Eua zebrina

5-Year Review
Summary and Evaluation

U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
Honolulu, Hawai‘i

5-YEAR REVIEW

Species reviewed: Snail [no common name] (*Eua zebrina*)

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5-YEAR REVIEW
Eua zebrina

1.0 GENERAL INFORMATION

1.1 Reviewers:

James Breeden, Wildlife Biologist, Pacific Islands Fish and Wildlife Office (PIFWO)
John Vetter, Animal Recovery Coordinator, PIFWO
Megan Laut, Conservation and Restoration Team Manager, PIFWO

Lead Regional or Headquarters Office:
Region 1, Portland Regional Office

Lead Field Office:
Pacific Islands Fish and Wildlife Office, (808) 792–9400

Cooperating Field Office:
N/A

Cooperating Regional Office:
N/A

1.2 Methodology used to complete the review:

This review was conducted by staff of the Pacific Islands Fish and Wildlife Office of the U.S. Fish and Wildlife Service (Service), beginning in June 2021. The review was based on the final rule listing this species; peer-reviewed literature, gray literature (government, academic, business, and industry reports), and expert elicitation. Data gaps were addressed using data available for congeners or otherwise similar species, as well as using basic conservation biology principles and plant and animal biology to identify the needs of individuals, populations, and species. The evaluation completed by James Breeden, Wildlife Biologist, was reviewed by John Vetter, Animal Recovery Coordinator, and Megan Laut, Conservation and Restoration Team Manager.

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2019. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews for 91 Species in Oregon, Washington, Hawaii, and American Samoa. Federal Register 84(112): 27152–27154, June 11, 2019.

1.3.2 Listing history

Original Listing
FR notice: [USFWS] U.S. Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants; Endangered Status for Five Species From American Samoa; final rule. Department of the Interior, Federal Register 81 (184): 65466–65508.

Date listed: October 24, 2016
Entity listed: *Eua zebrina*
Classification: Endangered

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

1.3.3 Associated rulemakings:

N/A

1.3.4 Review History:

This is the first 5-year review for *Eua zebrina*.

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

5C

1.3.6 Current Recovery Plan or Outline

Name of plan or outline: Draft Recovery Plan for Five Species from American Sāmoa
Date issued: May 17, 2021
Dates of previous revisions, if applicable: N/A

2.0 REVIEW ANALYSIS

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

2.1.1 Is the species under review a vertebrate?

____**Yes**
__X _**No**

2.1.2 Is the species under review listed as a DPS?

____ **Yes**
____ **No**

2.1.3 Was the DPS listed prior to 1996?

____ Yes
____ No

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

____ Yes
____ No

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

____ Yes
____ No

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

____ Yes
____ No

2.2 Recovery Criteria

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

____Yes
_X_No

2.2.2 Adequacy of recovery criteria.

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

__-_ Yes
____ No

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

_____Yes
____ No

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

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

The biology of Samoan partulid snails has not been extensively studied, but there is considerable information on the partulid snails of the Mariana Islands (Crampton 1925a, pp. 1–113;, Cowie 1992, pp. 167–191; Hopper and Smith 1992, pp. 77–85) and Society Islands (Crampton 1925b, pp. 5–35; Crampton 1932, pp. 1–194; Murray et al. 1982, pp. 316–325; Johnson et al. 1986, pp. 167–177 and 319–327). The life history traits of these well-studied partulids are very similar, and unless otherwise stated, the biology of these Partulid snails will act as a proxy for that of *Eua zebrina.*

Eua zebrina is a tropical tree snail in the family Partulidae, and is endemic to the islands of Tutuila and Ofu in American Sāmoa. *Eua zebrina* varies in color, ranging from almost white to pale-brown, dark brown or purplish, with or without a zebra-like pattern of flecks and lines (Cowie and Cook 1999, pp. 29–30). Most shells have transverse patterning (distinct coloration perpendicular to whorls) with a more flared aperture (i.e., tapered or wide-rimmed shell lip) than species of the related genus *Samoana* (Cowie et al. 2017). Adult *Eua zebrina* shells usually vary between 0.7 and 0.8 inch (in) (18 to 21 millimeters [mm]) in height, and between 0.4 and 0.5 in (11 to 13 mm) in width (Cowie and Cook 1999 pp. 29–30).

Snails in the family Partulidae are predominantly nocturnal arboreal herbivores that feed mainly on partially decayed and fresh plant material (Cowie 1992 pp. 167, 175; Murray et al. 1982, p. 324). Though *Eua zebrina* is considered to be primarily herbivorous, individuals have been observed eating other living non-partulid snails (Cowie 1992, p. 175).

2.3.1.2 Abundance, population trends (e.g., increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Partulids are slow growing and hermaphroditic (Cowie 1992, pp. 167, 174), and sexual maturity is reached in about 11 months. Adult partulid snails give birth about every 20 days, producing approximately 18 offspring per year over at least a 5-year lifespan (Cowie 1992, pp. 174, 179–180). Eggs develop within the maternal body and hatch internally or immediately after extrusion; they may or may not receive nourishment directly from the parent prior to extrusion (Cowie 1992, p. 174). Some species in the family are known to be self-fertile, but most partulids rely predominantly on out-crossing (Cowie 1992, pp. 167, 174).

A review of long-term changes in the American Sāmoa land snail fauna based on surveys from 1975 to 1998 and pre-1975 collections characterized 3 of 12 species as being stable in numbers, with the rest described as declining (Solem 1975, as cited in Cowie 2001, pp. 214–216; Miller 1993, p. 13). *Eua zebrina* was one of those land snail species. In the 1993 survey, 34 live *E. zebrina* were found at two of nine previously occupied sites on Tutuila; shells were found at four of the nine

sites (Miller 1993, pp. 11–13). Twenty-three of the 34 *E. zebrina* were seen on the offshore island of Nu‘usetoga (Miller 1993, p. 24). This small island is approximately 230 feet (ft) (70 meters [m]) high and located 328 ft (100 m) offshore of north-central Tutuila. It is forested with moderately open understory. No introduced snails were seen on the island, although rats (*Rattus* spp.) are probably present, as indicated by rat-damaged shells. This population may represent an isolated remnant of an ancestral lineage isolated in prehistoric time when Nu‘usetoga was still connected to Tutuila (Miller 1993, pp. 13).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

No new information.

2.3.1.4 Taxonomic classification or changes in nomenclature:

Cowie’s (1998, entire) taxonomic work is the most recent and accepted taxonomic treatment of this species.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g., corrections to the historical range, change in distribution of the species’ within its historic range, etc.):

Eua zebrina was historically known only from the island of Tutuila (Cowie and Cook 2001, p. 49), but in 1998 a single population was found on the island of Ofu (Cowie and Cook 1999, p. 30) (Figure). Until 1975, it was considered widespread and common (Cowie 2001, p. 215). The large number of collections (927) of this species from Tutuila between the 1920s and 1960s indicate this species was widely distributed and abundant; some collections included hundreds of specimens (Cowie and Cook 2001, p. 154). In addition, the large number of shells of this species used in hotel chandeliers on Tutuila also suggest that this species was historically an abundant resource (Cowie 1993, p. 1).

