalulk*, he placed only two subspecies, both from Micronesia: *H. arakalulk marianensis* from the Marianas and *H. arakalulk arakalulk* for Palau. However, in this article I will use *Hypolimnas octocula marianensis* as the valid name.

This scientific name for the Mariana eight spot butterfly is often misspelled (Table 1). The most egregious error occurs in a U.S. National Park Service document (Haysmith et al., 2005), available online, where the authors misspelled all three components of the trinomial, “*Hypolymnus octocula mariannensis*”, and used this name in the caption for a photograph of a butterfly taken on Rota, which is outside the known range for *H. o. marianensis*. The butterfly in the image is clearly a female *H. bolina*, a common species in the Marianas. This misidentified image was reused in a fact sheet on the Marianas eight spot butterfly published as part of the Guam Military Buildup Draft Environmental Impact Statement (Volume 9, Chapter 2, ).

A valid scientific name can be considered to be a key which unlocks the global information base for a taxon. Information associated with misspelled or otherwise invalid names may be inaccessible or overlooked. This is especially true for information stored in databases which use valid scientific

names as unique identifiers. A recent attempt to use databases to assess the relationship between rare species and invasive species illustrates this problem. [Roberts et al. \(2013\)](#) have developed an innovative strategy where they use bibliographic database queries to extract information to be used in a massive literature review aimed at assessing the relationships between invasive species and threatened species. To extract information on threatened species, they used a query based on scientific names from lists provided by the U. S. Fish and Wildlife Service. Unfortunately, the name currently listed for *H. o. marianensis* is misspelled (*H. o. mariannensis*). So it is likely that only literature keyed to this particular misspelling of the scientific name will be identified for the review, and literature which uses the valid scientific name, synonyms, or other misspellings will be ignored.

## 2 Observations and Distribution

Here I attempt to list all known observation and collection records for *H. o. marianensis*.

Both *H. o. marianensis* and its synonym, *H. o. arakaluk* (misspelled as “arakaluk”), are listed by the Global Biodiversity Information Facility (GBIF). There are currently no occurrence records available for this subspecies, although there are records for other subspecies of *H. octocula*.

### 2.1 Type Specimens - Saipan (n=2)

According to [Samson \(1986\)](#), locations of the type specimens for *H. o. marianensis* are unknown. He examined a neotype and an alloneotype, both collected on Saipan:

Neotype, male, Museum Paris, Saipan (Mariannes), M. A. Marche, 200-83 (BM); Neallotype, female, Saipan, Mariana Isl., July 30, 1920 (AMNH).

These are the only Saipan collection records I was able to find. There are no specimens of *H. o. marianensis* in the Northern Marianas Islands insect collection housed at the Northern Marianas College on Saipan ([Schreiner and Nafus \(1996\)](#)).

### 2.2 Swezey Collection - October 17, 1936 - Guam (n=1)

[Swezey \(1942\)](#) collected a single female *H. o. marianensis* during his 1936 entomological survey of Guam. The collection data are reported as “Piti, from hibiscus at residence, Oct. 17, Swezey”. This specimen is in the Bishop Museum collection.

Some authors infer from the fact that Swezey collected only a single specimen of *H. o. octocula* that this subspecies was rare in 1936. However, this may not be the case. Swezey’s mission on Guam was an agricultural pest survey ([Swezey and Association, 1942](#); [IMMS, 1943](#)) and presumably he did not spend much time and effort collecting in karst habitats inhabited by *H. o. marianensis* and its host plants. The single adult specimen he collected was caught opportunistically while feeding on *Hibiscus* nectar at Swezey’s temporary residence in Piti ([Samson, 1986](#)).

### 2.3 Muniappan Collection - 15 and 20 August, 1975 - Guam (n=3)

As reported by [Samson \(1986\)](#), Muniappan reared 3 butterflies from “larvae collected on limestone forest plant, *Procris* sp. at Hilaan Point, 15 and 20 August, 1975”. Specimens are in the University of Guam insect collection.

Table 1: Synonymy for *Hypolimnas octocula marianensis* Fruhstorfer 1912.

