Newcombia cumingi
(Newcomb's tree snail)

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: *Newcombia cumingi* (Newcomb's tree snail)

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1.0 GENERAL INFORMATION

1.1 Reviewers:

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John Vetter, Animal Recovery Coordinator, PIFWO
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Lead Field Office:
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Cooperating Field Office(s):
N/A

Cooperating Regional Office(s):
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 October 2019. The review was based on the final rule listing this species; the final critical habitat designation; peer reviewed scientific publications; unpublished field observations by the Service, State of Hawai'i, and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information. The evaluation completed by Diane Sether, Ph.D., Invertebrate and 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. 2018. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 156 species in Oregon, Washington, Hawaii, Palau, Guam, and the Northern Mariana Islands. Federal Register 88(83): 20088–20092, May 7, 2018.

1.3.2 Listing history:

Original Listing
FR notice: [USFWS] U.S. Fish and Wildlife Service. 2013. Endangered and threatened wildlife and plants; determination of endangered status for 38 species on Molokai, Lanai, and Maui; final rule. Department of the Interior, Federal Register 78: 32014-32065, May 28, 2013.

Date listed: May 28, 2013
Entity listed: *Newcombia cumingi*
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:
FR notice: [USFWS] U.S. Fish and Wildlife Service. 2016. Endangered and threatened wildlife and plants; Designation and nondesignation of critical habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 species; Final Rule. Federal Register 81: 17790-18110.

A total of 65 acres (ac) (26 hectares [ha]) of critical habitat is designated on State land at Moʻomoku, on the northwestern slopes of West Maui. This area was considered "possibly occupied" at the time of critical habitat designation.

The Service also made the determination to exclude 534 ac (216 ha) of lowland wet habitat on the Puʻu Kukui Watershed Preserve on West Maui (USFWS 2016). The Puʻu Kukui site was occupied by what was described by the Service, as the last remaining nine *Newcombia cumingi,* observed in 2006. The decision to exclude the land from critical habitat was based on: 1) permanent dedication of Puʻu Kukui Watershed Partnership to conservation; 2) ongoing conservation management by Maui Land and Pineapple Company, LLC; and 3) recognition that active management is needed for the tree snail's protection and conservation. At the same time, the Service established a 5- year cooperative agreement with Maui Land and Pineapple to construct a predator proof tree snail enclosure for the conservation of Newcomb's tree snails.

1.3.4 Review History:
This is the first 5-year review for *Newcombia cumingi*.

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

1.3.6 Current Recovery Plan or Outline:
Name of plan or outline: Recovery Outline for the Islands of Maui, Molokaʻi, Kahoʻolawe, and Lānaʻi (Maui Nui).
Date issued: October 31, 2019
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?

____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:
The draft recovery plan for *Newcombia cumingi* is currently under review and is expected to be finalized in 2020.

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:
Newcombia cumingi, (Newcomb 1853), is a member of the family Achatinellidae and the endemic subfamily Achatinellinae (Newcomb 1853, p. 25). The genus *Newcombia* (Pfeiffer) is endemic to the islands of Maui and Moloka‘i. Newcomb's tree snail has a sinistral (left-coiling) oblong, spindle-shaped shell of five to seven whorls that is coarsely sculptured (Cooke and Kondo 1960, p. 9, 278). Its shell is modeled with shades of brown that blend with the bark of its host plants. The adult reaches a length of approximately 0.8 inches (in) (21 millimeters [mm]; Pilsbry and Cooke 1912-1914, p 10 and plate 3).

Newcomb's 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). Reproductive maturity is believed to be obtained at 4 to 5 years of age based on other Achatinellinae (Thacker and Hadfield, p. 9; Kobayashi and Hadfield 1996, p. 348; Hadfield and Miller 1989, p. 10). Like other Achatinellidae, *Newcombia cumingi* gives birth to live young. The birth size of the live young is particularly large, approximately 0.20 to 0.24 in (5 to 6 mm) in length (Sischo 2019 in litt., entire). Newcomb's tree snail is believed to exhibit the low reproductive rate of other Achatinellinae tree snails, producing 0 to 4 live juveniles in a year (Hadfield 1994, p. 330).