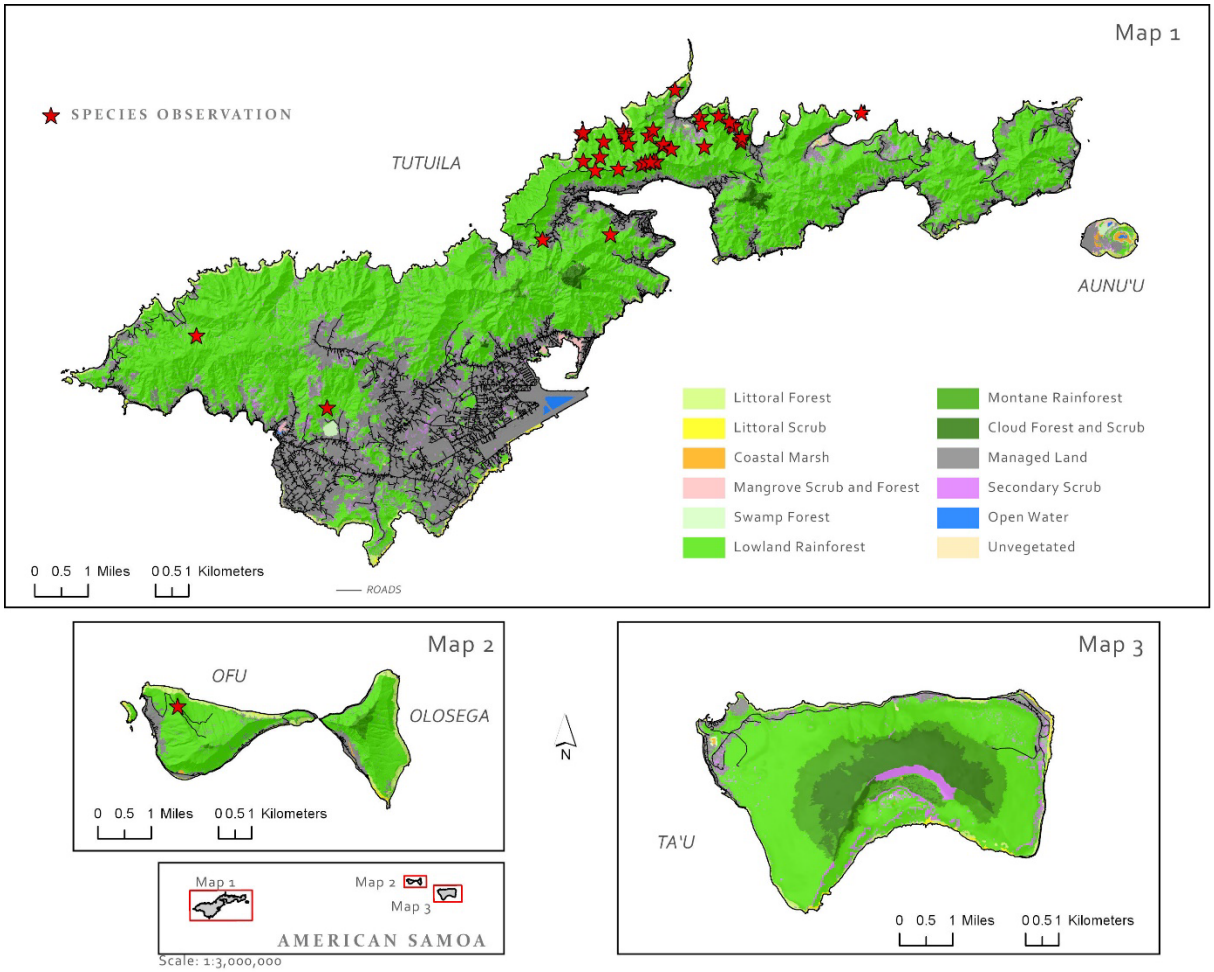

Figure 1. Map of *Eua zebrina* observations and vegetation on American Sāmoa. Data by Meyer et al. (2017).

Eua zebrina currently is known to occur solely on the islands of Tutuila and Ofu in American Sāmoa. In 1998 (Cowie and Cook 1999, entire) on Tutuila, American Sāmoa, *Eua zebrina* was seen alive on vegetation at 80 of 186 sites (timed, untimed, and incidental sites) visited. *Eua zebrina* was seen alive for the first time (Cowie and Cook 1999, pp. 13, 22; Cowie 2001, p. 215) on Ofu on vegetation at 1 of 20 sites (timed, untimed, and incidental sites) visited. No *E. zebrina* have ever been recorded from Olosega or Ta‘ū. During this 1998 survey, 1,102 live *E. zebrina* were recorded on Tutuila, and 88 live *E. zebrina* were recorded on Ofu (Cowie and Cook 1999, p. 30).

The uneven distribution of 1,102 snails at 186 locations (sites and incidental sites) on Tutuila, and the low number of occupied sites (two of nine previously occupied sites, 22.2 percent; Miller 1993, pp. 11–13; and 80 of 186 surveyed sites, 43.0 percent; Cowie and Cook 1999, pp. 13, 22) suggests an overall decline in distribution and abundance:

- 728 snails (66.1 percent of all observed snails) were in five locations (2.7 percent of all sites; 6.2 percent of all occupied sites): one incidental site (Vatia powerline trail; Cowie and Cook 1999, p. 99), and three timed sites plus one incidental site all in one area (Amalau Valley at about 26 to 138 ft [8 to 42 m] elevation; Cowie and Cook 1999, pp. 61, 99);

- 228 snails (20.7 percent of all observed snails) were distributed over nine sites (4.8 percent of all sites; 11.3 percent of all occupied sites): seven timed sites on five ridges, and two incidental sites on two ridges (236 to 1,490 ft [72 m to 454 m] elevation; Cowie and Cook 1999, pp. 61, 99);

- The remaining 146 (13.2 percent) observed snails were in 66 sites (35.5 percent of all sites; 82.5 percent of all occupied sites): 13 timed and 9 not-timed sites, plus 44 incidental sites, with fewer than 10 snails recorded at each site (Cowie and Cook 1999, pp. 61, 99).

On Tutuila, the sites with the highest numbers of *Eua zebrina* (except one site, Amalau) are concentrated in the central area of the National Park of American Sāmoa: Toa Ridge, Faiga Ridge, and eastward along Alava Ridge to the Vatia powerline trail (Cowie and Cook 1999, p. 30).

We are unaware of any systematic surveys conducted for *Eua zebrina* since 1998 (Table 1); however, *E. zebrina* are still periodically observed by American Samoan field biologists (Miles 2016, in litt., entire).