Name	References	Status
<i>Hypolimnas octocula marianensis</i>	<a href="#">Fruhstorfer (1912)</a> ; <a href="#">Swezey (1942)</a> ; <a href="#">Schreiner and Nafus (1997)</a> ; <a href="#">Wiles et al. (1999)</a> ; <a href="#">DAWR (2005)</a> ; <a href="#">NAVFAC (2010)</a> ; <a href="#">US Navy (2012)</a> ; <a href="#">Anonymous (2012a)</a>	valid name
<i>Hypolimnas arakalulk marianensis</i>	<a href="#">DAWR (2005)</a>	genus and sp. epithet concatenated
<i>Hypolimnas arakalulk marianensis</i>	<a href="#">DAWR (2005)</a>	genus and sp. epithet concatenated and misspelled subsp. epithet
<i>Hypolimnas arakalulk marianensis</i>	<a href="#">DAWR (2005)</a>	synonym
<i>Hypolimnas arakululk marianensis</i>	<a href="#">Anonymous (2013a,b)</a>	misspelled sp. epithet
<i>Hypolimnas octocula marianensis</i>	<a href="#">US Navy (2012)</a>	misspelled species epithet
<i>Hypolimnas octocula marianensis</i>	<a href="#">US Navy (2012)</a>	misspelled sp. epithet
<i>Hypolimnas octocula mariannensis</i>	<a href="#">US National Park Service (2005)</a> ; <a href="#">NAVFAC (2010)</a> ; <a href="#">US Navy (2012)</a> ; <a href="#">U.S. Fish and Wildlife Service (2012)</a> ; <a href="#">USAF (2006)</a>	misspelled sp. epithet and subsp. epithet
<i>Hypolimnas octocula mariannensis</i>	<a href="#">Schreiner and Nafus (1996)</a> ; <a href="#">Hawly and Castro (2008)</a> ; <a href="#">NAVFAC (2010)</a> ; <a href="#">US Navy (2012)</a> ; <a href="#">Anonymous (2012a,b)</a> ; <a href="#">Roberts et al. (2013)</a>	misspelled subsp. epithet
<i>Hypolimnus octocula mariannensis</i>	<a href="#">US Navy (2012)</a>	misspelled genus and subsp. epithet
<i>Hypolimnus octocula</i>	<a href="#">US Navy (2010b,a)</a>	misspelled genus and sp. epithet; subsp. epithet missing
<i>Hypolimnus octocula mariannensis</i>	<a href="#">Haysmith et al. (2005)</a>	misspelled genus, sp. epithet and subsp. epithet
<i>Hypolimnas octocula mariannensis</i>	<a href="#">Schreiner and Nafus (1996)</a>	misspelled subsp. epithet
<i>Hypolimnas octocula mariannensis</i>	<a href="#">NAVFAC (2010)</a>	misspelled subsp. epithet
<i>Hypolimnus oculata</i> var. <i>mariannensis</i>	<a href="#">USAF (2006)</a>	subsp. epithet misspelled and referred to as a var.

## 2.4 Schreiner and Nafus Surveys - 1995 - Saipan (n=0), Rota (n=0), Guam (n > 6)

Schreiner and Nafus (1996) surveyed for *H. o. marianensis* on Saipan, Rota and Guam during 1995. Early in the survey they discovered that the larvae fed upon *Elatostema calcareum* (tupun ayuyu) in addition to the previously known larval host plant, *Procris pendunculata*. Both are forest herbs in the family Urticaceae growing on karst limestone. For each site where the plants were found, 200 stems of *Procris* and 200 stems of *Elatostema* were searched, or as many as were available.

### 2.4.1 Saipan

*H. octocula* was not found on Saipan. *Procris* was located along the base of the cliff line going around from Suicide Cliff to Kalebrera Cave. Several large stands were located. However no sign of adult or larvae could be found. No specimens were found in the fairly extensive collection of butterflies in the Northern Mariana Islands Insect Collection.

### 2.4.2 Rota

Although no butterflies of this species have ever been collected on Rota, Schreiner and Nafus searched several sites, as Rota has not been collected as extensively as Guam and Saipan. *Elatostema* was abundant behind the Japanese gun on the way up to the Sabana, and at similar cliff-backed sites at that altitude and slightly higher. *Procris* occurred at some of these locations. Although chewing of the plants was noted, this appeared to be caused by the green caterpillar of a noctuid moth. No evidence of *H. octocula* was found.

