5-YEAR REVIEW

Short Form Summary

Species Reviewed: Pupu kani oe or Lānaʻi tree snail (*Partulina variabilis*)

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, Hawaii, 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, Hawaiʻi

Name of Reviewer(s):

Diane Sether, Ph.D., Invertebrate 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 February 2024. The review was based on a review of current, available information since the last 5-year review for the Pupu kani oe or Lānaʻi tree snail (*Partulina variabilis*) (USFWS 2020a, entire). The evaluation by Diane Sether, Ph.D., Invertebrate 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 https://ecos.fws.gov/ecp/species/8256.

Review Analysis:

Please refer to the Recovery Plan for 44 Species from the Islands of Maui, Molokaʻi, Kahoʻolawe, and Lānaʻi (Maui Nui), Species Report, and the previous 5-year review for the Lānaʻi tree snail published on August 20, 2020 (available at https://ecos.fws.gov/ecp/species/8256) 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 Lānaʻi tree snail as endangered.

Partulina variabilis is an endangered tree snail endemic only to the wet forests of Lānaʻihale, on Lānaʻi, in areas where annual precipitation is greater than 75 in (190 cm). The oblong to ovate shells of adult *Partulina variabilis* are 0.5 to 0.6 inches (in) (14 to 16 millimeters [mm]) long, have 5 to 7 whorls, and have white, yellow, black, or other

shades as a base color with a variable number of spiral bands of varying width or with no banding (Pilsbry and Cooke 1912-1914b, 83-86). The shell may coil to the right (dextral) or the left (sinistral), and both types of shells can be found in a single population. Only snails with the same coil type can mate. *Partulina* tree snails reach adult size in 4 to 7 years. Upon reaching adult size, the snails stop growing and form a thickened edge or lip along the opening of the shell. A tree snail may attain an age that exceeds 15 years.

Lānaʻi tree snails are simultaneous hermaphrodites, meaning they have both male and female reproductive organs, which are functional at the same time. Hermaphroditism is a form of sexual reproduction in which the snail can act as the female or male during mating. The species is not known to self-fertilize. After mating, the Hawaiian tree snails can store sperm and may produce live young for a year or more without breeding (Sischo 2019 in litt., entire). The species exhibits the late maturity and low reproductive rate characteristic of other Hawaiian tree snails belonging to the family Achatinellidae.

Lānaʻi tree snail feeds on microbes living on the leaf, branch and trunk surfaces of its plant hosts that include *Metrosideros polymorpha* (ʻōhiʻa)*, Broussaisia arguta* (kanawao) *Psychotria* spp. (kōpiko), *Coprosma* spp. (pilo), *Melicope* spp. (alani), and dead *Cibotium glaucum* (hapuʻu fern)*.* Occasionally, *Partulina variabilis* is found on nonnative plants such as *Psidium guajava* (guava) and *Cordyline australis* (New Zealand ti) (Hadfield 1994b, p. 2).

New status information:

- The minimum population estimate of Lānaʻi tree snail in 2019 was 10 small populations in the wild, all of which are located on Lānaʻihale (Sischo 2019 in litt., entire; USFWS 2020, p. 23). Additional, unknown populations may persist on the cliffs where terrain prohibits discovery. In March 2020 and August 2020, a single Lānaʻi tree snail was incidentally observed at two additional locations (Sprague 2024 in litt., entire).

- Two predator-proof tree snail enclosures are built for the Lānaʻi tree snails; one contains a stable to increasing *Partulina variabilis* population. A second enclosure was constructed in 2019 around an existing population of *Partulina semicarinata* and may be used for a future translocation site for *P. variabilis*.