The exact life span of Newcomb's tree snail is unknown, but estimates for other Achatinellinae range from "at least 9.25 years" (Hadfield and Mountain 1980, p. 350), "up to about 11 years" (Hadfield et al. 1993, p. 610; Hadfield 1994, p. 330), and perhaps longer in a threat-free habitat.

The lowland wet forest habitat of *Newcombia cumingi* is found below 3,300 feet (ft) (1,000 meters [m]) elevation (Gagne and Cuddihy 1999, p. 85). This habitat includes a variety of wet grasslands, shrublands, and forests that receive greater than 75 in (190 centimeters [cm]) annual precipitation. The lowland wet forest habitat of Newcomb's tree snail is generally found on the windward side or on shaded wet slopes and cliffs of Maui (Clark et al. 2019, p. 5; Gagne and Cuddihy 1999, p. 85; TNC 2006, entire). Distribution of *Newcombia cumingi* is clearly correlated with habitat quality (Thacker & Hadfield 1998, p. 9). Cool, shaded forest habitat with high humidity and low air movement that prevents excessive water loss are critical factors. Adults can estivate to survive temporary drier periods but juveniles are vulnerable to desiccation because of the greater shell-surface to air ratio. Newcomb's tree snail has been documented living on small, older *Metrosideros polymorpha* (ʻōhiʻa) primarily in areas with dense cover by *Dicranopterus linearis* (uluhe fern) (Thacker and Hadfield 1998, p. 3 and 9), though other hosts that support suitable microbes might also be used by the tree snail.

In general, tree snails subsist entirely by grazing throughout the night on microbes that live on the leaf and trunk surfaces of plants (Pilsbry and Cooke 1912–1914a, p. 103; O'Rorke *et al*. 2016, p. 177). This microbial ecosystem on the plant surfaces above the ground is called the phyllosphere and is comprised of a variety of microorganisms including fungi, algae, bacteria, protists, etc. The tree snails feed by scraping the surface they are on with their specialized radula. This does not appear to damage the plant host.

Baseline data on the life history of Newcomb's tree snail in the wild is limited. The estimated age for maximum size is 4-5 years (Thacker and Hadfield 1998, p. 9). Adults and sub-adults appear to be outnumbered by juveniles in the wild (Thatcher and Hadfield 1998, p. 6). However, in the limited surveys conducted for Newcomb's tree snail, largest snails were seen repeatedly, while smaller snails were often seen only once. While this certainly reflects the difficulty in finding the very cryptic small juveniles, it may also indicate high juvenile mortality or migration of juveniles from these populations (Thatcher and Hadfield 1998, p. 9). The absence of historical age-frequency distributions for most Hawaiian tree-snail populations provides little insight as to whether the observed situation is problematic or typical.

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:
In the early 1900s, *Newcombia cumingi* was reported to occur in the West Maui mountain range, near Lahaina and Wailuku, and in the East Maui mountains, near Makawao on the slopes of Haleakalā (Pilsbry and Cooke 1912–1914, p. 10). Snails were reported from relatively low elevation locations (probably around 1,000 ft (300 m) and up to over 3,280 ft [1,000 m]) above sea level.

Until 1994, Newcomb's tree snail had not been seen for more than 50 years (Thacker and Hadfield 1998, p. 3). In October 1994, a small population of *Newcombia cumingi* was located in the lowland wet ecosystem in the vicinity of Māhinahina Valley on the northwest slope of Mauna Kahalawai on Maui (Thacker and Hadfield 1998, p. 3). Surveys from 1996 to 1997 documented 86 snails occurring on small ʻōhiʻa growing on a ridge at an elevation of approximately 2,600 ft (792 m). The majority of the snails observed were solitary and on small trees. The population was restricted to a 0.6 ac (0.2- ha) area (Thacker and Hadfield 1998, p. 5). In June 2002, 36 Newcomb's tree snail individuals were observed (Hadfield 2003, entire). In 2006, only nine individuals were located during 144 person-hours of searching in the area (Hadfield 2006, entire); in 2012, only one individual was located (**Table 1**; Thacker and Hadfield 1998, p. 2; Hadfield 2007, p. 8); and in 2019, no *N. cumingi* were observed at this site (Sischo 2019 in litt, entire).