### 2.4.3 Guam

On Guam, a number of sites along the northern half of Guam were searched. *Procris* and occasionally *Elatostema* occur on the windward side in patches in limestone forest in a narrow band about 200 ft above sea level. Both *Elatostema* and *Procris* occurred on the leeward side in forests perhaps 100-200 ft. above sea level. At all locations where the host plants were found at least one of the stages of *H. o. marianensis* was also found. The most butterflies seen in one day at a suitable location was six. They found no eggs at most sites, but up to 71 at one site which was undergoing a small outbreak. Eggs and larvae were more abundant on *Elatostema* on the leeward side. Schreiner and Nafus did not search patches of host plants which are thought to occur in patches of limestone forest on the Southern mountains.

One site, below the University of Guam, was surveyed intensively for one year. See the Biology section below for results from observations at this site.

Schreiner and Nafus (1996) do not clearly indicate the total number of adult *H. o. marianensis* observed during their surveys. In a table of adult butterfly sightings, they list a total of 6 sightings: 3 individuals at Spanish Steps, Orote on 29-JUN-1995, 2 individuals at Tweed's Cave on 24-JUL-1995, and 1 individual at Lower Pagat on 2-AUG-1995. However, this table does not include any sightings at the site near the University of Guam campus in Mangilao and elsewhere in their report, they state that "The most butterflies seen in one day at a suitable location was six."

## 2.5 Muniappan Collection - 2001 - Guam (n=1)

A specimen of an adult *H. o. marianensis* specimen in the University of Guam insect collection is labeled: "Hilaan Pt., Guam, Sep 7 2001, Muniappan".

## 2.6 Bob Okoniewsky Sighting - April, 2008 - Guam (n=1)

Bob Okoniewsky emailed excellent images of an adult *H. octocula marianensis* to me in April, 2008. This individual accidentally flew into the passenger compartment of his vehicle as he was driving on Andersen Air Force Base, Yigo, Guam.

## 2.7 Hawly and Castro Survey - June - October, 2008 - Tinian (n=0)

Hawly and Castro (2008) surveyed Tinian for *H. o. marianensis*, even though the subspecies has never been reported from this island. They located populations of *Elatostema calcareum* at four locations and monitored these plants for all *H. o. marianensis* life stages. Each identified host plant site was visually scanned for life cycle stages (eggs, caterpillar, chrysalis, and imagoes/adults) by one or two observers for up to two weeks at various times of the day. At Japanese Cave site-2, 2 caterpillars and 4 chrysalises of *Hypolimnys bolina* were found feeding and pupating on *E. calcareum*, the chrysalises were reared in the lab for confirmation.

Two butterfly bait traps (lip type obtained from BioQuip.com) were set at each host plant site for up to two weeks. The butterfly bait traps were re-baited every three days with locally obtained mashed, rotting bananas, a liberal dose of raw cane sugar, and a dash of water. The bait was prepared the afternoon prior to the morning of use and typically became well fermented prior to being placed in the field. The traps were positioned within 5 meters of a host plant cluster and at approximately 3-4 meters above the ground.

After 4,806 documented minutes (approx. 80 hours) of visual searching and 1,848 documented trap hours (approx. 77 days) during the months of September and October, 2008 no life cycle stage of either species was observed.

## 2.8 Vegetation Survey 1 - 2008 - Guam (n=1)

A military contractor reported a sighting of an adult *H. o. marianensis* while doing vegetation surveys in the Pagat area of Yigo, Guam (Duenas 2010).

## 2.9 Vegetation Survey 2 - 2009 - Guam (n=0)

In a vegetation survey in at Andersen AFB in which “the specific task was to document the presence of host plants for butterfly species that are candidates for the Endangered Species Act, no *H. o. marianensis* butterflies were observed (TEC Inc. (2010)).