- The Snail Extinction Prevention Program (SEPP) rears a population of *Partulina variabilis* in captivity. Representatives from one wild population are maintained in captive rearing by SEPP (Table 1; Sischo 2020, p. 9; Sischo 2021, p. 8; Sischo 2022, p. 9; Sischo 2023, p. 8; Sischo 2024, p. 9). The Lānaʻi tree snail experienced a mortality event in during the year 2018. The cage affected contained all the adult snails in the lab population. The population has since rebounded as sub-adults reach reproductive age. Measures to minimize future mortality events were taken by the SEPP program, resulting in increased numbers. In 2023, the captive population again had a decline. The majority of captive population mortality observed occurs in newborn snails or is associated with mortality events likely from pathogens, parasites or toxic secondary metabolites on leaves that are brought in as a substrate for the

snails (Sischo 2020, entire; Sischo 2021, entire; Sischo 2022, entire; Sischo 2023, entire; Sischo 2024, entire)

Table 1. Population of *Partulina variabilis* in captive rearing.

Year	Total Births	Total Deaths	Juvenile	Sub-adult	Adult	Total Population
2019[a]	0	7	0	26	0	26
2020	11	5	12	18	4	34
2021	40	24	26	5	11	42
2022	27	18	34	9	5	48
2023	29	49	14	10	4	28

[a]*Partulina variabilis* experienced a mortality event during the year 2018. During this event, the cage affected contained all the adult snails in the lab population.

New threats:
There are no new threats known at this time that were not identified in the *Partulina variabilis* Species Report (USFWS 2020b) and 5-Year Review (USFWS 2020a). The wild populations not protected by a predator-proof enclosure are highly vulnerable to predation, as well as catastrophic and stochastic events, that threaten the existence of these populations. Given the small numbers of individuals per population, each population is at risk of extirpation.

New management actions:

- Monitoring and surveys –
    - Pūlama Lānaʻi reports on incidental Lānaʻi tree snails observed while conducting predator control and during monitoring of Lānaʻihale seabird burrows. A GPS location is taken when a tree snail or shell is observed, report written, and the tree snail left in place. These observations are purely incidental in discovery and are limited to accessible trails to avoid impacting seabird burrows. The staff are experienced biologists and trained in recognition of tree snails, existing or new threats to tree snails, and changes to the habitat that may impact the species population.
    - Conservation measures that benefit Lānaʻi tree snail focus on protecting the species from predation by rats and rosy wolf snails (*Euglandina* spp.), trampling by ungulates, and destruction and loss of host plants. The wild populations may be afforded limited protection from rat control, fencing, removal of ungulates, and habitat management to protect endangered plants and endangered seabirds that also occur on the mountain.
    - In 2018, Pūlama Lānaʻi completed one of two predator-proof tree snail enclosures protecting *Partulina variabilis* in its natural environment (USFWS 2020a, pp. 8, 15; USFWS 2020b, pp. 21–22). The enclosure may serve as a destination for translocation of tree snail populations that are in immediate peril in the wild and meet translocation criteria. The enclosure is maintained by Pūlama Lānaʻi with guidance from the USFWS and the SEPP. Changes in threats and tree snail population inside the enclosure are monitored by Pūlama Lānaʻi and SEPP and reported to the USFWS.

    - A second enclosure was constructed in 2019 around an existing population of *Partulina semicarinata* and may be used for a future translocation site for *Partulina variabilis*. Changes in threats and tree snail population inside the enclosure are monitored by Pūlama Lānaʻi and SEPP and reported to the USFWS. No sign of rats or invasive rosy wolf snails inside the enclosures have been reported.
- Habitat restoration:
    - Invasive plant species are periodically removed from inside enclosure areas. Plant material is inspected for tree snails before removal.
- Reintroductions:
    - No reintroductions from the captive population have occurred.
    - In 2021, the Service awarded SEPP a Competitive State Wildlife Grant to expand rearing efforts to Bernice Pauahi Bishop Museum and Honolulu Zoo. This project will allow populations to be divided between the three facilities to lower the risk of extinction by increasing (1) population redundancy and (2) capacity to generate individuals for release into the wild (Sischo 2023, p. 4).

Table 2. Status and trends of *Partulina variabilis* from listing through current 5-year review.