In 2019, a population of Newcomb's tree snail was identified in the wet forest between 2,500 and 3,000 ft (760-920 m) elevation in the Launuipoko Valley area of West Maui. This population appears to be distributed across a 0.5 ac (0.17 ha) area (**Table 1**). A subset of this population (20 individuals) was brought into the Snail Extinction Prevention Program captive rearing program (Sischo 2019, entire). The remainder of the population was left in place. Although the population continues to be at risk from predation, stochastic and catastrophic events, and threats to habitat, there is not sufficient space in the captive rearing lab to support all found individuals. The remaining wild population is not considered at imminent risk of extirpation, but is expected to decline given the lack of threat management. There are no conservation actions occurring at this site. A population census has not been conducted for this population; total number of snails remaining and their age class structure in unknown at this time.

Also in 2019, a second population of Newcomb's tree snail was discovered in Ukumehame Valley (**Table 1**). This population was under immediate threat of extirpation due to the presence of the predatory snail species, *Euglandina* spp., and the limited number of individuals. As a

result, what remained of this population (15 snails, consisting of 8 adults, 6 subadults, and 1 juvenile) was brought into the captive rearing program.

Although surveys have been conducted in suitable habitat of the Newcomb's snail it is possible that other populations persist in habitats such as steep cliffs where surveys have not been conducted and where the terrain would have provided some protection from threats. However, given the life history of the species and the extent of threats, it is anticipated that few (if any) unknown populations remain. Thus, the population in the Launuipoko Valley area of West Maui is currently the only population known to be extant in the wild.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):
There are currently two populations in captive rearing, one of which is also present in the wild. No genetic analysis has been conducted on these populations and it is unclear how closely these population mimic the historic genetic diversity of Newcomb's tree snail.

2.3.1.4 Taxonomic classification or changes in nomenclature:
Though Newcomb identified the species as *Achatinella Cumingi* [sic] in 1853, Pilsbry and Cooke's 1912-1914 taxonomic description of *Newcombia cumingi* is the most recent and accepted taxonomy for this species (Newcomb 1853, p. 25; Pilsbry and Cooke 1912-1914, p. 10, plate 3).

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.):
See section 2.3.1.2 above for historic and current spatial distribution of the species. Only one *Newcombia cumingi* population is known to remain in the wild, located in wet forest in the Launuipoko Valley area of West Maui. The species has drastically declined throughout its historical lowland wet forest range throughout Maui due to loss of habitat, fragmentation, and introduction of nonnative species that have either resulted in direct tree snail mortality or have altered the habitat, making it unsuitable for the tree snail. See section 2.3.2 for habitat altering threats.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):
Habitat loss and degradation have contributed significantly to population declines of the Newcomb's tree snail on Maui. Land use conversion to non-lowland wet forest, invasive species, drought, fire, and environmental change all contribute towards habitat loss and degradation. Anthropomorphic-related habitat loss began when humans first settled

Maui. Wet lowland forests that likely began just above the coastal habitat were cleared to make way for agriculture and development. The remaining lowland wet forest habitat on Maui with suitable humidity is fragmented.

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 (Factor A):

In addition to direct habitat destruction by humans, ungulates were introduced for hunting and consumption. Forests not cleared for agriculture were invaded by feral cattle (*Bos taurus*), horses (*Equus ferus caballus*), goats (*Capra hircus*), deer (*Axis axis*) and pigs (*Sus scrofa*) (Cuddihy and Stone 1990, pp. 63-67). The browsing, grazing, and trampling by these mammals degraded native forests and facilitated the invasion of exotic plants by spreading their seeds and creating disturbed areas where seeds could germinate (Hobdy 1993, pp. 205-208). Specific threats to the *Newcombia cumingi* habitat posed by introduced ungulates, include trampling and grazing, which directly effects the host plants used by Newcomb's tree snails for food, shelter, and reproduction; ungulate paths that increase soil disturbance and leads to mechanical damage of host plant roots and erosion; and creation of open, disturbed areas which facilitate weedy plant invasion and the establishment of nonnative plants from ungulate-dispersed fruits and seeds resulting in the conversion of a native community to one dominated by nonnative vegetation.