Table 1. Known populations of *Eua zebrina* from listing to this 5-year review.

Date	Populations	Individuals	Recovery Criteria[1]
2016 listing	2	1,102 (based on 1998 surveys)	N/A
2020 species report	2	unknown	N/A
2021 5-year review	2	unknown	N/A

[1]N/A=not available; the recovery plan and species-specific recovery criteria is currently under development and is expected to publish in 2021.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Partulids can have a single preferred host plant or multiple host plants, in addition to having preference toward anatomical parts of the plant (i.e., leaves, branch, or trunk). Habitat partitioning may occur among three partulids on Tutuila (Murray et al. 1982, pp. 317–318). *Eua zebrina* is commonly found on leaves, but is also be found on trunks and branches, as well as on the ground in the leaf litter (Cowie 1992, p. 175). A survey conducted by Miller (1993, p. 6) found all live snails on understory vegetation beneath an intact forest canopy.

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

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

Habitat Destruction and Modification by Agriculture and Development – Several thousand years of subsistence agriculture and more recent plantation agriculture has resulted in the alteration and reduction in forest area on lower elevation arable land throughout American Sāmoa (Whistler 1994, p. 40; Mueller-Dombois and Fosberg 1998, p. 361). Fifty-five percent of the island of Tutuila has slopes of less than 45 percent where land-clearing for agriculture or development is feasible (ASCC 2010, p. 13; DMWR 2006, entire). Currently, agriculture and urban development covers approximately 23 percent of Tutuila and three to four percent of the Manuʻa Islands of American Sāmoa (Ofu, Olosega, and Taʻu) (ASCC 2010, p. 13).

Farmers are increasingly encroaching on steep forested areas, and agriculture on Tutuila has spread from low elevation plots to plots in middle and high elevation areas (ASCC 2010, p. 13). Agricultural area on Tutuila has expanded by 59 percent from 1,675 to 2,664 acres (ac) (678 to 1,078 hectares [ha]) since 1970, but decreased by 68 percent from 507 to 161 ac (205 to 65 ha) on the Manuʻa Islands (Ofu, Olosega, and Taʻu) (Pereira, 1981 p. 68; MNRE, 2014). This loss of forest area likely reduces habitat resilience, and may directly contribute to the decline of *Eua zebrina* through the loss of populations of native snails. An increase in housing is also projected to occur in some rural forests along the northern coastline of Tutuila, and in a few scattered areas near existing population bases with established roads (Stein et al. 2014, p. 24). These areas are outside of known snail locations within National Park of American Sāmoa, but they do include forested habitat where snails may occur.

The development and maintenance of roads and utility corridors, and to a lesser extent, trails has caused habitat destruction and modification in or adjacent to populations of *Eua zebrina* on Tutuila (Cowie and Cook 1999, pp. 3, 30). Development and agriculture on Tutuila is increasing. The population and agricultural land area on this island has increased by approximately 118 percent (Table 2) and 59 percent (Pereira, 1981 p. 68), respectively, since 1970. Along the Alava Ridge road overlooking the western end of Pago Pago Harbor, and in the areas surrounding the Amalau inholding on the north central coast within National Park of American Sāmoa these factors pose a threat to populations of *Eua zebrina* (Whistler 1994, p. 41; Cowie and Cook 1999, pp. 48–49). The Amalau Valley area holds four of the five largest populations of *Eua zebrina* representing 57.6 percent of all known individuals. In addition, construction activities, regular vehicular and foot trail access, and road maintenance activities cause erosion and the increased spread of nonnative plants, resulting in further destruction or modification of habitat (Cowie and Cook 1999, pp. 3, 47–48).

Table 2. Census estimates of the American Sāmoa population on the islands of Tutuila, Ta'ū, Ofu, Olosega, and Swains.

Year	American Sāmoa	Island				
		Tutuila	Ta'ū	Ofu	Olosega	Swains Island
1920[1]	8,056	6,185	1,155	361	355	-
1930[1,2]	10,055	7,809	1,243	466	438	99
1940[1,2]	12,908	10,164	1,588	500	509	147
1950[1,2]	18,937	15,954	1,698	576	545	164
1960[2]	20,051	17,250	1,661	605	429	106
1970[3]	27,159	24,973	1,320	412	380	74
1980[3]	47,283	45,524	1,138	345	249	27
1990[4]	46,773	45,043	1,136	353	225	16
2000[5]	57,291	55,876	873	289	216	37
2010[5]	55,519	54,359	790	176	177	17

[1]Unkown (1956) , [2] Levin and Wright (1974), [3] U. S. Census Bureau (1982), [4] U. S. Census Bureau (1992), [5] U. S. Census Bureau (2010)

Available information for the Manua Islands (Olosega, Ofu and Ta'ū) does not indicate that agriculture and development are a current threat to the single known population of *Eua zebrina*. The population and agricultural land area on these islands has declined by approximately 45 percent (Table 2) and 68 percent (Pereira, 1981 p. 68), respectively, since 1970.

Land conversion to agriculture on steeper topography at elevations above the coastal plain will accelerate if the human population continues to grow, or if changes in the economy shift toward commercial agriculture (DMWR 2006, p. 71). This is especially true for Tutuila.

Habitat Destruction or Modification by Feral Pigs – Erosion resulting from rooting and trampling by feral pigs (*Sus scrofa*) impacts native plant communities by contributing to watershed degradation, alteration of plant nutrient status, and increasing the likelihood of landslides (Vitousek et al. 2009, pp. 3074–3086; Chan-Halbrendt et al. 2010, p. 251; Kessler 2011, pp. 320–324). In the Hawaiian Islands, feral pigs have been described as the most pervasive and disruptive nonnative influence on the unique native forests and are widely recognized as one of the greatest current threats to Hawai'i's forest ecosystems (Aplet et al. 1991, p. 56; Anderson and Stone 1993, p. 195).

Feral pigs have been present in American Sāmoa since human settlement (American Sāmoa Historic Preservation Office 2015, in litt., entire). In the past, hunting pressure kept their numbers down, however, increasing urbanization and increasing availability of material goods has resulted in the decline in the practice of pig hunting to almost nothing (Whistler 1992, p. 21; Whistler 1994, p. 41). Feral pigs are moderately common to abundant in many forested areas, where they spread invasive plants, damage understory vegetation, and destroy riparian areas by their feeding and wallowing behavior (DMWR 2006, p. 23; ASCC 2010, p. 15). Feral pigs are a serious problem in the National Park of American Sāmoa

because of the damage they cause to native vegetation through their rooting and wallowing (Whistler 1992, p. 21; 1994, p. 41; Hoshide 1996, p. 2; Cowie and Cook 1999, p. 48; Togia pers. comm. in Loope et al. 2013, p. 321). Feral pig densities have been reduced in some areas (Togia 2015, in litt., entire), but without control methods that effectively reduce feral pig populations, they are likely to persist and remain high in areas that provide habitat for *E. zebrina* (Hess et al. 2006, p. 53; ASCC 2010, p. 15). Based on the reliance of *E. zebrina* on understory vegetation under native forest canopy, as well as the snail's potential to feed on the ground in the leaf litter, the actions by feral pigs of rooting, wallowing, and trampling, and the associated impacts to native vegetation and soil, negatively affect the habitat of *E. zebrina* and are a current threat to the species.