Date	No. Adult Wild Individuals	Downlisting Criteria Identified in Recovery Plan	Downlisting Criteria Completed?
2013 (listing)	12 populations in the wild (<100 individuals)	No recovery plan developed yet.	N/A
2020 (Species Report and 5-Year Review)	9 populations in the wild, 1 population in a tree snail enclosure, and representatives of 1 wild population in captive rearing (>100 individuals)	No recovery plan finalized.	No
2021 (Draft Recovery Plan)	9 populations in the wild, 1 population in a tree snail enclosure, and representatives of 1 wild population in captive rearing (>100 individuals)	Draft Downlisting Criterion 1: At least 6 stable populations (possibly actively managed) exist on Lānaʻi. 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 or index trend that is stable or	No

		positive for at least 4 of the 5 years prior to consideration of downlisting. If multiple management units have been identified for the species based on genetic characters or geography, each unit must comprise one or more of these stable populations.	
		Draft Downlisting Criterion 2: Each population in Downlisting Criterion 1 occurs on suitable habitat that is managed to protect native forest vegetation. Habitat must be capable of supporting natural dispersal, expansion of the occupied range, and positive population growth as determined by the best available scientific information.	No
		Draft Downlisting Criterion 3: All predation threats are controlled or absent around each population in Downlisting Criterion 1. Evaluation of predation risk for each population in Downlisting Criterion 1 indicate that nonnative predators are absent or that predation is unlikely to have significant short-term impacts on the population. Species-specific management actions may continue to be necessary. Measures are in place to prevent introduction of new predators or disease to the populations in Downlisting Criterion 1 and captive reared populations.	No
2024 (5-yr review)	9–11 populations in the wild, 1 population in a tree snail enclosure, and representatives of	Draft Downlisting Criterion 1: At least 6 stable populations (possibly actively managed) exist on Lānaʻi. To be considered stable, a population must number at least 300	No

	1 wild population in captive rearing (>100 individuals)	individuals distributed across all size classes combined and must have a population growth curve or index trend that is stable or positive for at least 4 of the 5 years prior to consideration of downlisting. If multiple management units have been identified for the species based on genetic characters or geography, each unit must comprise one or more of these stable populations.	
		Draft Downlisting Criterion 2: Each population in Downlisting Criterion 1 occurs on suitable habitat that is managed to protect native forest vegetation. Habitat must be capable of supporting natural dispersal, expansion of the occupied range, and positive population growth as determined by the best available scientific information.	No
		Draft Downlisting Criterion 3: All predation threats are controlled or absent around each population in Downlisting Criterion 1. Evaluation of predation risk for each population in Downlisting Criterion 1 indicate that nonnative predators are absent or that predation is unlikely to have significant short-term impacts on the population. Species-specific management actions may continue to be necessary. Measures are in place to prevent introduction of new predators or disease to the populations in Downlisting Criterion 1 and captive reared populations.	No

Table 3. Threats to *Partulina variabilis* and ongoing conservation efforts.

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Agriculture and urban development	A	Ongoing	Partial—land management has reduced the threat of development
Ungulates	A	Ongoing	Partial— some strategic fencing is in place and maintained; some ungulate removal has occurred
Invasive nonnative plants	A	Ongoing	Partial—land management and invasive plant removal by Pūlama Lānaʻi
Fire	A	Ongoing	Partial— general fire management plans developed by Pūlama Lānaʻi are in place
Stochastic events (drought, hurricane)	A	Ongoing	None
Disease	C	Ongoing	Partial—Snail Extinction Prevention Program has implemented safeguards against introduction of disease and parasites to captive-reared tree snails
Predation by rats	C	Ongoing	Partial—two predator-proof snail enclosures are built by Pūlama Lānaʻi and one is occupied by *Partulina variabilis*; the Snail Extinction Prevention Program has one population of *P. variabilis* in captivity; extant tree snail populations may also benefit from rat control to protect endangered plants and endangered seabirds on Lānaʻihale
Predation by Jackson's chameleon	C	Ongoing	Partial— predator-proof snail enclosures built on Lānaʻihale are free of Jackson's chameleons; one population of *P. variabilis* is in captivity and not exposed to this threat
Predation by predatory snails	C	Ongoing	Partial— predator-proof snail enclosures built on Lānaʻihale are free of predatory rosy wolf snail; one population of *Partulina variabilis* is in captivity and not exposed to the threat
Predation by flatworms	C	Ongoing	Partial— predator-proof snail enclosures built on Lānaʻihale have excluders for flatworms; one population of *Partulina variabilis* is in captivity and not exposed to the threat
Inadequate existing regulatory mechanisms	D	Ongoing	Partial— restrictions on transport of invasive species to the island and inspections at the dock and airport are conducted