Invasive nonnative plant species present in the area of the Newcomb's tree snail population, such as *Rubus* spp. (blackberry), continue to degrade the native habitat. Thacker and Hadfield reported in 1998 that the trees containing Newcomb's tree snail they surveyed were surrounded by invasive grasses and blackberry which required constant management efforts to keep under control. Nonnative plants represent a serious and ongoing threat to the tree snail *Newcombia cumingi* because they: (1) adversely affect microhabitat by modifying the availability of light; (2) alter soil-water regimes; (3) modify nutrient cycling processes; (4) alter fire characteristics of native plant habitat, leading to incursions of fire-tolerant nonnative plant species into native habitat; and (5) outcompete, and possibly directly inhibit the growth of, native plant communities (Cuddihy and Stone 1990, p. 74; Vitousek 1992, pp. 33–35). This conversion has negative effects on the ʻōhiʻa on which *Newcombia cumingi* feeds upon. Changes of the plant community can destroy continuity of the phyllosphere created by overlapping canopies. This invasive plant changes the hydrology, canopy structure, and microclimate needed for the habitat of the tree snail. Changes to the native plant communities effect the availability of the tree snail's alternate native plant hosts via environmental changes in water, canopy and shading structure.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes (Factor B):
Achatinellidae tree snails were extensively collected for scientific as well as recreational purposes in the 18th to early 20th centuries (Hadfield 1986, p. 320-321). These impacts may have been especially severe to some species and populations within the genera of *Achatinella* and *Partulina*, but the collection of *Newcombia cumingi* does not seem to be nearly as extensive (Hadfield 1994, pp. 320). This is likely due to the shell of these snails lacking the luster and diversity of color and pattern that characterize the *Achatinella* spp., *Partulina* spp., and other snail species, the cryptic nature of the snail, or perhaps that the snail was not as abundant (Hadfield 1994, pp. 320, 322). While the threat of illegal collection does exist and would have an impact because of the low numbers of individuals, the rarity and cryptic nature of the Newcomb's tree snail makes this less likely.

2.3.2.3 Disease or predation (Factor C):
The most serious threat to *Newcombia cumingi* is predation by *Euglandina* spp. (Hadfield and Mountain 1980, p.355; Hadfield 1986, p. 327; Cowie 2001a, pp. 66-67; Cowie 2001b, entire). *Euglandina* spp. was purposefully introduced to the main islands of Hawai‘i in a failed attempt to control giant African snail, *Achatina fulica* (Davis and Butler 1964, entire; Cowie 2001b, pp. 66-67). Not only did *Euglandina* spp. fail to reduce giant African snail populations, the species decimated endemic tree snails and are a major cause of the decline and extinction of native tree and terrestrial snails throughout Hawai‘i, Moorea (French Polynesia) and other tropical and subtropical regions (Cowie 2001a, entire; Cowie 2001b, pp. 66-67; Hadfield 1986, p. 327; Hadfield et al. 1993, entire). The introduced predatory snails, initially identified as *Euglandina rosea* in Hawai‘i, was recently shown to be a mixture of *Euglandina* species (Meyer III et al. 2017 pp. 1402-1404). These predatory snail species actively hunt by following the slime trails of their prey (Clifford et al. 2003, entire; Holland et al. 2018, entire). The predatory snails will climb the host tree to find its tree snail prey and can decimate a tree snail population (Hadfield 1986, p. 327).

The nonnative terrestrial garlic snail, *Oxychilus alliarius*, poses a threat to smaller Newcomb's tree snails. Hadfield (2007 p. 8) reported finding many shells of the garlic snail within the habitat of *Newcombia cumingi* on Maui.