Habitat Destruction and Modification by Nonnative Plant Species – Nonnative plant species can adversely modify native habitat and render it unsuitable for native snail species (Hadfield 1986, p. 325). Although some Hawaiian tree snails have been recorded on nonnative vegetation, it is more generally the case that native snails throughout the Pacific are specialized to survive only on the native plants with which they have evolved (Cowie 2001, p. 219). Cowie (2001, p. 219) reported few observations of native snails, including *Eua zebrina*, in disturbed habitats on Tutuila.

Although the island of Tutuila contain many areas that are relatively free of human disturbance and nonnative plant invasion and largely represent pre-contact vegetation, the threat of invasion and further spread by nonnative plant species is of concern (Space and Flynn 2000, pp. 23–24; Craig 2009, pp. 94, 96– 98; Atkinson and Medeiros 2006, p. 17; ASCC 2010, pp. 15, 20). Of the approximately 20 or more nonnative pest plant species in American Sāmoa, at least 11 have altered or may alter the habitat of *Eua zebrina* and include: *Adenanthera pavonina* (lopa, red bean tree, coral bean tree), *Castilla elastica* (pulu mamoe, Mexican rubber tree), *Cinnamomum verum* (tinamoni, cinnamon), *Clidemia hirta* (Koster's curse), *Falcataria moluccana* (tamaligi, albizia), *Funtumia elastica* (pulu vao, African rubber tree), *Leucaena leucocephala* (fua pepe, lusina, wild tamarind,), *Merremia peltata* (fue lautetele, merremia), *Mikania micrantha* (fue saina, mile-a-minute vine), *Psidium cattleianum* (kuava, strawberry guava), and *Spathodea campanulata* (faapasi, African tulip).

- Nonnative plants can degrade or destroy native habitat in Pacific island environments by: (1) modifying light availability by altering canopy structure; (2) altering soil-water regimes; (3) modifying nutrient cycling; (4) converting native-dominated plant communities to nonnative plant communities; and (5) increasing the frequency of landslides and erosion (Smith et al. 1985, pp. 217–218; Cuddihy and Stone 1990, p. 74; Matson 1990, p. 245; D'Antonio and Vitousek 1992, p. 73; Vitousek et al. 1997, pp. 6– 9; Atkinson and Medeiros 2006, p. 16). Nonnative plant species often exploit disturbance caused by other factors such as tropical cyclones, agriculture, development, and feral ungulates. In combination, these

disturbances reinforce or exacerbate their negative impacts to native habitats.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:
In American Sāmoa, thousands of partulid tree snail shells (mostly *Eua zebrina*) have been collected and used for decorative purposes (e.g., chandeliers) (Cowie 1993, pp. 1, 9). In general, the collection of tree snails persists to this day, and the market for rare tree snails serves as an incentive to collect them. Based on the history of collection of *E. zebrina*, the evidence of its sale on the Internet, and the vulnerability of the small remaining populations of this species, we consider over-collection for commercial and recreational purposes to be a threat to the continued existence of *E. zebrina*.

2.3.2.3 Disease or predation:
There are currently no known threats to *Eua zebrina* that are attributable to disease.

Predation by Nonnative Snails – At present, the primary threat to long-term survival of the native snail fauna in American Sāmoa is predation by the nonnative rosy wolf-snail, the most commonly recommended biological control agent of the giant African snail (*Achatina fulica*), which also is invasive in American Sāmoa. Numerous studies show that the rosy wolf-snail feeds on endemic island snails and is a causal factor in their decline and extinction (Hadfield and Mountain 1980, p. 357; Howarth 1983, p. 240; Howarth 1985, p. 161; Howarth 1991, p. 489; Clarke et al. 1984, pp. 101–103; Hadfield et al. 1993, pp. 327, 616–620; Murray et al. 1982 pp. 150–153; Cowie 2001, p. 219).

In 1980, the rosy wolf-snail was released on Tutuila to control the giant African snail (Lai and Nakahara 1980 as cited in Miller (1993, p. 9). By 1984, the rosy wolf-snail was considered to be well established and widely spread dispersed at all elevations on Tutuila (Eldredge 1988, pp. 122, 124–125). In 2001 the rosy wolf-snail was reported as widespread within the National Park of American Sāmoa on Tutuila (Cowie and Cook 2001, pp. 156–157). Live individuals have been observed within meters of partulids on Tutuila, including *Eua zebrina* and *Samoana conica* (Miller 1993, p. 10). Shells of *E. zebrina* and *S. conica* were found on the ground at several of the locations surveyed on Tutuila, along with numerous shells and an occasional live rosy wolf-snails (Miller 1993, pp. 13, 23–28). While there are no records of introduction of the rosy wolf-snail to the Manuʻa Islands (Ofu, Olosega, and Taʻū), this species has been reported on Taʻū (Miller 1993, p. 10).

Predation by several other nonnative carnivorous snails, *Gonaxis kibweziensis*, *Streptostele musaecola*, and *Gulella bicolor*, also are a threat to *Eua zebrina* and other native land snails. Several *Gonaxis* spp. also were widely introduced in the Pacific in attempts to control the giant African snail. These species have been implicated in contributing to the decline of native snail species in the region (Cowie and Cook 1999, p. 46). *Gonaxis kibweziensis* was introduced on Tutuila in

American Sāmoa in 1977 (Eldredge 1988, p. 122). This species may be restricted to Tutuila (Miller 1993, p. 9, Cowie and Cook 1999, p. 36), and based on dead shells observed on the ground, is not as common as the rosy wolf-snail (Miller 1993, p. 11).

Two predatory snails have been recorded in American Sāmoa: *Streptostele musaecola* (0.34 in [8.7 mm] long by 0.11 in [2.7 mm] wide) on Tutuila, Taʻū, and Ofu, and *Gulella bicolor* (0.24 [6 mm] long by 0.07 [1.8 mm] wide) on Ofu (Cowie and Cook 1999, pp. 36–37). The potential impacts of these two species on the native fauna are unknown; both are much smaller than the rosy wolf-snail (3 in [76 mm] long by 1.1 [28 mm] wide) and *Gonaxis kibweziensis* (0.79 in [20 mm] long by 0.47 [12 mm] wide), and were rarely observed during surveys (Cowie and Cook 1999, pp. 36–37, 46). However, Solem (1975 as cited in Miller 1993, p. 16) speculated that *S. musaecola* might have a role in the further decline of native species.