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Loss of plant hosts	E	Ongoing	Partial—some landscape-scale plant and pathogen management
Limited numbers	E	Ongoing	Partial— Snail Extinction Prevention Program has one population in captivity; two enclosures are built to protect additional populations; one enclosure is occupied by *Partulina variabilis*
Low population number	E	Ongoing	Establishing new populations outside of predator-proof enclosures is not occurring because other threats in those appropriate habitats are not manageable with the current technology available to ensure success.
Treefall	E	Ongoing	None
Climate change	E	Ongoing	None

Synthesis:
Downlisting and delisting objectives are provided in the draft recovery plan for 44 species from the islands of Maui, Molokaʻi, Kahoʻolawe, and Lānaʻi (Maui Nui) (USFWS 2021). Based on the draft recovery plan at least 6 stable populations of at least 300 individuals with a population growth curve that stable or positive for at least 4 to 5 years must occur before the downlisting Criterion 1 can be met; Criteria 2 and 3 are predicated on Criterion 1 being met. There are 9–11 populations of *Partulina variabilis* known in the wild, 1 population in a tree snail enclosure, and representatives of 1 wild population in captive rearing (>100 individuals). There are two existing predator-proof enclosures for Lānaʻi tree snails on Lānaʻi; one is populated by *P. variabilis* and the other, occupied by *Partulina semicarinata* is suitable for translocation of *P. variabilis*. Populations in the wild continue to be at risk of predation from rats, predatory snails, Jackson's chameleons, habitat-related threats, and catastrophic and stochastic events. The population within the enclosure is also at risk should the barriers fail or catastrophic or stochastic events damage the enclosure or habitat inside. With only 9–11 small populations of Lānaʻi tree snail known within the natural landscape, a low number of individuals in those populations, one population in captive rearing, and most threats still unmanaged across the landscape, this species continues to meet the definition of endangered.

Recommendations for Future Actions:

- Finalize the draft recovery plan with measurable downlisting and delisting criteria for the recovery of *Partulina variabilis*.
- Conduct surveys for extant populations throughout the range of *Partulina variabilis.*
- Monitor and assess abundance of individuals and growth trend of populations.

- Monitor populations to detect disease, assess impacts, and control outbreaks as soon as possible, if needed.
- Protect existing populations in the wild from threats.
- Identify pathogens or parasites causing disease in captive populations and develop and implement control measures.
- Expand the capacity of the captive rearing program and increase the number of captive-reared individuals and populations.
- Develop microclimate models and identify suitable habitat based on historical and existing species' distributions and potential future climate conditions.
- Identify and prepare suitable habitats for translocation of captive-reared Lānaʻi tree snail.
- Construct and maintain tree snail predator-proof enclosures to protect extant populations or to protect translocated Lānaʻi tree snails.
- Increase numbers of populations and individuals in suitable habitat through translocation to build resilient populations with redundancy and representation.
- Identify species suitable for translocation and develop and implement translocation plans.
- Monitor management and use results to adaptively manage recovery actions.
- Control invasive, nonnative plant species that degrade the wet forest habitat of *Partulina variabilis*.
- Develop and implement effective control methods for nonnative *Euglandina* spp. at all *Partulina variabilis* populations in habitats.
- Expand and continue to implement effective control methods for rats in all *Partulina variabilis* populations.
- Develop and implement effective control methods for Jackson's chameleon at all *Partulina variabilis* populations.
- Control any new threats to *Partulina variabilis* before they become widespread.
- Develop tools to enhance habitat and species survival and reproduction.
- Develop tools to inform actions that will improve species viability in situ and ex situ.
- Conduct Population Viability Analyses (PVA) for each species.
- Ensure long-term protection of all populations.
- Identify, develop, and support alliances and partnerships to plan and implement *Partulina variabilis* habitat restoration, protection from predators, and management to benefit and recover the species.
- Conduct studies on the optimization of conservation translocation survival and success.
- Implement the Hawaiʻi interagency biosecurity plan to prevent the influx of new pests and invasive species into Hawaiʻi and more specifically the islands of Maui Nui.