Rat predation poses a serious threat to extant Newcomb's tree snail populations. Three rat species, (black rat [*Rattus ratus*], Norway rat [*R. norvegicus*], and Polynesian rat [*R. exulans*]), are present on Maui, but the black rat appears to be the major threat to the Newcomb's tree snails

(Hobdy 1993, p. 208; Hadfield 1994, entire; Thacker and Hadfield 1998, entire; Hadfield 2007, entire). Rats appear to selectively prey on large snails rather than juveniles. Predation has been linked with the dramatic declines of populations of native tree snails (Hobdy 1993, p. 208; Hadfield and Saufler 2009, p. 1; Meyer and Shields 2009, p. 344). Rats decimated a large population of *Partulina splendida* on Maui leaving behind shells with rat predation marks (Thacker and Hadfield 1998, entire). This area had also supported a population of Newcomb's tree snail which appears to have been extirpated.

Jackson's chameleon (*Chamaeleo jacksonii*) is known to prey on native insects and tree snails. Currently, there are established Jackson's chameleon populations on all of the main Hawaiian Islands, with the greatest number of individuals on the islands of Hawai‘i, Maui, and O‘ahu (Holland et al. 2010, entire). Several dozen Jackson's chameleons, native to Kenya and Tanzania, were introduced to Hawai‘i in the early 1970s through the pet trade (Holland et al. 2010, p. 1,438). Inter-island transport of Jackson's chameleons for the pet trade was unrestricted until 1997, when they were classified as ‘‘injurious wildlife,’’ and export, as well as inter-island transport, was prohibited (State of Hawai‘i 1996, Hawai‘i Administrative Rule 13–124–3; Holland et al. 2010, entire). The rarity of Newcomb's tree snails in the wild may reduce their risk of being preyed upon by the Jackson's chameleon simply because of the extremely low chance of encounter.

Terrestrial flatworms (*Geoplana septemlineata* and *Platydemus manokwari* (Hadfield 2007, entire; Sugiura 2010, entire), have been reported to feed on terrestrial and tree snails. The flatworm is able to climb wet trees and locate arboreal snails via scent (Sugiura and Yamaura 2009, p. 740-741). *Platydemus manokwari* decimated populations of native tree snails on Guam (Hopper and Smith 1992, entire). Although *P. manokwari* has been found on the islands of O‘ahu and Hawai‘i and is likely on all of the main islands, the flatworm is not yet known from the wet forests of Maui nor has it been found in the wet forest location where the wild population of Newcomb's is found (Sischo 2019 in litt., entire).

Disease is a potential threat to the *Newcombia cumingi,* and to tree snails in general (Hadfield 1994, pp. 328-329). Newcomb's tree snails have not been subjected to testing for disease pathogens. However, an unknown disease has been observed in the tree snail captive rearing program and anecdotal evidence suggests it was introduced via leaf material used for the captive population (Sischo 2019 in litt., entire). Protocols are now in place to avoid or minimize introduction of disease organisms to the captive populations.

The plant disease, rapid ‘ōhi‘a death (ROD), is an ongoing threat to

Metrosideros polymorpha, an important host for *Newcombia cumingi*. This lethal disease of ʻōhiʻa is caused by two fungal pathogens, *Ceratocystis lukuohia and Ceratocystis huliohia* (Barnes et al., 2018, entire). *Ceratocystis lukuohia* is highly aggressive and has been identified on the islands of Hawaiʻi and Kauaʻi (Friday et al. 2020, entire; Heller et al. 2019, entire). The impacts of ROD on Newcomb's tree snail will depend on the movement of the fungi, distribution of the disease, and ability of the snails living on a dying tree to find a new food source. The multiple plant hosts used by this tree snail may reduce the effects of ROD on the wild populations.

2.3.2.4 Inadequacy of existing regulatory mechanisms:
Existing State and Federal regulatory mechanisms are not effectively preventing the introduction and spread of nonnative species from outside the State of Hawaiʻi or within the State between islands and watersheds. Predation by nonnative species such as predatory snails, rats, Jackson's chameleon, flatworms, and habitat-altering, nonnative plant species and ungulates pose major ongoing threats to the Newcomb's tree snail. The State's current management of nonnative game mammals is inadequate to prevent the degradation and destruction of habitat of the tree snail.