Predation by the New Guinea Flatworm – Predation by the nonnative New Guinea flatworm is a threat to *Eua zebrina*. The extinction of native land snails on several Pacific Islands has been attributed to this terrestrial flatworm, native to western New Guinea (Ohbayashi et al. 2007, p. 483; Sugiura 2010, p. 1499). In the 1990s, it was released in Sāmoa in an unsanctioned effort to control the giant African snail (Cowie and Cook 1999, p. 47).

Although mostly ground-dwelling, the New Guinea flatworm has also been observed climbing trees to feed on partulid tree snails (Hopper and Smith 1992, p. 82). It has contributed to the decline of native tree snails due to its ability to ascend into trees and bushes (Sugiura and Yamaura 2010, p. 741). Areas with flatworms usually lack partulid tree snails or have declining numbers of snails (Hopper and Smith 1992, p. 82). Because *Eua zebrina* feeds on the ground as well as in shrubs and trees, it faces increased risk of predation by the New Guinea flatworm (Cooke 1928, p. 6).

Predation by Rats – Rats are known to prey upon arboreal snails endemic to the Pacific islands, and they can devastate native snail populations (Hadfield et al. 1993, p. 621). Rat predation on tree snails has been observed on the Hawaiian Islands of Lānaʻi (Hobdy 1993, p. 208; Hadfield and Saufler 2009, in litt, p. 4), Molokaʻi (Hadfield and Saufler 2009, p. 1595), Oʻahu (Hadfield et al., 1993, p. 616) and Maui (Hadfield 2006, in litt., entire). Three species of rats are present in American Sāmoa: The Polynesian rat (*Rattus exulans*), probably introduced by early Polynesian colonizers, and Norway (*Rattus norvegicus*) and black (*Rattus. rattus*) rats, both introduced subsequent to western contact (Atkinson 1985, p. 38; Cowie and Cook 1999, p. 47; DMWR 2006, p. 22). Polynesian and Norway rats are abundant in American Sāmoa, but insufficient data exist on the populations of black rats (DMWR 2006, p. 22).

Frequent evidence of predation by rats on *Eua zebrina* was observed at several

locations on Tutuila (Miller 1993, pp. 13, 16). Shells of *E. zebrina* were damaged in a fashion that is typical of rat predation; the shell is missing a large piece of the body whorl or the apex (Miller 1993, p. 13). Frequent evidence of rat predation was also observed on *E. zebrina*, and other native land snails, during subsequent surveys (Cowie and Cook 1999, p. 47).

2.3.2.4 Inadequacy of existing regulatory mechanisms:

No existing Federal laws, treaties, or regulations specify protection of *Eua zebrina* habitat from the threat of deforestation, or address the threat of predation by nonnative species such as rats, the rosy wolf-snail, and the New Guinea flatworm.

Existing Territorial laws and regulatory mechanisms have the potential to offer some level of protection for *Eua zebrina* and its habitat but are not currently implemented in a manner that would do so (Table 3). The Department of Marine and Wildlife Resources (DMWR) has not exercised its statutory authority to address threats to *E. zebrina* such as predation by nonnative predators, and the species is not listed pursuant to the Territorial Endangered Species Act.

The Coastal Management Act and its implementing regulations have the potential to address the threat of habitat loss to deforestation more substantively, but in practice do not appear to do so. Based on the best available information, some existing regulatory mechanisms have the potential to offer some protection of *Eua zebrina* and its habitat, but their implementation does not reduce or remove threats to the species such as habitat destruction or modification or predation by nonnative species. For these reasons, existing regulatory mechanisms do not address the threats to *E. zebrina*.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Tropical Cyclones (Hurricanes) – Tropical cyclones are a common natural disturbance in the tropical Pacific and have impacted American Sāmoa with varying frequency and intensity. Hurricanes adversely affect *Eua zebrina* habitat by destroying vegetation, opening the canopy, and modifying light intensity and moisture, leading to the formation of disturbed areas that are open to invasion by nonnative plant species (Elmqvist et al. 1994, p. 387; Asner and Goldstein 1997, p. 148; Harrington et al. 1997, pp. 539–540; Lugo 2008, pp. 373–375, 386). Surveys conducted after three tropical cyclones in 1987, 1990, and 1991 failed to document any snails in areas bordering agricultural plots or in forested areas that were severely damaged (Miller 1993, p. 16). These cyclone-mediated changes destroy or modify habitat elements (e.g., stem, branch, and leaf surfaces, undisturbed ground, leaf litter) that are essential in sustaining the snails' life-history. In addition, high winds and intense rains from tropical cyclones can also dislodge individual snails from leaves and branches of host plants and deposit them on the forest floor where they may be crushed by falling vegetation or

exposed to predation by nonnative rats and snails (Hadfield 2011, pers. comm.).

Low Numbers of Individuals and Populations – Species that have experienced a decline in numbers and range reduction are inherently vulnerable to extinction from loss of habitat, predation, and localized catastrophes such as severe storms, diseases, climate change, or demographic stochasticity (Gilpin and Soule 1986, pp. 24–34; Pimm et al. 1988, p. 757; Mangel and Tier 1994, p. 607). Conditions leading to this level of vulnerability are easily reached by island species, such as *Eua zebrina*, that are in small isolated populations. Small, isolated populations can exhibit reduced levels of genetic variability, which can further diminish the species' capacity to adapt to environmental changes, thereby increasing the risk of inbreeding depression and reducing the probability of long-term persistence (Shaffer 1981,p. 131; Gilpin and Soule 1986, pp. 24–34; Pimm et al. 1988, p. 757). For *Eua zebrina*, 82.5 percent of all occupied sites had fewer than 10 snails (mean occurrence = 2.2 snails per site; median = 2.0 snails; mode = 1 snail). The threat of small population size could seriously jeopardize the continued existence of *Eua zebrina*.

Effects of Climate Change – There are no climate change studies that directly address impacts to the specific habitats of *Eua zebrina*. The scientific assessment completed by the Pacific Science Climate Science Program (Australian Bureau of Meteorology and Commonwealth Scientific and Industrial and Research Organization 2011, Vol. 1 and Vol. 2) provides general projections or trends for predicted changes in climate and associated changes in ambient temperature, precipitation, hurricanes, and sea level rise for countries in the western tropical Pacific region including Sāmoa (used as a proxy for American Sāmoa).

Although there is no specific information on the impacts of the effects of climate change to *Eua zebrina*, increased ambient temperature and precipitation and increased severity of hurricanes will exacerbate threats to this species, as well as provide additional stresses on its habitat. The probability of extinction are increased by climate-change impacts (Intergovernmental Panel on Climate Change 2007, p. 48), especially given the restricted range of *E. zebrina*, and the small number of populations.

Table 3. Status of threats to *Eua zebrina* and ongoing conservation efforts.

