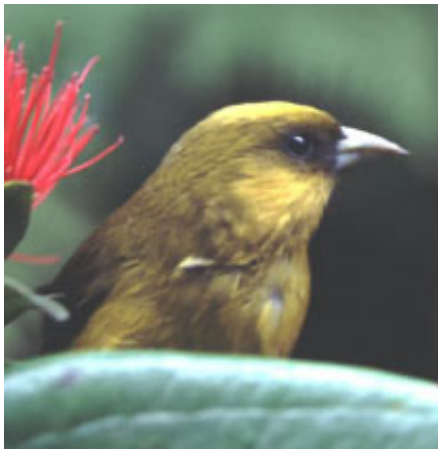


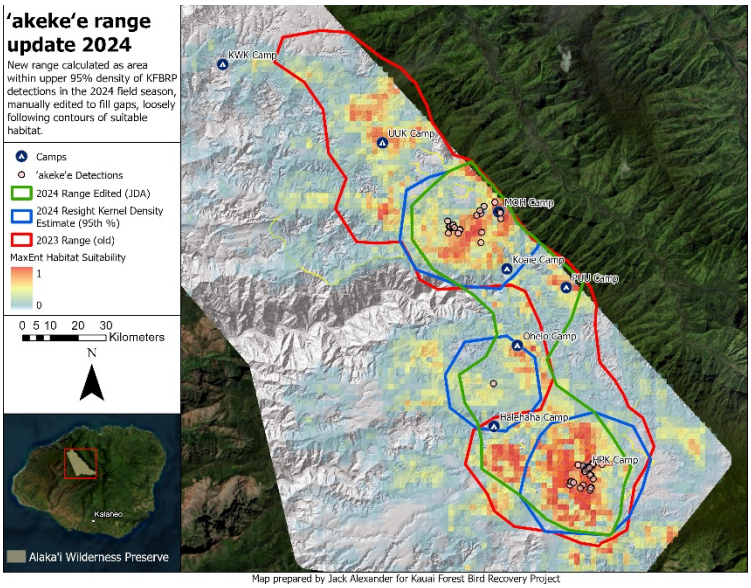
Forest Birds

‘Akeke‘e or Kaua‘i‘ākepa

Loxops caeruleirostris

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank G1—Critically Imperiled
IUCN Red List Ranking—Critically Endangered
Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2006
Kauai Islandwide Recovery Plan – USFWS 2021

SPECIES INFORMATION: The ‘akeke‘e, or Kaua‘i ‘ākepa, is a small, slightly sexually dichromatic, insectivorous Hawaiian honeycreeper (Family: Fringillidae) endemic to Kaua‘i. Adult males and females are greenish above and yellow below with a yellow crown and a black mask; females are slightly duller than males. Unlike the similar Kaua‘i ’amakihi (*Hemignathus kauaiensis*), the ‘akeke‘e’s bill is conical. Although not visible in the field, the lower mandible of the ‘akeke‘e is slightly bent to one side which results in the mandible tips being offset; a characteristic shared with the ‘ākepa (*L. coccineus*). The ‘akeke‘e uses its bill to pry open ‘ōhi‘a (*Metrosideros polymorpha*) leaves and flower buds in search of arthropods, primarily spiders, psyllids, and caterpillars. The species is an ‘ōhi‘a specialist and rarely even perches on other trees or shrubs. Its methodical probing of leaf buds is distinctive and can be used to identify the species. keke‘e are most often observed in pairs or family groups. A study of 22 ‘akeke‘e nests monitored from 2012-2017 found a preference for nesting in small terminal branches of ōhi‘a trees at higher elevation and taller canopy heights, as well as a negative relationship with slope (Fricker et al. 2021). In a sample of eight nests monitored in 2012 and 2013, mean nest height was 11.1 ± 2.3 m, and all nests were also located in the small terminal branches of ‘ōhi‘ . 2015). On one occasion a male was observed helping the female build the nest, btu on all other occasions, only the presumed female has built the nest (few ’akeke’e are color banded so it is often difficult to determine which bird is the female unless she is incubation. The species has been observed to renest and double brood in at least one instance. Multiple adults and subadults attend nests.



Map prepared by Jack Alexander for Kauai Forest Bird Recovery Project

DISTRIBUTION: Formerly found in native forests of the Alaka‘i swamp, upper Waimea, and Kōke‘e regions mostly above 1,000 meters (3,280 feet) elevation but are now restricted only to the Alaka’i Wilderness Preserve (DOFAW, unpubl. data) at a mean elevation of 1298.7m (± 50.6m; Fricker et al. 2021). Although historically widespread, ‘akeke‘e apparently did not occur at lower elevations. Occupancy rates in 2012 increased from west to east along the plateau ($\psi = 0.03 \pm 0.10$ to 0.53 ± 0.33) but were low throughout its range (Behnke et al. 2016). The estimated suitable habitat range based on surveys from 2012-2017 was 58km^2 (Fricker et al 2021), which represented a small fraction of the former range. Based on data from 2023 and 2024, the range is now much smaller at approximately 1234 ha (3049 ac; KFBRP, unpubl. data), and the species occurs primarily at Halepa’akai and Mohihi .

