

5-YEAR REVIEW

Short Form Summary

Species Reviewed: O‘ahu Tree Snails (*Achatinella* spp.)

Current Classification: Endangered

FR Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2022. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews for 167 Species in Oregon, Washington, Idaho, Montana, California, Hawai‘i, Guam, and the Northern Mariana Islands. Federal Register 87(90):28031–28034.

Lead Region/Field Office: Region 1/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawai‘i

Name of Reviewer(s):

James Breeden, Fish and Wildlife Biologist, PIFWO

John Vetter, Animal Recovery Coordinator, PIFWO

Megan Laut, Recovery Team Manager, PIFWO

Methodology used to complete this 5-year review: This review was conducted by staff of the PIFWO of the U.S. Fish and Wildlife Service (USFWS), beginning in June 2024. The review was based on a review of current, available information since the last 5-year review for the O‘ahu tree snails (*Achatinella* spp.) (USFWS 2019, entire). The evaluation by James Breeden Fish and Wildlife Biologist, was reviewed by John Vetter, the Animal Recovery Coordinator, and Megan Laut, the Recovery Program Manager.

Background:

For information regarding the species’ listing history and other facts, please refer to the USFWS Environmental Conservation Online System database for threatened and endangered species at <http://ecos.fws.gov/ecp/species/304>).

Review Analysis:

Please refer to the Recovery Plan for O‘ahu Tree Snails of the Genus *Achatinella* (USFWS 1992, entire), Amendment to the Recovery Plan for the O‘ahu Tree Snails of the Genus *Achatinella* (USFWS 2019, entire) and the previous 5-year reviews for the O‘ahu tree snails published on 2011 and 2019 (available at <https://ecos.fws.gov/ecp/species/304>) for a complete review of the species’ status, threats, and management efforts. No new threats or no new information regarding the species biological status have come to light since listing to warrant a change in the Federal listing status of the O‘ahu tree snails as endangered.

The genus *Achatinella* is endemic to the island of O‘ahu in the Hawaiian Islands and is listed as endangered at the genus level. A total of 41 species have been documented from the Wai‘anae and Ko‘olau mountain ranges. Of the 41 documented *Achatinella* spp., 10 are known to exist: *A. bulimoides*, *A. byronii*, *A. concavospira*, *A. decipiens*, *A. fulgens*, *A. fuscobasis*, *A. lila*, *A. livida*, *A. mustelina*, and *A. sowerbyana* (Kitamura 2023, p. 2,

20). All species share common characteristics such as being arboreal, nocturnal, and grazing on fungus from the surface of leaves (USFWS 1992, p. 17).

Achatinella spp. shells are oblong to ovate and have a glossy surface. Both dextral and sinistral shell coiling occurs, although some species are restricted to one form or the other. The adult shell has 5 to 7 whorls, and the umbilicus is closed or has only a minute opening. The lip is simple in some species but becomes thickened at maturity in others. The columella bears a strong spiral lamella. Shells are often strikingly colored with spiral bands or streaks in the direction of the growth lines (Pilsbry and Cooke, 1912–1914, entire). Adult *Achatinella* spp. have relatively large shells, 17 to 24 millimeters (mm) (0.67 to 0.94 inches [in]) length. Young are live born, ranging from 3 to 4 mm (0.12 to 0.16 in) (Severns 1981 in USFWS 1992, p. 17). One to four young are born to a hermaphroditic adult each year, with reproductive maturity ranging from five to seven years old.

New status information:

- The genus *Achatinella* is part of an endemic sub family (Achatinellinae) that includes other genera (*Partulina*, *Perdicella*, and *Newcombia*). Genomics on the species in these genera are being conducted which may result in the reclassification of some or all of these species into the genus *Achatinella* (Norine Yeung, Bishop Museum, 2024, pers. comm.).