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Deforestation - agricultural/urban development	A	Ongoing	None
Invasive plants	A	Ongoing	None
Pigs	A	Ongoing	None
Collection	B	Ongoing	None

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Rat predation	C	Ongoing	None
Nonnative invertebrate predation	C	Ongoing	None
Inadequate existing regulatory mechanisms	D	Ongoing	Partial; Existing Territorial laws and regulatory mechanisms have the potential to offer some level of protection for *Eua zebrina* and its habitat but are not currently implemented in a manner that would do so.
Cyclone impacts	E	Ongoing	None
Low population size	E	Ongoing	None
Loss of genetic diversity	E	Ongoing	None

2.4 Synthesis

The snail *Eua zebrina* is an endangered endemic species found only on the islands of Tutuila and Ofu in American Sāmoa. *Eua zebrina* was considered widespread and common until 1975. The species is known to occur on the trunks, branches, and leaves of trees and has also been found on the ground in leaf litter (Cowie 1992, p. 175). Miller (1993, p. 6) found all live snails on understory vegetation beneath an intact forest canopy.

The following summarizes the threats of *Eua zebrina*. *Eua zebrina* is likely to be affected by loss of forest habitat, overcollection for commercial purposes, predation by nonnative snails, flatworms, and rats, and the vulnerability of its small, isolated populations to chance demographic and environmental occurrences. Climate change effects as another source of risk to the species because increased ambient temperature and storm severity resulting from climate change are likely to exacerbate other direct threats to *E. zebrina* in American Sāmoa, and in particular place additional stress on its habitat; these effects of climate change are projected to increase in the future. Multiple stressors acting in combination have greater potential to affect *E. zebrina* than each factor alone. For example, projected warmer temperatures may enhance reproduction in nonnative predatory snails and flatworms or the spread of nonnative invasive plants. The combined effects of environmental, demographic, and catastrophic-event stressors, especially on small populations, can lead to a decline that is unrecoverable and results in extinction (Brook et al. 2008, pp. 457–458). The impacts of any one of the stressors described above might be sustained by a species with larger, more resilient populations, but in combination, habitat loss, predation, small-population risks, and climate change have the potential to rapidly

affect the size, growth rate, and genetic integrity of a species like *E. zebrina* that persists as small, disjunct populations. Thus, the synergy among factors may result in greater impacts to the species than any one stressor by itself. Given the extent of threats, declining numbers of individuals and populations, and lack of management of these threats, this species best fits the definition of endangered. A draft recovery plan is expected to be completed in 2021.

3.0 RESULTS

3.1 Recommended Classification:

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist** (Indicate reasons for delisting per 50 CFR 424.11):
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X__ **No change is needed**

3.2 New Recovery Priority Number:

No change

Brief Rationale:

3.3 Listing and Reclassification Priority Number:

No change

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

Brief Rationale:

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Finalize the Draft Recovery Plan for Five Species from American Sāmoa
- Identify and survey extant populations of *Eua zebrina* and the habitats in which they occur to assess current distribution, abundance, and habitat use.
- Survey historically occupied areas for any persisting populations.
- Develop fine-scale climate models for *Eua zebrina* to identify future suitable habitat based on existing and historical ranges and to determine potential future climate conditions.
- Identify and prioritize areas necessary for habitat protection and restoration.
- Ensure long-term protection of management units.
- Monitor management and use results to adapt management actions.

- Develop and implement control programs for rats, updating methods as new technology becomes available.
- Develop and implement control programs for nonnative invertebrates (e.g., rosy wolf-snail, New Guinea flatworm), updating methods as new technology becomes available.
- Control other threats to specific species as appropriate.
- Monitor management and use results to adapt management actions.
- Expand the distribution of existing wild populations and establish additional populations.
- Utilize regulations and policy to support species recovery

5.0 REFERENCES

Anderson, S.J. and C.P. Stone. 1993. Snaring to control feral pigs *Sus scrofa* in a remote Hawaiian rain forest. Biological Conservation, 63, Pp. 195–201.

[ASCC] American Samoa Community College Forestry Program. 2010. American Samoa Forestry Assessment and Resource Strategy. Technical Report. Pago Pago, American Samoa: American Samoa Community College.

Aplet, G., S. Anderson, and C. Stone. 1991. Association between feral pig disturbance and the composition of some alien plant assemblages in Hawaii Volcanoes National Park. Vegetatio. 95. Pp. 55–62.

Asner, G.P. and G. Goldstein. 1997. Correlating Stem Biomechanical Properties of Hawaiian Canopy Trees with Hurricane Wind Damage. Biotropica 29 (2): 145–50.

Atkinson, I.A.E. 1985. The spread of commensal species of Rattus to oceanic islands and their effects on island avifaunas. Pp 35–81. In Moors, P.J. (ed.), Conservation of island birds. Tech. Publ. No. 3, Int. Coun. Bird Preserv., Cambridge, England.

Atkinson, C.T. and A.C. Medeiros. 2006. Trip Report: Pilot Studies of Factors Linking Watershed Function and Coastal Ecosystem Health in American Samoa. USGS Numbered Series 2006–1383. Open-File Report. U.S. Geological Survey.

Australian Bureau of Meteorology and Commonwealth Scientific and Industrial Research Organization. 2011. Climate Change in the Pacific: Scientific assessment and new research. Volume 2: Country Reports. Chapter 12. Samoa.

Brook, B.W., N.S. Sodhi, and C.J.A. Bradshaw. 2008. Synergies among Extinction Drivers under Global Change. Trends in Ecology & Evolution 23 (8): 453–60. DOI: https://doi.org/10.1016/j.tree.2008.03.011.

Chan-Halbrendt, C., T. Lin, F. Yang, and G. Sisior. 2010. Hawaiian residents' preferences for Miconia control program attributes using conjoint choice experiment and latent class analysis. Environmental Management 45: 250–260.

Clarke, B., J. Murray, and M.S. Johnson. 1984. The Extinction of Endemic Species by a Program of Biological Control, April.

Cooke, C.M. 1928. Food Habits of Partula Zebrina Gould. Bull. B. P. Bishop Museum, no. 47: 5–12.

Cowie, R.H. 1992. Evolution and extinction of Partulidae, endemic Pacific island land snails. Philosophical Transactions: Biological Sciences 335:167–191.

Cowie, R.H. 1993. Why Tree Snails Are Becoming Scarce in Samoa. Hawaiian Shell News 41 (3): 1–9.

Cowie, R.H. 2001. Decline and homogenization of Pacific faunas: the land snails of American Samoa. Biological Conservation 99:207–222.

Cowie, R.H. and R.P. Cook. 1999. The Distribution and Abundance of Land Snails in the National Park of American Samoa, with Particular Focus on Partulidae. Report. Cooperative National Parks Resources Studies Unit, University of Hawaii at Manoa, Department of Botany.

Cowie, R.H. and R.P. Cook. 2001. Extinction or Survival: Partulid Tree Snails in American Samoa. Biodiversity & Conservation 10 (2): 143–59.