## 2.10 Andersen Air Force Base Butterfly Survey, Sept. 28 - Oct. 2, 2009 and Jan. 25, 2010 - Jan. 31, 2010 - Guam (n=0)

A survey for the Mariana Eight-Spot Butterfly, *H. o. marianensis*, was conducted on three Department of Defense parcels on Guam: Andersen Air Force Base (AAFB), Andersen South and Navy Barrigada during late 2009 and early 2010 (AECOM Inc., 2010).

The survey used two methods: timed counts and baited traps. Timed counts were conducted along linear transects within each of the three parcels. At every 30 meters two scientists would stand back-to-back and enumerate observations of all butterfly species within a 5-minute period. The areas investigated along the transect consisted of 20 m diameter circle plots. The biologists communicated with each other frequently throughout the survey period so as not to count the same individual butterfly twice. A total of five transects were studied. Three transects were located on AAFB and one transect was located on Andersen South and Navy Barrigada. [The report refers

to figures which show the locations of the transects. However, these figures are missing from the Natural Resources Survey Report (NAVFAC, 2010).]

Two baited traps were placed on each transect during daylight hours. The bait consisted of a mixture of mashed ripe bananas, apple cider, sugar, and yeast. At the end of the trapping period, which lasted approximately 6 hours, the traps were checked, and captured butterflies were noted and then released.

There were no observations of *H. o. marianensis* during this survey. Presence or absence of host plants was not reported.

### **2.11 Campora Survey - Pagat - 2010, Guam (n=1)**

A survey for all life stages of the Mariana Eight-Spot Butterfly, *H. o. marianensis*, and its two host plants along three transects in the Route 15 - Pagat Village area of Yigo, Guam from July 15 to July 24, 2009 (NAVFAC Pacific, 2010).

Transects were first surveyed over their entire length for host plants. Once the most probable areas of butterfly habitat (i.e. areas with a high density of host plants) were identified, efforts were then focused on those sites. This consisted of searching host plants for eggs, larvae, and pupae, monitoring the understory and upper forest canopy for adults, and monitoring bait pans. A digital camera (Canon 30D) was used to capture images of host plants and all butterfly life stages. Field binoculars were used to identify adult butterflies from long distances. Bait pans consisted of aluminum pie tins and were suspended approximately five to six feet from the ground. Banana and pieces of fish were used as bait. Bananas were prepared one day in advance by mashing and mixing with cane sugar and water and leaving at room temperature in a sealed bag for 24 hours. Fish pieces were obtained from a local market and placed in bait stations on the same day of purchase. Three bait pans were used in each area of butterfly habitat for a period of two days.

A single adult male *H. o. marianensis* was observed and photographed at the same location on consecutive days on a transect near the Route 15 North transect near the Yigo race track.

A total of 7 *Hypolimnas* larva were found at 5 different locations on both *E. calcareum* and *P. pedunculata*. *Hypolimnas* eggs were found only on *E. calcareum*, with a total of 19 eggs at 5 different locations. One viable *Hypolimnas chrysalis* was found on *E. calcareum*, and three empty *Hypolimnas* chrysalides were found on *P. pedunculata*. These immatures were probably *H. o. marianensis*. However, this could not be definitely confirmed in the field. *H. octocula* eggs and caterpillars are very similar to those of *H. bolina* and *H. anomola* which are common on Guam. Note that *H. bolina* has been observed to feed on *E. calcareum* (Hawly and Castro, 2008).

All of the 19 eggs were black, indicating that they were parasitized.

### **2.12 UH (Rubinoff) Surveys - 2011 and 2012 - Guam (n=?)**

Reports for these surveys are currently unavailable.

### **2.13 Alexandra Kerr Sighting - January 12, 2012**

During a survey conducted as part of the Ecology of Bird Loss Project, Alexandra Kerr sighted an eight spot butterfly adult at Elev. 595 ft N 13 32.560' E 144 55.596'.

### **2.14 UOG Survey - 2013, Guam (n=?)**

The report for this survey is currently unavailable.

## 3 Biology

Most of what is known about the biology of *H. o. marianensis* comes from [Schreiner and Nafus \(1996\)](#), an unpublished report of rare butterfly surveys on Guam, Saipan and Rota. During these surveys, they found *H. o. marianensis* only on Guam, at several sites. One site, below the University of Guam was surveyed for one year. Butterflies were most abundant between December and February. These months include the end of the rainy season and the beginning of the dry season on Guam. Population levels were very low in July and August, the beginning of the rainy season.