New threats:

- Social media (e.g., YouTube, Flickr, Facebook, Twitter, Instagram [Kaplan and Haenlin 2010, entire; Bergman et al. 2022, p. 361]) platforms are an increasing threat to *Achatinella* spp. throughout their range. The main threats from social media platforms include an increase in visitor pressure, exploitation, illegal trade, introduction of predators, damage to exclusion barriers, and damage to habitat (Bergman et al. 2022, p. 362–363; David Sischo, DLNR, 2024a, pers. comm.).
- There are currently seven (occupied) predator-free enclosures in the Wai‘anae mountains (DLNR 2024, p. 2) and 1 (unoccupied) enclosure in the Ko‘olau mountains (OARNP 2023, p. 135; Sischo 2024a, pers. comm.). Climate models predict that all *Achatinella* spp. are predicted to lose a minimum of 86 percent of their climate-suitable habitat and *A. bulimoides*, *A. concavospira*, *A. lila*, and *A. sowerbyana* are likely to lose all climate-suitable habitat on O‘ahu within the next 75 years (Kitamura 2023, p. 17). To protect three populations from each of the ten remaining *Achatinella* spp., a minimum of 14 predator free enclosures are needed on O‘ahu under current climate conditions (Kitamura 2023, p. 21). Models show that within the next 75 years up to 18 predator-free enclosures will be needed (Kitamura 2023, p. 21).
- Mortality spikes continue to impact the captive population, which primarily feed on surface biofilms from vegetation collected in the suitable habitat (DLNR 2024, p. 7). Although the cause remains unknown, a pathogen or parasite is suspected to be the cause (DLNR 2024, p. 3). Over the past three years mortality spikes have occurred in

late September and early October during the driest time of year (DLNR 2024, p. 3). This may indicate that something causing mortality may be accumulating on the leaves that is normally washed off by rain (DLNR 2024, p. 3). Protocols are being developed to identify disease agents and develop a screening protocol (DLNR 2024, p. 3). In addition, the snail diets are being analyzed to develop a completely manufactured diet that would negate the need for wild-collected leaves (DLNR 2024, p. 3).

- An invasion of yellow crazy ants (*Anoplolepis gracilipes*) was first detected in an *Achatinella mustelina* enclosure in 2017 (OARNP 2023 p. 138). The enclosure has an increase in tree snail empty shells numbers and a downward trend in individual tree snails (OARNP 2023 p. 138). The impacts of yellow crazy ants remains unclear and methods for controlling the ants in the forest setting is uncertain (OARNP 2023 p. vii).

New management actions:

The Hawai‘i Department of Land and Natural Resources (DLNR) Snail Extinction Prevention Program (SEPP) and the O‘ahu Army Natural Resources Program (OARNP) manage *Achatinella* spp. Management includes building and maintaining snail enclosures, predator control, monitoring, moving unprotected O‘ahu tree snails to enclosures, captive propagation, and moving captive bred O‘ahu tree snail to enclosures (OARNP 2023, p. xvi; DLNR 2024, p. 2). All captive propagation is conducted by SEPP.

- There are currently a total of 7 O‘ahu tree snail enclosures in the Wai‘anae mountain range, 6 enclosures are managed by OARNP and 1 is managed by SEPP (OARNP 2023, pp. xviii, 236). One unoccupied snail enclosure currently occurs in the Ko‘olau mountain range and plans are underway to move O‘ahu tree snails to that enclosure in the fall of 2024. In all, only *Achatinella mustelina* is known to occur outside of enclosures in the wild and *A. concavospira* and *A. mustelina* occur within enclosures (Table 1). SEPP continues to manage a captive collection of 10 *Achatinella* spp. to prevent extinction of these species (Table 2). SEPP reproduces captive snails, transfers wild snails to captivity and performs captive to wild conservation translocations (Table 2).

Table 1. Number (No.) of individual species known to occur in the wild and within enclosures (OARNP 2023, p. 135, Sischo 2024b, pers. comm.).