- Implement public outreach and education and enforce policies that prohibit species collection and harassment.

References:
See previous 5-year reviews for additional references.

Sischo, D. 2019. Report to the U.S. Fish and Wildlife Service for native endangered species recovery permit, Permit: ES19045-3, tree snail section: Reporting period: January 1, 2018, to December 31, 2018. Department of Land and Natural Resources, Division of Forestry and Wildlife. Honolulu, Hawaii. 12 pp.

Sischo, D. 2020. Report to the U.S. Fish and Wildlife Service for native endangered species recovery permit, Permit: ES19045-3, tree snail section: Reporting period: January 1, 2019, to December 31, 2019. Department of Land and Natural Resources, Division of Forestry and Wildlife. Honolulu, Hawaii. 11 pp.

Sischo, D. 2021. Report to the U.S. Fish and Wildlife Service for native endangered species recovery permit, Permit: ES19045-3, tree snail section: Reporting period: January 1, 2020, to December 31, 2020. Department of Land and Natural Resources, Division of Forestry and Wildlife. Honolulu, Hawaii. 9 pp.

Sischo, D. 2022. Report to the U.S. Fish and Wildlife Service for native endangered species recovery permit, Permit: ES19045-3, tree snail section: Reporting period: January 1, 2021, to December 31, 2021. Department of Land and Natural Resources, Division of Forestry and Wildlife. Honolulu, Hawaii. 11 pp.

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Sischo, D. 2024. Report to the U.S. Fish and Wildlife Service for native endangered species recovery permit, Permit: ES19045-3, tree snail section: Reporting period: January 1, 2023, to December 31, 2023. Department of Land and Natural Resources, Division of Forestry and Wildlife. Honolulu, Hawaii. 40 pp.

[USFWS] U.S. Fish and Wildlife Service. 2020a. 5-Year Review for *Partulina variabilis* (Lānaʻi tree snail). U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, HI. 24 pp.

[USFWS] U.S. Fish and Wildlife Service. 2020b. Species report for *Partulina variabilis* (Pupu kani oe, Lānaʻi tree snail). Version 1.0. Pacific Islands Fish and Wildlife Office, Pacific Islands Interior Region 12, Portland, Oregon. 29 pp.

[USFWS] Draft U.S. Fish and Wildlife Service. 2021. Recovery plan for 44 species from the islands of Maui, Molokaʻi, Kahoʻolawe, and Lānaʻi (Maui Nui). Portland,

Oregon. xvi + 77 pages. https://ecos.fws.gov/docs/recovery_plan/Maui_Nui_Draft_RP_20211217_Signed.pdf

In Litt

Sprague, J. 2024. Lānaʻi Tree Snails. Email between Jon Sprague, Pūlama Lānaʻi, and Diane Sether, USFWS. March 13, 2024.

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW on Pupu kani oe or Lāna‘i tree snail
(*Partulina variabilis*)

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
__X__ No Change in listing status

Review Conducted By:

Diane Sether, Ph.D., Invertebrate and Wildlife Biologist, USFWS
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for **Field Supervisor, Pacific Islands Fish and Wildlife Office**

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