ABUNDANCE: In the early 1970s the island-wide population was estimated at 5,066 ± 1,680 (SE) individuals. The Kaua‘i Forest Bird Survey in 2012 suggested that the population was rapidly declining, especially in the periphery of its range; the 2012 population estimate was 945 (95% confidence interval: 460 to 1,547) individuals (Paxton et al. 2016). Surveys in 2018 suggested that the population was relatively stable (Paxton et al. 2020), however the 2023 surveys showed ongoing declines to 765 (95% confidence interval: 297 to 1285) individuals (U.S. Geological Survey unpublished data). Preliminary data from occupancy surveys in 2024 suggest further declines in abundance to fewer than 100 individuals, and ongoing range contraction (Kauai Forest bird Recovery Project, unpublished data). Densities are highest in the interior of the Alaka‘i Wilderness Preserve.

LOCATION AND CONDITION OF KEY HABITAT: Occurs above 600 meters (1,950 feet), although populations are densest above 1,100 meters (3,600 feet), in lowland mesic and wet forests dominated by ‘ōhi‘a, koa (*Acacia koa*), ‘ōlapa (*Cheirodendron trigynum*), and lapalapa (*C. platyphyllum*). Most of the current range the southern Alaka‘i Wilderness Preserve; the species no longer occurs in Kōke‘e State Park or the northern or western Alaka’i. Occupancy is positively correlated with canopy height and maximum ‘ōhi‘a diameter at breast height.

THREATS:

- Habitat degradation. The spread of non-native plants and degradation by ungulates may reduce habitat suitability. The correlation of occupancy with large tree metrics suggest that damage done by two hurricanes may also limit distribution and abundance.

- Disease. ‘Akeke’e is highly susceptible to mosquito-borne avian malaria. Two of 11 ‘akeke’e have tested positive for malarial anitibodies since 2011; since malaria is established on the Alakai’ Plateau, the most likely explanation for this result is high mortality after infection with malaria. Disease and habitat degradation are the most probable causes of population declines in this species in the last decade.
- Competition. Non-native insects, especially yellow-jackets (*Vespula pensylvanica*) and ants (*Linepithema humile*), may compete with or prey on the native arthropods on which ‘akeke’e feed. The role of non-native insects in native Hawaiian forests is unclear.
- Predation. Rats (*Rattus* spp.), cats (*Felis catus*), Hawaiian short-eared owls (*Asio flammeus sandwichensis*), and barn owls (*Tyto alba*) occur throughout the forests of Kaua’i and may prey on young and adults. Rat predation on a female ‘akeke‘e and her young was observed at Halepa’akai.
- Small population dynamics. The observed hatching failures may indicate genetic issues associated with small population sizes.

CONSERVATION ACTIONS: ‘Akeke‘e likely benefited from actions to conserve other endangered forest birds including the establishment of the Alaka‘i Wilderness Preserve, regular surveys of forest bird populations, habitat monitoring, studies of disease and disease vectors, control of feral ungulates through public hunting and fencing, suppression of rats on two A24 trapping grids over approximately 150 ha (470 ac), and public education featuring Kauai’s endangered forest birds. In 2015-2018, an effort to form a captive flock was initiated by collecting ‘akeke’e eggs from the wild. Twenty-six eggs were harvested from ten nests; most eggs hatched but many chicks survived to fledging, resulting in a 10 adult ‘akeke’e.
The flock has since suffered more attrition, but successful breeding was achieved in 2023 and there are currently eight ‘akeke’e in human care. In addition to these efforts, future actions specific to the ‘akeke‘e may include the following:

- Resume collections of 'akeke’e to increase the size of the captive flock
- Aggressively control ungulates to improve habitat quality, facilitate the recovery of degraded habitat, and potentially reduce breeding habitat for mosquitoes. Control of non-native plants should be part of forest restoration efforts.
- Eradicate or manage mosquito breeding habitat on the Alaka’i Plateau
- Suppress mosquito populations through releases of incompatible or sterile mosquitoes
- Investigate options to eradicate mosquitoes, including use of genetic manipulation.
- Suppress/control rats, feral cats, and barn owls from the Alaka‘i Wilderness Preserve, Na Pali-Kona Forest Reserve, and Kōke‘e State Park
- Prevent the introduction of the small Indian mongoose (*Herpestes auropunctatus*) and other predators.
- Prevent the spread of Rapid ‘ōhi‘a Death on the Alaka’i Plateau
- Conduct public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue Forest bird surveys and habitat monitoring. Conduct species-specific monitoring for ‘akeke’e (e.g., occupancy surveys with play back, territory monitoring, use of

ARUs) that take into account the inability of the HFBS to accurately track populations of rare species

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the ‘akeke‘e include the following:

- Investigate techniques for improving survival and reproduction of the captive flock
- Conduct PVAs for both wild and captive flocks
- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology, and success of this poorly known species.
- Continue to assess the species’ susceptibility to avian malaria and avian pox.
- Determine sources of mosquitoes and investigate appropriate methods of mosquito control.
- Investigate efficacy of other methods of controlling invasive rodents (e.g., different methods of applying rodenticide, snap traps)
- Determine the effects of recently established non-native insects on native arthropods, especially those that are part of the species’ diet.