Species	No. Individuals in Wild (Enclosures)	No. Individuals in Wild (Enclosures)	No. Individuals in Wild (Enclosures)
	2011	2019	2024
<i>Achatinella abbreviata</i>	0	0	0
<i>Achatinella apexfulva</i>	0	0	0
<i>Achatinella bulimoides</i>	2 (0)	Unknown (0)	0
<i>Achatinella byronii</i> *	3 (0)	243 (0)*	Unknown (0)

<i>Achatinella concavospira</i>	47 (0)	Unknown (100)	Unknown (200)
<i>Achatinella decipiens</i>	7 (0)	243 (0)*	Unknown (0)
<i>Achatinella fulgens</i>	14 (0)	Unknown (0)	0
<i>Achatinella fuscobasis</i>	2 (0)	0	0
<i>Achatinella lila</i>	22 (0)	Unknown (200)	0
<i>Achatinella livida</i>	103 (0)	Unknown (0)	Unknown (0)
<i>Achatinella mustelina</i>	2752 (50)	3,608 (1,183)	2,078 (1,046)
<i>Achatinella pupukanioe</i>	0	0	0
<i>Achatinella sowerbyana</i>	21 (0)	5 (50)	Unknown (0)

*Data is combined for *A. byronii* and *A. decipiens* in 2019.

Table 2. The years in captivity, total number of individuals in captive propagation, and total number of *Achatinella* spp. transferred to enclosures from 2019–2023 (DLNR 2020, p. 10; DLNR 2021, p. 9; DLNR 2022, p. 10; DLNR 2023, p. 9; DLNR 2024 pp. 9–11). Genetic analysis is being conducted on the unidentified species, a portion of these are thought to be *Achatinella byronii* (Sischo 2024, pers. comm.)

Species	In Captivity	Total in Captive Propagation	Total Translocated from 2019–2023 (Facility to Enclosures)
<i>Achatinella bulimoides</i>	Yes (2005–present)	290	0
<i>Achatinella decipiens</i>	Yes (1990–present)	1,030	0
<i>Achatinella concavospira</i>	Yes (2018–present)	743	191
<i>Achatinella fulgens</i>	No (2006–present)	91	0
<i>Achatinella fuscobasis</i>	Yes (1991–present)	1,014	0
<i>Achatinella lila</i>	Yes (1997–present)	1,997	0
<i>Achatinella livida</i>	Yes (1997–present)	208	0
<i>Achatinella mustelina</i>	Yes (1989–present)	79	227
<i>Achatinella sowerbyana</i>	Yes (1993–present)	821	0
Unidentified	2024	37	0

- Throughout the Waiʻanae mountain range *Achatinella mustelina* is represented in 7 Evolutionary Significant Units (ESU) (OARNP 2023, p. xvii). Of these ESUs, only 2 have more than 300 *A. mustelina* individuals in the wild populations (OARNP 2023, p. xvii).