Cowie, R., R. Rundell, and N. Yeung. 2017. Samoan Land Snails and Slugs - An Identification Guide. Null edition. Pago Pago, American Samoa: lulu.com.

Craig, P, ed. 2009. Natrual History Guide to American Samoa. 3rd ed. National Park Service.

Crampton, H.E. 1925a. Studies on the Variation, Distribution, and Evolution of the Genus Partula. Vol. no. 228A. Washington: Carnegie Institution.

Crampton, H.E. 1925b. Contemporaneous Organic Differentiation in the Species of Partula Living in Moorea, Society Islands. The American Naturalist 59 (660): 5–35.

Crampton, H.E. 1932. Studies on the Variation, Distribution, and Evolution of the Genus *Partula*. Vol. no. 410. Washington: Carnegie Institution.

Cuddihy, L.W. and C.P. Stone. 1990. Alteration of Native Hawaiian Vegetation: Effects of Humans, Their Activities and Introductions. 1st Edition. edition. Honolulu, Hawaii: Univ of Hawaii Pr.

D'Antonio, C.M. and P.M. Vitousek. 1992. Biological Invasions by Exotic Grasses, the Grass/Fire Cycle, and Global Change. Annual Review of Ecology and Systematics 23 (1): 63–87.

[DMWR] Department of Marine and Wildlife Resources. 2006. A Comprehensive Strategy for Wildlife Conservation in American Samoa. Technical Report. Pago Pago, American Samoa.

Eldredge, L.G. 1988. Case Studies of the Impacts of Introduced Animal Species on Renewable Resources in the U.S.-Affiliated Pacific Islands. In Topic Reviews in Insular Resource Development and Management in the Pacific U.S.- Affiliated Islands, edited by B.D. Smith, 88. Guam: Univ. Guam Marine Lab.

Elmqvist, T., W.E. Rainey, E.D. Pierson, and P.A. Cox. 1994. Effects of Tropical Cyclones Ofa and Val on the Structure of a Samoan Lowland Rain Forest. Biotropica 26 (4): 384–391.

Gilpin, M. and M.E. Soule. 1986. Chapter 2: Minimum Viable Populations. In Conservation Biology: The Science of Scarcity and Diversity, edited by Michael E. Soulé. Sinauer Associates.

Hadfield, M.G. 1986. Extinction in Hawaiian achatinelline snails: A Natural History of the Hawaiian Islands, Honolulu: University of Hawaii Press, 2021, pp. 320–334.

Hadfield, M.G., S.E. Miller, and A.H. Carwile. 1993. The Decimation of Endemic Hawaiian Tree Snails by Alien Predators. American Zoologist 33 (6): 610–22.

Hadfield, M.G. and B.S. Mountain. 1980. A Field Study of a Vanishing Species, Achatinella Mustelina (Gastropoda, Pulmonata), In the Waianae Mountains of Oahu, October.

Hadfield, M.G. and J.E. Saufler. 2009. The Demographics of Destruction: Isolated Populations of Arboreal Snails and Sustained Predation by Rats on the Island of Moloka'i 1982–2006. Biological Invasions 11 (7): 1595–1609.

Harrington, R.A., J.H. Fownes, P.G. Scowcroft, and C.S. Vann. 1997. Impact of Hurricane Iniki on Native Hawaiian Acacia Koa Forests: Damage and Two-Year Recovery. Journal of Tropical Ecology 13: 539–58.

Hess, S.C., J.J. Jeffrey, D.L. Ball, and L. Babich. 2006. Efficacy of feral pig removals at Hakalau Forest National Wildlife Refuge, Hawaii. Transactions of the Western Section of the Wildlife Society 42:53–67.

Hopper, D.R. and B.D. Smith. 1992. Status of Tree Snails (Gastropoda: Partulidae) on Guam,

with a Resurvey of Sites Studied by H. E. Campton in 1920, January.

Hoshide, H. 1996. Preliminary assessment of feral pig problem American Samoa. Report for the National Park of American Samoa and AS Environmental Protection Agency. Final Report March 29, 1996. 11 pp.

Howarth, F.G. 1983. Classical Biocontrol: Panacea or Pandora's Box. Proceedings, Hawaiian Entomological Society 24: 239–244.

Howarth, F.G. 1985. Impacts of Alien Land Arthropods and Mollusks on Native Plants and Animals in Hawaii. In Hawaii's Terrestrial Ecosystems: Preservation and Management., edited by C.P. Stone and J.M. Scott, 149–79. Honolulu, Hawaii: Cooperative National Park Research Studies Unit.

Howarth, F.G. 1991. Environmental Impacts of Classical Biological Control. Annual Review of Entomology 36 (1): 485–509. DOI: https://www.annualreviews.org/doi/abs/10.1146/annurev.en.36.010191.002413.

[IPCC] Intergovernmental Panel on Climate Change. 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 976 pp.

Johnson, M.S., J. Murray, and B. Clarke. 1986. Allozymic Similarities among Species of Partula on Moorea. Heredity 56 (3): 319–327.

Kessler, C.C. 2011. Invasive species removal and ecosystem recovery in the Mariana Islands; challenges and outcomes on Sarigan and Anatahan. In Island Invasives: Eradication and Management, Veitch, C.R., M.N. Clout, and D.R. Towns (eds.), IUCN, Gland. Pp. 320−324.

Lai, P. and L.M. Nakahara. 1980. Evaluation of the giant African snail control program in American Samoa. Unpublished. Hawaii Department of Agriculture 12p.

Levin, M. J. and P. A. Wright. 1974. Report on the 1974 Census of American Samoa: Part II. Honolulu, Hawaii: University of Hawaii at Manoa, East West Population Institute.

Loope, L.L., Hughes, R.F. and J-Y Meyer. 2013. Plant invasions in protected areas of tropical Pacific Islands, with special reference to Hawaii. Pp. 313–348 in L.C. Foxcroft et al. (eds.), Plant Invasions in Protected Areas: Patterns, Problems and Challenges, Invading Nature - Springer Series in Invasion Ecology 7. Springer Science+Business Media Dordrecht.

Lugo, A. E. 2008. Visible and Invisible Effects of Hurricanes on Forest Ecosystems: An

International Review. Austral Ecology 33 (4): 368–98.

Mangel, M. and C. Tier. 1994. Four Facts Every Conservation Biologists Should Know about Persistence. Ecology 75 (3): 607–14.

Matson, P. 1990. Plant-Soil Interactions in Primary Succession at Hawaii Volcanoes National Park. Oecologia 85 (2): 241–46.

Meyer, R., J. Seamon, S. Fa'aumu, and I. Lalogafuafua. 2017. Classification and Mapping of Wildlife Habitat in American Samoa: An Object-Based Approach Using High Resolution Orthoimagery and LIDAR Remote Sensing Data. Technical Report 1. American Samoa: Department of Marine and Wildlife Resources.

Miles, A. 2016. Species Maps, January 12, 2016.