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Photo: UH EECB

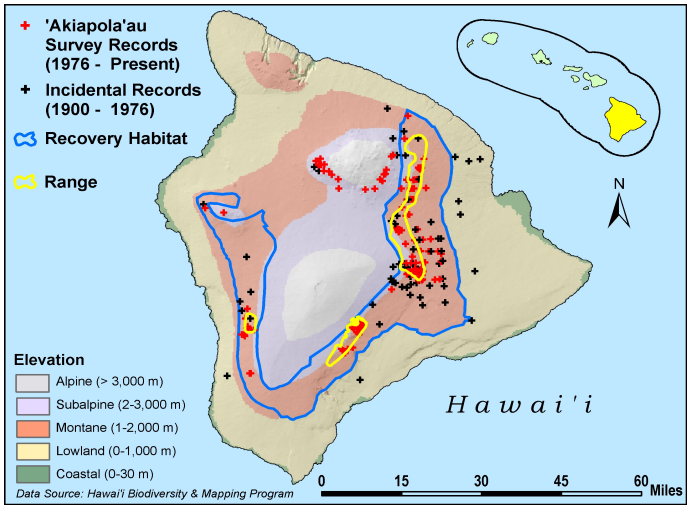
Forest Birds

ʻAkiapōlāʻau

Hemignathus munroi

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank G1—Critically Imperiled
IUCN Red List Ranking—Endangered
Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: Theʻakiapōlāʻau is a stocky Hawaiian honeycreeper (Family: Fringillidae) endemic to the island of Hawaiʻi and most famous for their specialized bills, which have a long, decurved upper mandible and a short woodpecker-like lower mandible. Adult males have a bright yellow head and underparts, yellow-green back and wings, and a small, black mask. Adult females are olive above with grayish-yellow to yellow underparts. Males are larger than females and have longer bills. They often join mixed species foraging flocks; the constituent species vary depending on habitat. ʻAkiapōlāʻau are mainly insectivorous, with Lepidoptera larva, spiders, and beetle larva being the most important prey items; rarely takes nectar but takes sap from holes it excavates in ʻōhiʻa (*Metrosideros polymorpha*) trees. Most frequently, creeps along lichen covered and dead branches of koa (*Acacia koa*), kōlea (*Myrsine lessertiana*), māmane (*Sophora chrysophylla*), and naio (*Myoporum sandwicense*) trees tapping branches with their lower mandible to locate prey. Once a food item is located, lower mandible is used similar to that of a woodpecker bill to chisel open a hole. The upper mandible is then used to fish out the prey item. Upper mandible also used to probe natural cracks and crevices. Breeding has been documented year-round, although most activity occurs from February to July. The species' open cup nest is most often placed in ʻōhiʻa trees. Clutch size is usually one, rarely two, and females perform all incubation and brooding. Males provide females and nestlings with the majority of food. Only one fledgling is produced per year, and a long period of parental dependency, usually four to five months, is typical. Family groups



consisting of hatch-year and second-year young have been observed. This species is characterized by low annual productivity.

DISTRIBUTION: Occurs in three disjunct populations between 1,500 and 2,000 meters (4,875–6,500 feet) elevation on the Island of Hawai‘i. Original range likely included all forested areas of the island.

ABUNDANCE: The Hawaiian Forest Bird Survey (1976-79, 1983), estimated the population at 1,500 ± 400 (95% confidence interval). Surveys conducted between 1990 and 1995 estimated the population at 1,109-1,217 birds and most recent analysis puts the population closer to 1,900. Significant declines occurred in two of the four populations known in the 1980s. The Ka‘ū /Kapāpala population decreased from approximately 530 individuals to 44, and a Mauna Kea population dropped from approximately 50 birds to less than 10; in 2000 only three birds remained on Maunakea and this population is now extinct. The Ka‘ū /Kapāpala population has since stabilized or increased at upper elevations, but the status of the small Kona population is unknown.

LOCATION AND CONDITION OF KEY HABITAT: Occurs in mesic and wet montane forests dominated by koa and ‘ōhi‘a. The small and declining population on Mauna Kea occurred in subalpine dry forest dominated by māmane and naio. A recent study documented ‘akiapōlā‘au occurring entirely in areas reforested with koa (i.e., second-growth, young forests). Habitat quality varies across the species’ occupied range. Most remaining populations occur on lands managed by the State of Hawai‘i and the U.S. Fish and Wildlife Service.

THREATS: ‘Akiapōlā‘au are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including habitat loss and degradation, predation by introduced mammals, and disease. For ‘akiapōlā‘au populations, the following are of particular concern:

- Low reproductive potential. Unlike many Hawaiian honeycreepers, ‘akiapōlā‘au have low annual fledgling production. This life history characteristic may be related to their very specialized foraging strategy. Regardless, the species is very susceptible to factors that reduce population size.
- Disease. Unlike several other honeycreepers found on the island of Hawai‘i (e.g., Hawai‘i amakihi [*H. virens*]), the ‘akiapōlā‘au is absent from most areas below 1,350 meters (4,500 feet). This suggests that the species is particularly susceptible to mosquito-borne avian disease.
- Predation. Although little evidence exists, predation by rats (*Rattus* spp.), cats (*Felis* silvestris), small Indian mongoose (*Herpestes auropunctatus*), and owls (*Asio flammeus sandwichensis, Tyto alba*) may limit ‘akiapōlā‘au populations. Recent surveys have determined that rat density in the Hakalau Forest National Wildlife Refuge, which supports a significant portion of the ‘akiapōlā‘au population, is high. In addition, the loud, persistent begging of juveniles may make them especially vulnerable to predators.
- Habitat degradation. Habitat loss and degradation from development, logging, and grazing has greatly fragmented the species’ habitat.

- Population size. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios and stochastic factors include natural disasters. Habitat fragmentation exacerbates demographic and genetic problems.