- Predator control consists of predator-proof fencing that includes a rat hood, metal angle barrier, cut-mesh barrier, copper electric wires, GoodNature A24 traps, Victor snap traps, Diphacinone-50 rodenticide, and quarterly sweeps for rosy wolf snails and Jackson's chameleon (Rohrer et al. 2016, p. 10; OANRP 2020, p. 196, OANRP 2021, p. 148 OANRP 2023, pp. 137,153, 237, 242).
- O'ahu tree snail enclosures are designed and constructed to keep predators such as the rosy wolf snail (*Euglandina* spp.), rodents (*Rattus* spp. and *Mus musculus*), and Jackson's chameleon (*Trioceros jacksonii xantholophus*) away from *Achatinella mustelina* populations, while allowing O'ahu tree snails to remain in suitable habitat (OANRP 2023, p. 236).
- In June of 2023 SEPP moved all snails to a new facility located on a state campus in Pearl City on O'ahu. The new building increased the capacity for rearing snails and conducting critical research (DLNR 2023, p. 4). The location is inside a gated and guarded state facility which provides more protection against vandalism and theft (DLNR 2023, p. 4; DLNR 2024, p. 4). In addition, the new location is higher in elevation, eliminating the threat of tsunamis and flooding during torrential rain (DLNR 2024, p. 4).
- SEPP is partnering with the Bishop Museum and the Honolulu Zoo to expand the captive program (DNLN 2024, p. 4). Both facilities have acquired environmental chambers and other necessary equipment to care for and reproduce rare snails and are modifying their spaces to receive snails (DNLN 2024, p. 4). Snails are expected to move between these facilities in 2024 (DNLN 2024, p. 4).
- Survival of captive newborn snails is higher when placed with large sub-adult and adult snails (DLNR 2022, p. 7). All juveniles are currently placed in enclosures with sub-adults or adults (DLNR 2022, p. 7). It's unclear why survival is higher, although it is likely sub-adults and adults either 1) inoculate newborns with beneficial bacteria or 2) lower the abundance of detrimental microorganisms by directly consuming them (DLNR 2022, p. 7).
- Captive O'ahu tree snails are dependent on the collection of wild leaves of native host plants for food (DLNR 2022, p. 5; DLNR 2024, p. 7). As the captive colony increases in density and expands to multiple locations, the demand for suitable native vegetation to support the captive collection is becoming problematic (DLNR 2022, p. 5; DLNR 2024, p. 7). Feeding trials are being conducted to develop a manufactured diet to reduce the demand on native vegetation (DLNR 2022, p. 5; DLNR 2024, p. 7) that will allow the captive program to expand to sites off of O'ahu if necessary. While a captive diet is being developed, part of their diets are being supplemented with a native tree fungus in the genus *Cladosporium*, isolated from snail host trees (DLNR 2024, p. 7).
- To better understand post-release movement of snails raised in captivity and released into the wild, SEPP has initiated a study to track released *Achatinella concavospira*

using weekly surveys and capture-mark recapture assessments with photo-recognition software (DLNR 2024, p. 11). Surveys are conducted weekly (DLNR 2024, p. 11). When observed snails are photographed and their locations are mapped (DLNR 2024, p. 11).

- Non-lethal tissue samples are collected from individuals to clarify taxonomic uncertainty and for phylogenetic studies (DLNR 2020, p. 5; DLNR 2021, p. 9; DLNR 2022, p. 10; DLNR 2023, p. 9; DLNR 2024, p. 10). Tissue samples are deposited at the Bishop Museum biobanking facility (DLNR 2024, p. 10). Taxonomic identity of the unknown snails are assigned when the results are complete (DLNR 2024, p. 10).
- The genus *Achatinella* was listed as federally endangered in 1981 and a recovery plan was finalized in 1992. A draft amendment to the recovery plan occurred in 2019 which updated the downlisting and delisting criteria (Table 3).

Table 3. Status and trends of *Achatinella* spp. from listing through current 5-year review.

Date	No. Adult Wild Individuals	Downlisting and Delisting Criteria Identified in Recovery Plan	Downlisting Criteria Completed?
1981 (listing)	Unknown	None established yet	N/A
1992 (recovery plan)	Unknown	No downlisting goal established but downlisting may be considered once all remaining populations have been located and stabilized.	No
2011 (5-year review)	See Table 1	No downlisting goal established but downlisting may be considered once all remaining populations have been located and stabilized.	No
2019 (5-year review)	See Table 1	At least 6 to 10 stable populations (possibly actively managed) are distributed across the known historical range of the species. Also, each ESU of the species (or each Geographic Unit [GU] if ESUs have not been identified) must be represented by one or more stable populations; thus any species for which more than six GUs or ESUs are identified will require more than six stable populations to represent every GU or ESU.	No
		To be considered stable, a population must number at least 300 individuals distributed across all size classes combined, and must have a population	No