Miller, S.E. 1993. Final Report on Surveys of the Arboreal and Terrestrial Snail Fauna of American Samoa. Honolulu, Hawaii: Pacific Biomedical Research Center. 30 pp.

Mueller-Dombois, D. and F.R. Fosberg. 1998. Western Polynesia. In: Vegetation of the Tropical Pacific Islands. Ecological Studies (Analysis and Synthesis). Springer, New York, NY.

Murray, J.., M.S. Johnson, and B. Clarke. 1982. Microhabitat Differences Among Genetically Similar Species of Partula. Evolution 36 (2): 316–25.

Ohbayashi, T., I. Okochi, H. Sato, T. Ono, and S. Chiba. 2007. Rapid Decline of Endemic Snails in the Ogasawara Islands, Western Pacific Ocean. Applied Entomology and Zoology 42 (3): 479–85. DOI: https://doi.org/10.1303/aez.2007.479.

[PCCSP] Pacific Climate Change Science Program. 2014. Current and future climate of Samoa. 8 pp.

Pereira, J.M. 1981. A coastal zone management atlas of American Samoa. 1981. Development Planning Office, American Samoa Government. Statistical Tables (p.68), Land use trends by planning district.

Pimm, S.L., H. L. Jones, and J. Diamond. 1988. On the Risk of Extinction. The American Naturalist 132 (6): 757–85.

Shaffer, M.L. 1981. Minimum Population Sizes for Species Conservation. BioScience 31 (2): 131–34. https://doi.org/10.2307/1308256.

Solem, A. 1975. Final report, Office of Endangered Species. Contract No. 14·16-0008·837.

Space, J.C. and T. Flynn. 2000. Observations on Invasive Plant Species in American Samoa. Invasive plant species survey: Technical Report. Pacific Islands Committee, Council of Western State Foresters.

Space, J.C. and T. Flynn. 2002. Report to the Government of Samoa on Invasive Plant Species of Environmental Concern. Pacific Invasive Learning Network. Technical Report. Honolulu, Hawaii: U.S.D.A. Forest Service, Pacific Southwest Research Station, Institute of Pacific Islands Forestry.

Stein, S.M., M.A. Carr, G.C. Liknes, and S.J. Comas. 2014. "Islands on the Edge: Housing Development and Other Threats to America's Pacific and Caribbean Island Forests: A Forests on the Edge Report." Gen. Tech. Rep. NRS-137. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 137: Pp. 1–55.

Sugiura, S. 2010. Prey Preference and Gregarious Attacks by the Invasive Flatworm Platydemus Manokwari. Biological Invasions 12 (6): 1499–1507.

Sugiura, S. and Y. Yamaura. 2010. Potential Impacts of the Invasive Flatworm Platydemus Manokwari on Arboreal Snails. In Restoring the Oceanic Island Ecosystem: Impact and Management of Invasive Alien Species in the Bonin Islands, edited by Kazuto Kawakami and Isamu Okochi, 45–50. Tokyo: Springer Japan. DOI: https://doi.org/10.1007/978-4-431-53859-2_7.

Unkown. 1956. Census of American Samoa: 1930–1956." Census. Pacific Web, Statistical Resource for Pacific Islands. DOI: http://pacificweb.org/categories/Statistical%20Activities/Census/AmericanSamoaCensus.html.

U.S. Census Bureau. 1982. Chapter A: Number of Inhabitants. Volume 1: Characteristics of the Population. 1980 Census of Population, Part 56: American Samoa. Census. U.S. Census Bureau, Economics and Statistical Administration, U.S. Department of Commerce. DOI: http://pacificweb.org/categories/Statistical%20Activities/Census/AmericanSamoaCensus.html.

U.S. Census Bureau. 1992. Social Economic, and Housing Characteristics: American Samoa. 1990 Census of Population and Housing. Census. U.S. Census Bureau, Economics and Statistical Administration, U.S. Department of Commerce. DOI: http://pacificweb.org/categories/Statistical%20Activities/Census/AmericanSamoaCensus.html.

U.S. Census Bureau. 2010. Census 2000 and 2010 for American Samoa [Data File]. 2010. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwjynsCqj8LjAhWmTN8KHTlxAmIQFjAAegQIBBAC&url=https%3A%2F%2Fwww.census.gov%2F2010census%2Fnews%2Fxls%2Fcb11cn177_as.xls&usg=AOvVaw28FqcLYgSuUELROmbr5BGH.

[USFWS] U.S. Fish and Wildlife Service. 2019. Amendment to the recovery plan for the Oahu tree snails of the genus *Achatinella*. August 7, 2019. 11 pp.

Vitousek, P.M., C.M. D'Antonio, L.L. Loope, M. Rejmánek, and R. Westbrooks. 1997. Introduced Species: A Significant Component of Human-Caused Global Change. N. Z. J. Ecol. 21 (1): 1–16.

Whistler, W.A. 1992. Botanical Inventory of the Proposed Ta'u Unit of the National Park of American Samoa. Report. Cooperative National Park Resources Studies Unit, University of Hawaii at Manoa, Department of Botany. DOI: http://scholarspace.manoa.hawaii.edu/handle/10125/7120.

Whistler, W.A. 1994. Botanical Inventory of the Proposed Tutuila and Ofu Units of the National Park of American Samoa. Report. Cooperative National Park Resources Studies Unit, University of Hawaii at Manoa, Department of Botany. DOI: http://scholarspace.manoa.hawaii.edu/handle/10125/7240.

In Litteris

American Samoa Historic Preservation Office. 2015. Cultural history of American Samoa. DOI: http://www.ashpo.org/index.php/history.html?tmpl=component&print=1&page=.

Hadfield, M.G. 2006. Memo regarding survey for *Newcombia cumingi*, October 20–22, 2006, 4 pp.

[MNRE] Ministry of Natural Resources & Environment. 2014. Table 1: Samoa Land Cover by Island 2014. DOI: http://www.sbs.gov.ws/index.php/new-document-library?view=download&fileId=1749.

Togia, T. 2015. Email from Tavita Togia, National Park of American Samoa terrestrial ecologist, to James Kwon, U.S. Fish and Wildlife Service, regarding nonnative plant and feral pig control, dated 24 APR 2015.

Personal Communication

Hadfield, M.G. 2011. Communication between Dr. Mike Hadfield to U.S. Fish and Wildlife Biologist Carrie Harrington providing information on threats to Hawaiian tree snails, February 7, 2011.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Eua zebrina*

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X_ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By:
James Breeden, Wildlife Biologist, PIFWO
John Vetter, Animal Recovery Coordinator, PIFWO
Megan Laut, Conservation and Restoration Team Manager, PIFWO

FIELD OFFICE APPROVAL:

for MEGAN LAUT Digitally signed by MEGAN LAUT Date: 2021.06.17 15:05:29 -10'00' _____ Date _____

Lead Field Supervisor, Fish and Wildlife Service