CONSERVATION ACTIONS: To date, conservation actions specific to ʻakiapōlāʻau have been restricted to annual population surveys of the Hakalau, ʻŌlaʻa/Kīlauea, Kona, and Mauna Kea populations. However, ʻakiapōlāʻau likely have benefited from actions to conserve other endangered forest birds in the Kapāpala Forest Reserve, Hakalau Forest National Wildlife Refuge, Puʻu Lāʻau, Hawaiʻi Volcanoes National Park, and the ʻŌlaʻa/Kīlauea Watershed Partnership. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future management specific to the ʻakiapōlāʻau may include the following:

- Add Hāmākua, the upper Waiākea kīpuka, Kaʻū /Kapāpala and south Kona to annual surveys.
- Continue koa forest restoration and fencing in the Hakalau Forest National Wildlife Refuge.
- Continue restoration of māmane forests on Mauna Kea.
- Conduct public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING:

- Continue forest bird surveys and habitat monitoring.
- Test survey methods for ʻakiapōlāʻau, and continue regular population surveys with improved methods.
- Monitor small mammal populations to assess effectiveness of control efforts, especially in dry forest sites.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to ʻakiapōlāʻau include the following:

- Conduct life history studies to quantify population structure, dispersal patterns, survivorship, nesting phenology, and success.
- Document habitat selection, preference, and foraging ecology, particularly in young forests.
- Document the response of ʻakiapōlāʻau to control of mammalian predators.
- Develop captive propagation techniques.
- Determine the feasibility of ʻakiapōlāʻau re-introductions to suitable locations (e.g., Puʻu Waʻawaʻa, Hawaiʻi Volcanoes National Park).
- Record vocalizations of distinct populations for archival analysis

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Forest Birds

ʻAkikiki or Kauaʻi creeper

Oreomystis bairdi

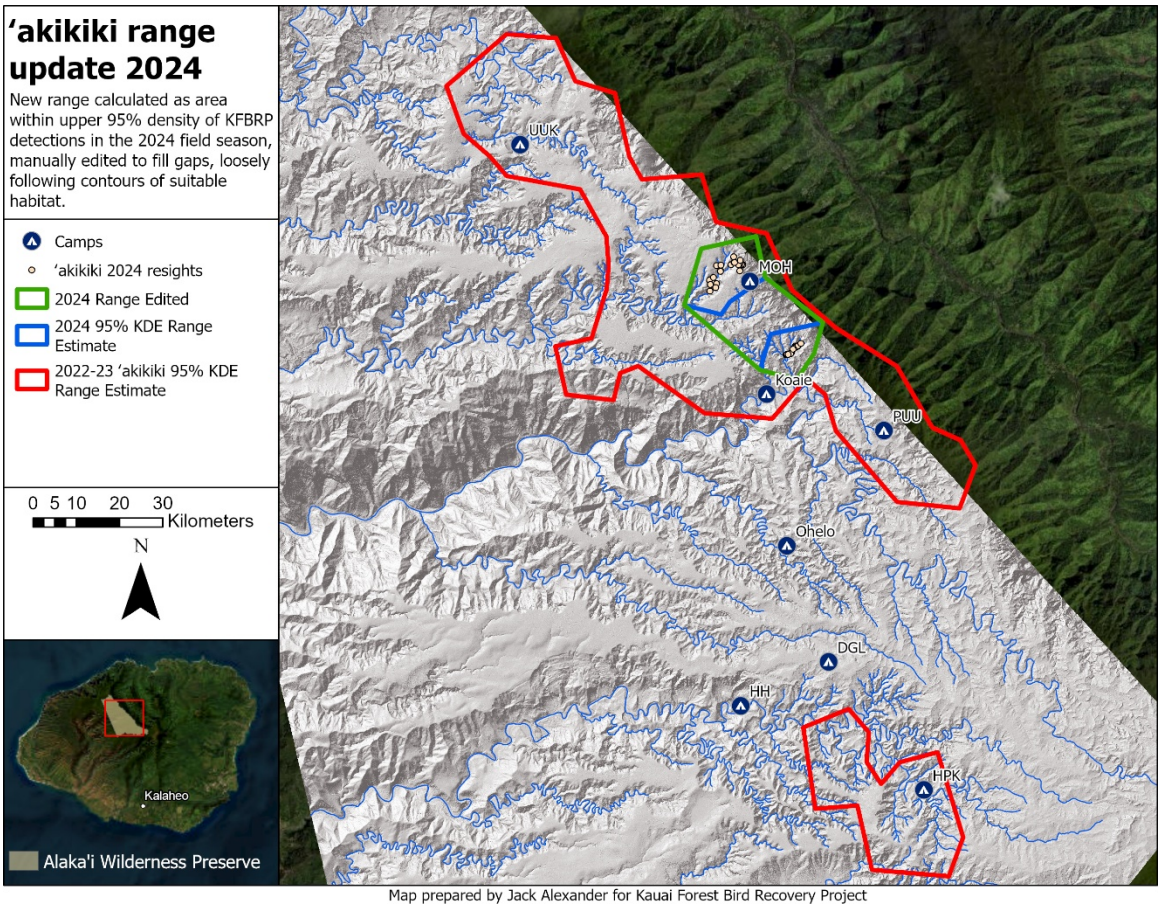
SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank G1—Critically Imperiled
IUCN Red List Ranking—Critically Endangered
Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2006
Kauai Islandwide Recovery Plan – USFWS 2021