		growth curve that is stable or positive for at least 4 of 5 sequential years.	
2024 (5-year review)	See Table 1	Downlisting: (1) At least 6 to 10 stable populations (possibly actively managed) are distributed across the known historical range of the species. Also, each ESU of the species (or each GU if ESUs have not been identified) must be represented by one or more stable populations; thus any species for which more than six GUs or ESUs are identified will require more than six stable populations to represent every GU or ESU. (2) To be considered stable, a population must number at least 300 individuals distributed across all size classes combined, and must have a population growth curve that is stable or positive for at least 4 of 5 sequential years.	No
		Delisting: (1) At least 12 to 20 populations are distributed across the known historical range of the species. Also, each ESU of the species (or each GU if ESUs have not been identified) must be represented by at least 2 populations; thus any species for which more than 6 GUs or ESUs are identified will require more than 12 populations to sufficiently represent every GU or ESU. (2) Each of these populations must have a population growth curve that is stable or positive for at least 7 of 10 sequential years, and have available habitat that is capable of supporting natural dispersal, expansion of the occupied range, and positive population growth. Any new populations that are established through natural dispersal from these populations should also maintain a positive growth trajectory for 4 of 5 sequential years. (3) At least 12 populations must number at least 300 individuals, distributed across all size classes combined.	No

Table 4. Threats to the genus *Achatinella* and ongoing conservation efforts.

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Habitat degradation, alteration, and destruction	A	Ongoing	ESA section 7 consultations and Partners programs assist to decrease loss and degradation of <i>Achatinella</i> forest habitat.
Collection	B	Ongoing	None
Predators	C	Increasing	Installation of predator-proof fences, improving predator control programs, survey and monitoring, and research.
Disease	C	Ongoing	Monitoring and implementing avian disease response plans when available.
Tropical cyclone intensity and frequency	E	Increasing	Research
Temperature and precipitation changes	E	Increasing	Research
Resiliency and redundancy to stochastic events	E	Ongoing	Captive rearing

Syntheses:

Downlisting and delisting objectives are provided in the Amendment to the Recovery Plan for the O‘ahu Tree Snails of the Genus *Achatinella* for *Achatinella* spp. (USFWS 2019, pp. 3–4). To be downlisted, at least 6 to 10 stable populations (possibly actively managed) are distributed across the known historical range of the species. Also, each ESU of the species (or each GU if ESUs have not been identified) must be represented by one or more stable populations; thus any species for which more than six GUs or ESUs are identified will require more than six stable populations to represent every GU or ESU. To be considered stable, a population must number at least 300 individuals distributed across all size classes combined and must have a population growth curve that is stable or positive for at least 4 of 5 sequential years. For any of the O‘ahu tree snail species to be considered fully recovered, it must maintain viable free-living populations in areas actively managed to protect native vegetation. The following criteria must be met for any of the O‘ahu tree snail species to be considered for delisting: 1) At least 12 to 20 populations are distributed across the known historical range of the species. Also, each ESU of the species (or each GU if ESUs have not been identified) must be represented by at least two populations; thus any species for which more than six GUs or ESUs are identified will require more than 12 populations to sufficiently represent every GU or ESU. 2) Each of these populations must have a population growth curve that is stable or positive for at least 7 of 10 sequential years, and have available habitat that is capable of supporting natural dispersal, expansion of the occupied range, and positive population

growth. Any new populations that are established through natural dispersal from these populations should also maintain a positive growth trajectory for 4 of 5 sequential years. 3) At least 12 populations must number at least 300 individuals, distributed across all size classes combined. The current population of the species in the genus is *Achatinella* are decreasing with all but 2 species in captivity (Tables 1, 2).

The genus *Achatinella* is a conservation-reliant genus, meaning that the genus will require active management in perpetuity (Scott et al. 2005, pp. 383–389; Scott et al. 2010, pp. 92–93; Goble et al. 2012, pp. 869–872). Catastrophic declines of *Achatinella* spp. populations continue (DLNR 2020, p. 4; DNLR 2021, p. 4; DNLR 2022, p. 4; DNLR 2023, p. 4; DNLR 2024, p. 4). The key threats to the species are predation by terrestrial snails (rosy wolf snails and potentially other predatory snails [*Oxychilus allinarius* and *Gonaxis kibwexiensis*]), rodents, Jackson’s chameleons, terrestrial flatworms (*Geoplana septemlineata* and *Platydemis manokwari*), and yellow crazy ants which continue to negatively impact wild populations. Climate change models show that a majority their climate-suitable habitat will no longer be available within the next 75 years. Management of these threats are being managed by snail enclosures and captive propagation. However, population numbers continue to decline. Therefore, all species within the genus *Achatinella* continue to meet the definition of endangered as they remain in danger of extinction throughout its range.