### 3.1 Larval Host Plants and Feeding Habits

Early in their surveys, Schreiner and Nafus found that larvae fed upon *Elatostema calcareum* (tupun ayuyu) in addition to the previously known host, *Procris pedunculata*. Both are forest herbs in the family Urticaceae growing on karst limestone. [Schreiner and Nafus \(1996\)](#) noted a tight association in occurrence of the butterfly and its host plants: “At all locations where the host plants were found at least one of the stages of *H. octocula* was also found.”

“In Guam, a number of sites along the northern half of Guam have been searched. *Procris* and occasionally *Elatostema* occur on the windward side in patches in limestone forest in a narrow band about 200 ft above sea level. Both *Elatostema* and *Procris* occurred on the leeward side in forests perhaps 100-200 ft. above sea level. At all locations where the host plants were found at least one of the stages of *H. octocula* was also found. The most butterflies seen in one day at a suitable location was six. We found no eggs at most sites, but up to 71 at one site which was undergoing a small outbreak. Eggs and larvae were more abundant on *Elatostema* on the leeward side. Still to be searched are patches of these plants which are thought to occur in patches of limestone forest on the Southern mountains.”

### 3.2 Life Cycle

[Schreiner and Nafus \(1996\)](#) provide developmental times for eggs and six instars of *H. o. marianensis* caterpillars (Table 2). The length of time spent as a pupa and longevity of adults is unknown.

### 3.3 Stage Specific Survivorship

[Schreiner and Nafus \(1996\)](#) made repeated observations of individuals in the field until they changed to the next life stage or disappeared (Table 2). They used recovery rates as lower bound estimates of stage specific survivorship. Only 10 per cent of individuals observed as eggs were recovered as first instar caterpillars. Schreiner and Nafus attribute this low rate to egg predation by ants and egg parasitism by hymenopterans (see below). Recovery rates for larval instars two to five ranged from 44 to 88 per cent. However, the recovery rate for sixth instar caterpillars was only 29 per cent. Schreiner and Nafus attribute this low rate to the dispersal of the large sixth instar caterpillars when they are searching for food or a cryptic location for pupation.

### 3.4 Predation and Parasitism

In their year-long study of the *H. o. marianensis* population near the University of Guam campus in Mangilao, Schreiner and Nafus found that egg predation, probably by ants, and egg parasites killed the majority of eggs. Parasitized eggs were brought to the laboratory and reared. Except for two eggs which produced *Ooencyrtus* sp., all the eggs were parasitized by a *Telenomus* sp. In contrast to the Mangilao site, however, eggs recovered from other sites did produce *Ooencyrtus* sp.

Table 2: Field observations of *H. o. m.* development at a site near the University of Guam campus during 1995. Data from [Schreiner and Nafus \(1996\)](#).

Stage	Days Spent in Stage	No. Found	No. Found after Hatching or Moulting to Next Stage	Percent Recovered
egg	6	445	45	10
1st instar	2.4 ± 0.6	47	21	44
2nd instar	2.0 ± 0.7	37	21	57
3rd instar	2.5 ± 0.8	36	32	88
4th instar	2.9 ± 0.8	46	30	65
5th instar	3.7 ± 1.0	46	33	72
6th instar	6.1 ± 1.5	51	15	29

They suspected that these were the same native species of wasps observed attacking *H. anomala* and *H. bolina* eggs. No egg, larval or pupal parasites which are known to have been introduced for biological control purposes were recovered.

The Guam Comprehensive Wildlife Conservation Strategy ([DAWR, 2005](#)) lists “predation of caterpillar by an ichneumonid wasp” as a threat to *H. o. marianensis*. I was unable to find any other reference for *H. o. marianensis* caterpillars being attacked by ichneumon wasps, which are parasitoids, not predators.

## 4 Conservation

When planning an effective conservation strategy, one must first collect enough information about the threatened taxon to understand and prioritize risks to be mitigated. Unfortunately, except for Schreiner and Nafus’s year long study of a population of *H. o. marianensis* near the University of Guam [Schreiner and Nafus \(1996\)](#), our knowledge of this rare butterfly is limited to data from accidental sightings plus presence/absence surveys with some observations on association with the two known host plants.