SPECIES INFORMATION: The ʻakikiki, or Kauaʻi creeper, is a small, drab Hawaiian honeycreeper (Family: Fringillidae) endemic to the island of Kauaʻi. Both males and females are predominantly dark gray to olive above, whitish below. ʻAkikiki have pinkish legs and feet, and their short, slightly decurved bill also is pink. Usually found in pairs, family groups, or small flocks (8 – 12 individuals); during the non-breeding season ʻakikiki join mixed species foraging flocks. ʻAkikiki gleans and probes the bark and lichens and moss on trunks, branches, and twigs of live and dead ʻōhiʻa (*Metrosideros polymorpha*) and koa (*Acacia koa*) trees for insects and spiders. They usually nest high (9 meters or higher) in the terminal branches of ʻōhiʻa, but one female has been observed nesting in ōlapa on two occasions. Nest construction begins in early March, and continues into June; males occasionally help with nest building. Most nests contain two eggs, some contain only one egg. Both males and females feed chicks. Despite a long period of parental dependency, manycases of double brooding havebeen observed, with the male provisioning both the incubating female and the older chicks. Causes of nest failure include predation, likely by rats, poor female attendance, infertility, weather, and hatch failure.

DISTRIBUTION: As of 2024, apparently extirpated throughout most of its recent range in the Alakaʻi Wilderness Preserve, including Halepaʻakai, with a few individuals still occuring in and near the headwaters of Mohihi Stream and side drainages feeding Koaie Stream where it turns west. Occupancy rates in 2012 increased from west to east along the plateau, from 0.02 ± 0.07 near Koke'e State Park to 0.55 ± 0.21 in the southeast part of the range, and were positively correlated with canopy height. The suitable habitat range was recently estimated at ~38km^2 and suitable nesting habitat ~18 km^2 (Fricker et al. 2021), but newer estimates in 2004 suggest that it is only 94 ha (233 ac; KFBRP, unbubl. data). Historically occupied high- and low-elevation forests, although by the 1960s was most common above 1,140 meters (3,750 feet), and is now

restricted to those higher elevations. Subfossil remains suggest a prehistoric island-wide distribution.

ABUNDANCE: The Kauaʻi Forest Bird Survey (KFBS 2000), estimated the population at 2,448 ± 1,200 (SE) birds. Density estimates were 26 birds per square kilometer; 15 percent lower than in 1981. In 2012, the KFBS estimated density at 8.8 birds per square kilometer, and the population at only 468 (95% confidence interval: 231-916) birds. In 2024, despite extensive surveys through its former range, only four-five individuals were detected, although it is possible that a few more individuals occur on private land or escape detection due to lack of intensive survey effort.



Map prepared by Jack Alexander for Kauai Forest Bird Recovery Project

LOCATION AND CONDITION OF KEY HABITAT: Currently restricted to elevations > 1200 m (mean 1304.5 ± 38.5 m; Fricker et al. 2021) and are found only in the wet tropical rainforest of the eastern Plateau. Occupancy is positively correlated with elevation and large trees (i.e., canopy height) and canopy density. They also exhibit a tendency to nest along lower slopes (e.g., along streams in areas of higher canopy height, and more complex understory (Fricker et al. 2021). The montane forests of Kauaʻi are dominated by ʻōhiʻa with a subcanopy comprising ʻōlapa or lapalapa (*Cheirodendron* spp.) and ʻōhiʻa hā (*Syzygium sandwicensis*). Common understory species include ʻōhelo (*Vaccinium calycinum*), kanawao (*Broussaisia arguta*), ʻōhā wai (*Clermontia* spp.), kāwaʻu (*Ilex anomala*), kōlea (*Myrsine lessertiana*),

na‘ena‘e (*Dubautia spp.*), and pūkiawe (*Styphelia tamieameiae*). Occupancy is very low in areas invaded by non-native plants.

THREATS:

- Disease. Mosquitoes likely are ubiquitous on Kaua‘i, and avian malaria and avian pox are likely the most important factors limiting the species’ distribution. Five of 42 ‘akikiki have tested positive for malarial antibodies between 2011 and 2023; some were later resighted, indicating that a few individuals have resistance or tolerance. However, three of the individuals that tested positive were caught in 2022, and one was resighted up to nine months later, but then disappeared. The recent dramatic population declines indicate that avian malaria is a primary threat to this species. Pox lesions have been observed on several birds in the wild, and pox was implicated in the mortality of several individuals transferred to human care in 2023 (KFBRP and SDZWA, unpubl. data).
- Habitat degradation. Pigs (*Sus scrofa*) and goats (*Capra hircus*) have contributed to the spread of non-native plants, but effects to ‘akikiki are unknown. Severe hurricanes in 1982 and 1992 heavily damaged native forests, possibly resulting in short-term reductions in arthropod food resources and long-term damage to forest structure preferred by ‘akikiki, given their affinity for large trees, which are now rare on the landscape
- Natural disasters. Hurricanes in 1982 and 1992 likely caused the death of an unknown number of individuals.
- Competition. Although little evidence exists, it has been suggested that competition with introduced Warbling white-eyes (*Zosterops japonicus*) and Japanese bush warblers (*Horornis diphone*) may negatively affect ‘akikiki. Non-native insects, especially yellow jackets and ants, may compete with or prey on the native arthropods on which ‘akikiki feed. The role of non-native insects in native Hawaiian forests is unclear.
- Predation. Predation by rats (*Rattus* spp.), on eggs has been documented in several instances; predation on chicks and females is suspected in a few cases. Cats (*Felis catus*), Hawaiian short-eared owls (*Asio flammeus sandwichensis*), and barn owls (*Tyto alba*) occur throughout the forests of Kaua’i, and may prey on young and adults.
- Population size. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios and stochastic factors include natural disasters. Habitat fragmentation exacerbates demographic and genetic problems. Some of the observed infertility and failure to hatch may be due to these small population issues.