2.3.2.5 Other natural or manmade factors affecting its continued existence (Factor E):
Drought is a significant direct threat to juvenile Newcomb's tree snails (Kobayashi and Hadfield 1996; Sischo 2019, in litt., entire; Snail Extinction Prevention Program 2019, entire). Adults can create a seal between the opening of their shell and the plant surface to minimize moisture loss during times of drought or high temperatures. However, juveniles have a shell-surface area to body mass ratio that makes them far less tolerant to drought. In addition, drought can cause habitat degradation and loss of host tree(s) as well as an increase in forest and brush fires. Because of the limited dispersal capability of the tree snail, drought conditions are lethal to juveniles and can be lethal to adults in wild population if the drought is prolonged. Neither juveniles nor adults can survive a fire.

High winds and intense rains from hurricanes can dislodge snails from host plants and deposit them on the forest floor where they may be crushed by falling vegetation or exposed to predation by rats and predatory snails (Hadfield *et al*. 1993, p. 620). Damage by future hurricanes could further decrease the remaining native plant-dominated habitat. Newcomb's tree snail requires a shaded, high humidity habitat. Hurricanes adversely impact Newcomb's tree snail habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species (Asner and Goldstein 1997, p. 148; Harrington *et al.* 1997, pp.

539-540). Wind storms can disperse tree snails, but it can also result in isolation of individuals. Adults require several years to reach sexual maturity, have low reproductive rates and limited dispersal, with most individuals remaining in the bush, tree, or tree complex on which they were born. All of these traits make these snails very sensitive to any stochastic or catastrophic event that could lead to a reduction or loss of reproductive individuals and an imbalance in demographic distribution (Lande 1988).

Climate change has the potential to adversely affect the Newcomb's tree snail. The remaining lowland wet forests on which the snail depends may be impacted by changes in temperature, humidity, precipitation and the frequency and severity of storms (Clark *et al*. 2019). These stressors may change the forest habitat rendering it unsuitable.

The threat to *Newcombia cumingi* from limited numbers of populations and number of individuals is ongoing and is expected to increase into the future. As a result, the species may experience reduced reproductive vigor due to inbreeding depression, reduced levels of genetic variability leading to diminished capacity to adapt and respond to environmental changes, and increased vulnerability to a catastrophic event (e.g., hurricane, drought) (Hadfield 1986, entire; Hadfield and Miller 1989, pp. 7-15; Hadfield et al. 1993, entire; Kobayashi and Hadfield 1996, entire). Together these may result in population extirpation and potentially to the extinction of this species

The persistence of Newcomb's tree snails is hampered by having only one small wild population and the shrinking geographic range of the species. These circumstance makes this species extremely vulnerable to extinction due to a variety of natural and anthropogenic caused factors. Though the tree snails are hermaphroditic and can store sperm for a limited time, small populations are particularly vulnerable to reduced mating encounter and reproductive vigor caused by inbreeding depression. They may suffer a loss of genetic variability over time due to random genetic drift, resulting in decreased evolutionary potential and ability to cope with environmental change (Lande 1988).

Conservation Actions

The wet forest and what remains of the wet lowland forest and cliffs benefits by State Natural Area Reserves and conservation efforts of the watershed partnerships (**Table 2**). *Newcombia cumingi* have been observed on land managed by the watershed partnerships in habitat dominated by native plants and has some protection from nonnative ungulates through active management (*e.g.*, fencing). In addition, some rat and weed control occurs as well. The partnerships work to protect and restore the watershed through natural resource management, which

includes, but is not limited to, fencing, ungulate removal, nonnative invasive plant and animal control including rats. In addition, other private landowners on Maui are engaged in, or initiating, voluntary conservation actions on their lands, including fencing to exclude ungulates, removing ungulates, constructing a predator-proof snail enclosure, controlling nonnative plants, and outplanting native and rare plants. These landowners are partners in one of the watershed partnerships on Maui, or cooperate or work collaboratively with watershed partners. The conservation actions provided by these landowners ameliorate some of the threats from nonnative species at the macro scale.