The Guam Department of Agriculture Division of Aquatic and Wildlife Resources and the United States Fish and Wildlife Service have independently developed published threat assessments and conservation recommendations for *H. o. marianensis*. Both are brief enough to be quoted here.

**Threat Assessment and Recommendations from the Guam Comprehensive Wildlife Conservation Strategy (GCWCS)** (Quoted verbatim from [DAWR \(2005\)](#))

**Threats:**

Habitat loss for the host plants by introduced plant species, and predation of caterpillar by an ichneumonid wasp, are believed to be causes of this species rarity.

...

**Action Plan:**

**Habitat degradation and loss:** Identify and map occurrences of *Procris pedunculata*. Reduce impacts of ungulates and invasive plants in limestone forests areas where *Procris* occurs.

**Small or extirpated population:** Conduct monthly surveys at the Hilaan Point to observe seasonal activity for this butterfly species, and cultivate caterpillars of this species and rear them to adult stage in a parasite and predation free enclosure for propagation. Release reared in the lab adults in limestone habitats where the host plant is abundant and especially in conservation areas Guam.

The GCWCS action plan for *H. o. marianensis* has not been implemented.

**Threat Assessment and Recommendations from the U.S. Fish and Wildlife Service (USFWS) Species Assessment and Listing Priority Assignment Form** (Quoted verbatim from [Anonymous \(2012a\)](#))

**Summary of Threats :**

Based on our evaluation of predation and parasitism we conclude there is sufficient information to develop a proposed rule for this species due to the threat of predation by ants and parasitism by small wasps. The likely extirpation of this species from Saipan and its reduction to low numbers on Guam makes it vulnerable to random demographic and environmental events. We find that this species is warranted for listing throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is threatened or endangered in a significant portion of its range.

...

**Recommended Conservation Measures :**

- Develop and implement monitoring surveys for the Mariana eight spot butterfly
- Conduct parasite control
- Conduct ant control

The USFWS recommendation for conserving *H. o. marianensis* by controlling parasites and ants may not produce positive results. There is currently no evidence that larvae or pupae are being parasitized and it is probable that the two known egg parasitoids are native parasitic wasps [Schreiner and Nafus \(1996\)](#) which have coevolved with *H. o. marianensis*. *H. o. marianensis* immatures are attacked by alien ant species, but closely related butterfly species on Guam are abundant despite attacks from these same ants.

Although reasons for the scarcity of *H. o. marianensis* are not fully understood, there seems to be a consensus among entomologists that have studied this butterfly that the subspecies is rare because its host plants are heavily grazed by introduced deer and pigs, which have high populations in most of Guam's limestone forest areas. There is a tight association between occurrence of *H. o. marianensis* and its host plants. Schreiner and Nafus (1996) reported "At all locations where the host plants were found at least one of the stages of *H. o. marianensis* was also found." Recent surveys have shown that Eight-spot butterflies are rarely observed except in close proximity to host plants.

The loss of *E. calcareum* and *Procris pedunculata* in many areas of Guam due to heavy deer and pig feeding has been linked to the rarity of the butterfly *H. o. marianensis*, which is endemic to Guam and Saipan (Wiles et al., 1999).

Browsing damage to native forests can be extensive, causing significant changes in forest structure and species composition. The objectives of current deer management programs in the Marianas are not compatible with the conservation of native ecosystems and recovery of endangered species. Recommendations are made to reduce deer densities dramatically through intensive continuous harvest over large areas of each island and to eradicate deer from sites of significant ecological value (Wiles et al. (1999)).

Host plants (*Procris pedunculata* and *Elatostema calcareum*) for larvae of the candidate Mariana eight spot butterfly, *Hypolimnas octocula marianensis*, are found in the limestone forest of Andersen Air Force Base. Deer browse has limited occurrence of these plant species to pinnacle karst and cliff edges that are inaccessible to deer. Anonymous (2012b).

Exclusion of ungulates and repopulation of limestone forest conservation areas with larval host plants may present the most promising conservation measure.

#### 4.1 Acknowledgment

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