Recommendations for Future Actions:

The recovery strategy for the genus *Achatinella* centers on habitat protection and management, predator control, and studying the impacts from climate change on all the main Hawaiian islands.

- Assess the systematics of *Achatinellidae* and relationships within all Hawaiian subfamilies include the *Achatinellinae*.
- Research snail diseases and impacts to captive rearing.
- Survey and monitor distribution of rosy wolf snails. Identify biology, life history, and ecology differences between the 2 species.
- Identify the geographic distribution and population density of Jackson’s chameleons in the Wai‘anae and Ko‘olau mountain ranges with particular interest in areas where there are wild populations of *Achatinella* spp. or within habitats similar to where snails are known from (Kraus et al. 2012, p. 590; Chiaverano and Holland 2014, p. 121).
- Identify the actions to take when *Achatinella* spp. are found in the wild.
- Routinely survey and monitor areas with currently existing populations of *Achatinella* spp.
- Survey areas with suitable habitat, within the historical ranges of *Achatinella* spp.
- Continue and expand captive propagation efforts with the intended goals of increasing the population size in a predator-free environment and eventually reintroducing captive-reared *Achatinella* spp.
- Develop reintroduction plans for future releases into predator free sites in the wild.
- Identify areas within the historical ranges of *Achatinella* spp. to construct predator proof enclosures where snails could be moved into.

- Survey, assess impacts, and monitor the presence and abundance of predators (e.g., rosy wolf snails, rodents, terrestrial flatworms, yellow crazy ants, and Jackson’s chameleons within the *Achatinella* spp. historical range.
- Assess the impact of and control feral pigs (*Sus scrofa*) and other ungulates on *Achatinella* spp. habitat.
- Continue to improve and implement more effective predator elimination techniques within the historical range of *Achatinella* spp.
- Remove invasive plant species responsible for habitat degradation.
- Research and develop an appropriate diet for captive rearing to expand breeding options.
- Study the effects of abrupt diet changes on the immediate health and long-term fitness (O’Rorke et al. 2016, p. 8) of all extant *Achatinella* spp.
- Study the role of snails in structuring their microbial environment (O’Rorke et al. 2016, p. 8).
- Study microbial habitats specific to *Achatinella* spp. where snails are still present in the wild.
- Identify the need to incorporate microbial habitat manipulation into *Achatinella* spp. release plans.
- Identify locations in both the Wai‘anae and Ko‘olau mountain ranges that may sustain populations of *Achatinella* spp. within their historical ranges as weather patterns change.
- Design and construct predator-proof enclosures to protect habitat and snails from habitat degradation and predation as the climate changes.
- Research and identify ways to effectively control yellow crazy ants.

References:

See previous 5-year reviews for additional references.

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Personal Communication

- Sischo, D. 2024a. Phone conversation between David Sischo, State of Hawai‘i Department of Land and natural Resources, Snail Extinction Prevention Program to James Breeden, US Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, regarding snails in the genus *Achatinella*. June 6, 2024.
- Sischo, D. 2024b. Electronic mail communication between David Sischo, State of Hawai‘i Department of Land and natural Resources, Snail Extinction Prevention Program to James Breeden, US Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, regarding snails in the genus *Achatinella*. June 26, 2024.
- Yeung, N. 2024. Electronic mail communication between Norine Yeung, Bishop Museum, Malacology Curator to James Breeden, US Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, regarding snails in the genus *Achatinella*. June 18, 2024.

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW on O‘ahu Tree Snails (*Achatinella* spp.)

Pre-1996 DPS listing still considered a listable entity? ___ N/A ___

Recommendation resulting from the 5-year review:

- Delisting
- Reclassify from Endangered to Threatened status
- Reclassify from Threatened to Endangered status
- No Change in listing status

Review Conducted By:

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