Controlling the principal threats of *Euglandina* spp., Jackson's chameleons and rats in Newcomb's tree snail natural habitat is difficult, if not impossible. Predator-proof tree snail enclosures have proven successful for protecting tree snail species (Rohrer *et al*. 2016) in Hawai'i. A tree snail enclosure is constructed around tree snail habitat and when completed, excludes *Euglandina* spp., rats, and Jackson's chameleons. Enclosures are sited based on the tree snails' habitat requirements, known occupancy, and construction constraints of the terrain. Habitat within the snail enclosures must be suitable to support the tree snails for the foreseeable future, including being free of all tree snail predators. Enclosures can provide a protected habitat for tree snail translocation when a nearby wild population is in eminent danger of being extirpated. Enclosures are vulnerable to the same environmental risks as is the surrounding habitat including storms and vegetation senescence, and require targeted, iterative management and maintenance inside and outside of the fence in perpetuity to ensure they continue to provide effective barriers against *Euglandina* spp., rats, and chameleons. One enclosure has been constructed on private lands in West Maui and a second enclosure is planned in East Maui (**Table 2**). Captive reared snails can also be translocated to enclosures if they meet the biological criteria required for translocation.

Recent efforts to captive rear *Newcombia cumingi* have been successful by the State of Hawai'i, Division of Forestry and Wildlife, Snail Extinction Prevention Program (Sischo 2019, entire). Newcomb's tree snails from two populations are currently in captive rearing (**Table 2**). One of populations, collected from Ukumehame Valley, was brought into the captive rearing program because it was in imminent threat of extirpation in the wild. The other population is a subset of the only known population in the wild in Launiupoko Valley. The captive rearing program is designed with safeguards to prevent introduction of disease and parasites. These population may be used for translocation efforts once the tree snails produced meet the size and translocation standards. The long-term management plan of the tree snail captive rearing program is to translocate captive-reared Newcomb's tree snails to snail enclosures.

Table 1 – Known populations of *Newcombia cumingi* from listing to this 5-year review.

Date	Populations	Individuals	Recovery Criteria
2013 listing	1	1	N/A
2020 5-year review	2	<100	N/A

Table 2 – Status of threats to *Newcombia cumingi* from listing through the current 5-year review.

Threat	**Listing Factor**	**Current Status**	**Conservation/Management Efforts**
Agriculture and urban development	A	Ongoing	Partial—land management by watershed partnership, private landowners, and Natural Area Reserves
Ungulates	A	Ongoing	Partial— strategic fencing by watershed partners;
Invasive nonnative plants	A	Ongoing	Partial—land management by watershed partnership, private landowners, and Natural Area Reserves
Fire	A	Ongoing	Partial— watershed partnerships and Natural Area Reserves have fire management plans
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—predator-proof snail enclosure built on private land in the tree snails' habitat; Snail Extinction Prevention Program has two populations of *Newcombia cumingi* in captivity
Predation by Jackson's chameleon	C	Ongoing	Partial—predator-proof snail enclosure built on private land in the tree snails habitat; Snail Extinction Prevention Program has two populations of *Newcombia cumingi* in captivity
Predation by predatory snails	C	Ongoing	Partial—predator-proof snail enclosure built on private land in the tree snails habitat; Snail Extinction Prevention Program has two populations of *Newcombia cumingi* in captivity
Predation by flatworms	C	Ongoing	Partial— Snail Extinction Prevention Program has two populations of *Newcombia cumingi* in captivity
Inadequate existing regulatory mechanisms	D	Ongoing	Partial—restrictions on transport

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 two populations of *Newcombia cumingi* in captivity
Treefall	E	Ongoing	None
Climate change	E	Ongoing	Partial—some landscape modeling and strategic planning

2.4 Synthesis

Newcombia cumingi is an endangered endemic tree snail found only on Maui. The species is known from the lowland wet forest and cliff habitat below 3,300 feet (ft) (1,000 m) in elevation where annual rainfall exceeds 75 in (190 cm). Newcomb's tree snail habitat of is generally found on the windward side or on shaded wet slopes and cliffs of Maui. The distribution of *Newcombia cumingi* is clearly correlated with habitat quality. The species needs cool, shaded forest habitat with high humidity and low air movement to prevent excessive water loss. Newcomb's tree snail feeds on microbes living on the leaf, branch and trunk surfaces of its plant host, ʻōhiʻa lehua (*Metrosideros polymorpha*). The species exhibits the late maturity and low reproductive rate characteristic of other Hawaiian tree snails belonging to the family Achatinellidae.