CONSERVATION ACTIONS: ‘Akikiki likely have benefited from actions to conserve other endangered forest birds including establishment of the Alaka‘i Wilderness Preserve, regular surveys of forest bird populations, monitoring habitat conditions, studies of disease and disease vectors, control of feral ungulates through public hunting and fencing, control of feral ungulates through public hunting and fencing, suppression of rats on two A24 trapping grids over approximately 150 ha (470 ac), and public education efforts. Between 2015 and 2018, approximately eggs were collected to initiate captive flock of about 45 individuals. Six adults and subadults were added to the flock between 2021 and 2023, but only the single subadult survives. Overall, mortality and reproduction are approximately even in the captive population,

thus the current flock numbers still about 43 birds.s. In addition to these efforts, future management specific to the recovery of ‘akikiki may include:

- Continue to collect wild 'akikiki adults, subadults, chicks, and eggsAggressively control ungulates to improve habitat quality and facilitate recovery of degraded, but potential, habitat. It could also reduce breeding habitat for mosquitoes. Control of non-native plants should be part of forest restoration efforts.
- Reduce or manage mosquito breeding habitat on the Alaka’i Plateau a
- Suppress mosquito populations through releases of incompatible or sterile mosquitoes
- Investigate options to eradicate mosquitoes, including use of genetic manipulations.
- Suppress/control rats, feral cats, and barn owls from the Alaka‘i Wilderness Preserve, Na Pali-Kona Forest Reserve, and Koke;e State Park.
- Prevent the introduction of the small Indian mongoose *(Herpestes auropunctatus*) and other potential predators.
- Conduct public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.
- Prevent the spread of Rapid Ohia Death on the Alaka’i Plateau

MONITORING: Conduct species-specific monitoring for ‘akikiki (e.g., occupancy surveys with play back, territory monitoring) that take into account the inability of the HFBS to track populations of rare species.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the ‘akikiki include the following:

- Investigate techniques for improving survival and reproduction of the captive flock
- Conduct PVAs for captive flock, including impact of reintroduction back into the wild once malaria is controlled
- Investigate and evaluate different strategies for reintroducing the population to the wild
- Continue to assess the susceptibility of this species to avian malaria and avian pox.
- Determine sources of mosquitoes and investigate methods of mosquito control.
- Determine the effects of recently established non-native insects on native arthropods, especially those that are part of the species’ diet.
- Investigate efficacy of other methods of controlling invasive rodents (e.g., different methods of applying rodenticide, snap traps).
- Assess the impact of introduced rodents on food sources important to 'akikiki.
- Investigate the feasibility of food supplementation.