Rats and habitat degradation have decimated the once abundant snail. Remaining wild populations face imminent threats from nonnative predatory snails (*Euglandina* spp.), rats, and Jackson's chameleon. In the early 1900s, *Newcombia cumingi* was reported to occur in the West Maui mountains, near Lahaina and Wailuku, and East Maui mountains, on the slopes of Haleakala near Makawao. Currently, the species is known to occur in the wild at only one location, in the West Maui mountains. This population appears to be distributed across a 0.5 ac (0.17 ha) area. A subset of this population (20 individuals) was brought into the Snail Extinction Prevention Program captive rearing program (Sischo 2019). The remainder of the population remains *in situ*. A second population was discovered in Ukumehame Valley in 2019. This population was under immediate threat of extirpation due to the presence of *Euglandina* spp. and the small number of remaining individuals. As a result, what remained of this population was brought into the captive rearing program.

Conservation measures that benefit Newcomb's tree snail focus on protecting the species from predation by *Euglandina* spp. and rats. The principal means of conserving the species is through man-made predator-proof tree snail enclosures which have proven successful for protecting other Achatinellinae tree species. Sixty-five acres (26 ha) of critical habitat has been designated in West Maui for

the species. Captive rearing is also used to prevent extirpation of wild populations and to preserve genetic representation. Captive rearing is conducted with the intent of translocation back to the natural habitat within which predatory threats have been abated.

With only two *Newcombia cumingi* populations known, the extremely low numbers of individuals, and most threats unmanaged across the landscape, this species continues to meet the definition of endangered.

3.0 RESULTS

3.1 Recommended Classification:

____Downlist to Threatened
____Uplist to Endangered
____Delist
___ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X__ **No change is needed**

3.2 New Recovery Priority Number:

Brief Rationale:

3.3 Listing and Reclassification Priority Number:

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 recovery plan with measureable downlisting and delisting criteria for the recovery of *Newcombia cumingi*.
- Conduct surveys for extant populations throughout the range of *Newcombia cumingi.*
- Monitor and assess abundance of individuals and growth trend of populations.
- Protect existing populations in the wild from threats.
- Expand the capacity of the captive rearing program and increase the number of captive-reared individuals and populations.
- Identify and prepare suitable habitats for translocation of captive reared Newcomb's tree snail.

- Construct and maintain tree snail predator-proof enclosures to protect extant populations or to protect translocated tree snails.
- Increase numbers of populations and individuals in suitable habitat through translocation to build resilient populations with redundancy and representation.
- Develop and implement fire management plans for all populations of *Newcombia cumingi* and its habitat.
- Control invasive, nonnative plant species that degrade the lowland wet forest habitat of *Newcombia cumingi*.
- Implement effective control methods for nonnative *Euglandina* spp. at all *Newcombia cumingi* populations in habitats.
- Implement effective control methods for rats in all *Newcombia cumingi* populations.
- Implement effective control methods for Jackson's chameleon at all *Newcombia cumingi* populations.
- Control any new threats to *Newcombia cumingi* before they become widespread.
- Develop fine-scale climate models to identify future suitable habitat based on existing and historical distributions and determine potential future climate conditions.
- Identify, develop, and support alliances and partnerships to plan and implement *Newcombia cumingi* habitat restoration and management to benefit and recover the species.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Newcombia cumingi*
(Newcomb's tree snail)

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:
Diane Sether, Ph.D., Invertebrate and Wildlife Biologist, PIFWO
John Vetter, Animal Recovery Coordinator, PIFWO
Megan Laut, Conservation and Restoration Team Manager, PIFWO

FIELD OFFICE APPROVAL:

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for _____
Field Supervisor, Pacific Islands Fish and Wildlife Office