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Photo: Robby Kohley

Forest Birds

ʻĀkohekohe or Crested honeycreeper

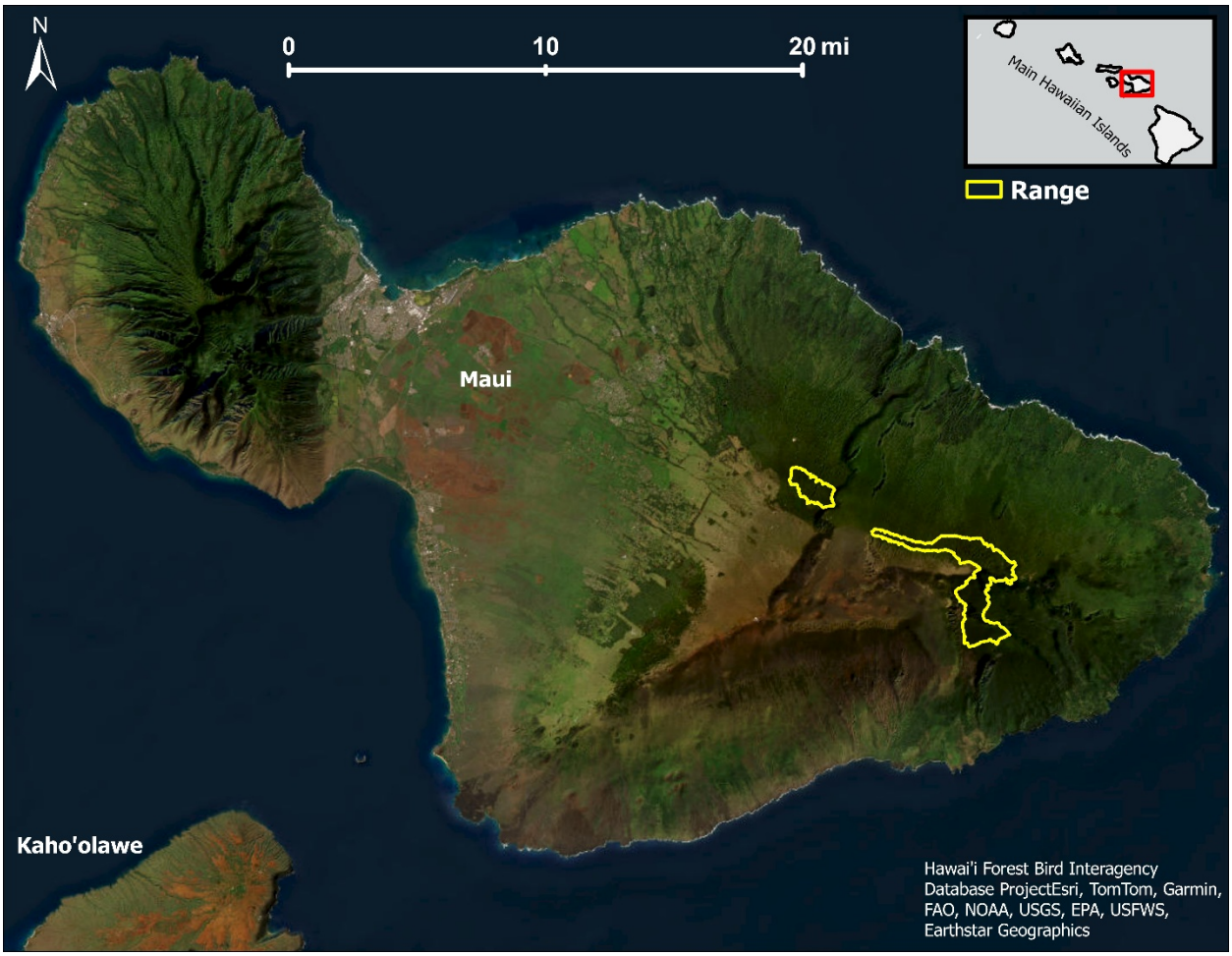
Palmeria dolei

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank G1—Critically Imperiled
IUCN Red List Ranking—Critically Endangered
Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: The ʻākohekohe, or crested honeycreeper (Family: Fringillidae), is the largest extant honeycreeper on Maui Nui (Lānaʻi, Molokaʻi, Maui, and Kahoʻolawe). Although primarily black, the plumage of the ʻākohekohe is striking. Depending on their location, feathers are tipped with orange-yellow, gray, silver, or white. Orange feathers surround the eyes and extend over the nape, orange or yellow-white feathers cover the thighs, the epaulettes are white with orange tips, and there is a distinctive plume of white feathers that curl forward over the bill. They do not sing, but produce a random series of buzzes, croaks, and whistles. They are primarily nectarivorous, feeding mainly on ʻōhiʻa (*Metrosideros polymorpha*), but also from the flowers of other trees and shrubs, such as 'ākala (*Rubus hawaiensis*) and kōlea (*Myrsine* species). Like ʻapapane (*Himatione sanguinea*) and ʻiʻiwi (*Vestiaria coccinea*), ʻākohekohe are strong fliers and will move from low to high elevations in search of blooming ʻōhiʻa. Arthropods, mainly gleaned from ʻōhiʻa, are also part of the species' diet. They spend up to 70 percent of the day foraging. They aggressively defend feeding and nesting territories year-round. Females build open-cup nests primarily in ʻōhiʻa, incubate the clutch of one or two eggs, and brood nestlings; male feeds female on nest. Fledglings can forage independently 10 to 14 days after leaving the nest. Pairs successfully fledge two to three broods per season.

DISTRIBUTION: Restricted to a 24 square kilometer (9 square mile) area on the northeastern slope of Haleakalā at 1,600 to 2,300 meters (5,200 – 7,000 feet). Subfossil evidence indicates they once occurred in Maui's lowland dry forests, and they also once occurred on eastern Molokaʻi. They currently occupy 2 percent of their historical range.

ABUNDANCE: The Hawaii' Forest Bird Survey . from 2022 estimated the population at 1768 ± 315 (95% CI 1193–2411) individuals, a 78% decline from 2001.



LOCATION AND CONDITION OF KEY HABITAT: Wet and mesic montane forests dominated by ʻōhiʻa and ʻōlapa (*Cheirodendron trigynum*); koa (*Acacia koa*) and kāwaʻu (*Ilex anomala*) occur at lower densities. Nearly all birds occur in forest between 1,700 and 2,100 meters (5,700 – 6,900 feet) elevation in rugged, steep terrain with a dense understory. The entire known range of the species occurs within State (e.g., Forest Reserve and Natural Area Reserve), Federally (e.g., National Park), or Privately (e.g. The Nature Conservancy) managed lands.

THREATS: ʻĀkohekohe are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including habitat loss and degradation, predation by introduced mammals, and disease. For ʻākohekohe, the following are of particular concern:

- Disease. Similar to ʻapapane and ʻiʻiwi, movements between low- and high-elevation foraging sites may increase these birds' exposure to mosquito-borne diseases.
- Habitat degradation. Feral pig (*Sus scrofa*) damage to understory vegetation may reduce the availability of nectar-producing plants important to ʻākohekohe, especially those flowering when ʻōhiʻa nectar is less available.
- Population size. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios and

stochastic factors include natural disasters. Habitat fragmentation exacerbates demographic and genetic problems.

CONSERVATION ACTIONS: Captive propagation of ʻākohekohe was attempted decades ago but was not successful. ʻĀkohekohe likely benefited from actions to conserve other endangered forest bird species on the northeastern slope of Haleakalā, including fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future actions specific to ʻākohekohe may include the following:

- Establish a second population to reduce the chances that a catastrophe could result in the species' extinction. Potential re-introduction sites (e.g., West Maui and Molokaʻi) are limited because of the presence of mosquitoes; therefore, it has been prioritized to research potential locations for a conservation translocation on Hawaiʻi Island which has more high elevation native protected forest than Maui.
- Capture and hold a small number of individuals to develop and adaptively manage captive holding conditions to reduce stress and promote breeding/cohabitation. These efforts would inform if and/or how captive holding can be used as part of the conservation strategy for this species.
- Develop and deploy mosquito control techniques as soon as possible to reduce the mosquito vector of avian disease.
- Continue fence management and feral pig control to improve understory conditions in occupied habitat and potentially facilitate expansion of ʻākohekohe populations if and when mosquito control occurs.
- Conduct public outreach and education. Incorporate Hawaiian knowledge and practices in conservation strategies
- Continue protection and management of wildlife sanctuaries and refuges.
- Develop and deploy new tools and evaluate above approaches.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to ʻākohekohe include the following:

- Determine if disease-resistant individuals exist, and if so, if resistance is passed to offspring. Disease-resistant individuals could be used to establish new populations.
- Determine the role of ʻākohekohe in transmitting disease between high- and low-elevation habitats.
- Determine if a conservation translocation if feasible to Hawaiʻi Island and develop translocation and field holding protocols.

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Photo: DOFAW

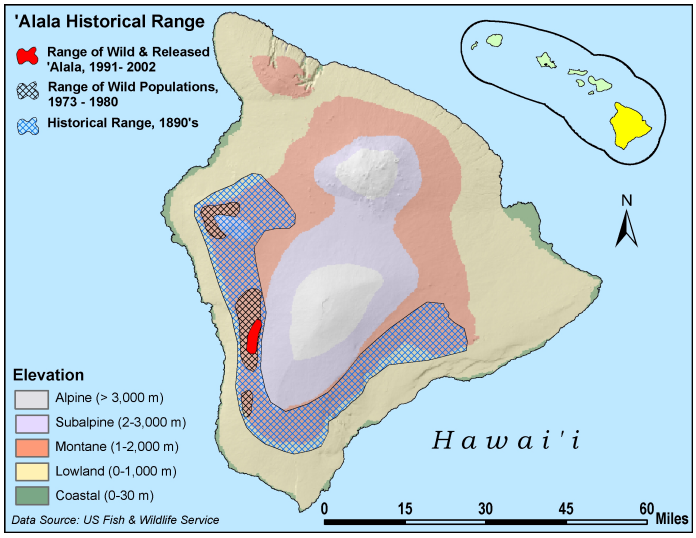
Forest Birds

ʻAlalā or Hawaiian crow

Corvus hawaiiensis

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank: GXC-Presumed Extinct/ Captive Population
IUCN Red List Ranking—Extinct in the Wild
Revised Recovery Plan for the ʻAlalā —USFWS 2009

SPECIES INFORMATION: Historically at least five crow species (Family: Corvidae) occurred in Hawaiʻi, only the ʻalalā, or Hawaiian crow survives. Like other crows, ʻalalā are raucous, gregarious and vocal; young, captive-raised birds often engage in tug-of-war with sticks. Like many corvids, ʻalalā are long-lived with a life span of 20 or more years. The diet primarily consists of native and introduced fruits, invertebrates, and eggs and nestlings of other forest birds, as well as nectar, flowers and carrion. Seasonal movements in response to weather and availability of food plants (e.g., ʻieʻie [*Freycinetia arborea*]) have been noted. Although individuals form long-term pair bonds, extra-pair copulations have been observed. Nests are predominantly constructed in ʻōhiʻa (*Metrosideros polymorpha*) trees. Both sexes participate in nest construction, although only females incubate eggs and brood young. Clutch size ranges from two to five, although usually only one or two nestlings fledge. Fledglings typically cannot fly and often remain near the ground for long periods, likely increasing their susceptibility to disease (i.e., toxoplasmosis) and predation. Juveniles depend on their parents for at least eight months and remain with their family group until the following breeding season. Large flock's characteristic of American



crows (*C. brachyrhynchos*) have not been reported, but there are historical reports of small local flocks after the breeding season.

DISTRIBUTION: No individuals are known to exist in the wild. Historically occurred in high- and low-elevation forests of the western and southeastern regions of the island of Hawai‘i.

ABUNDANCE: World population of 108 individuals in 2024, housed entirely in the Keauhou and Maui Bird Conservation Centers.

LOCATION AND CONDITION OF KEY HABITAT: Historically, ‘alalā occupied dry and seasonally wet ‘ōhi‘a and ‘ōhi‘a/koa (*Acacia koa*) forests between 300 and 2,500 meters (1,000 – 8,200 feet) elevation. Because the last wild individuals were confined to a small subset of the species’ former range, specific knowledge of key habitat requirements are unknown. Currently, all potential habitat is degraded. The presence of non-native mammalian predators and birds, which can act as disease reservoirs, further reduces habitat quality. Core areas of the species’ former range are now managed by the State of Hawai‘i and the U.S. Fish and Wildlife Service.

THREATS: ‘Alalā are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. For ‘alalā populations, the following are of particular concern:

- Predation. The small Indian mongoose, rats, and feral cats prey on ‘alalā. The ‘io (*Buteo solitarius*) and presumably pueo (*Asio flammeus sandwichensis*) also prey on juvenile and adults. ‘Io have been documented killing captive-raised birds released into the wild. Fledglings are unable to fly and this likely contributes to high rates of predation.
- Shooting. Many ‘alalā were killed around farms between 1890 and 1930. Despite legal protection in 1931, shooting of individuals occurred into the 1980s.
- Disease. Population declines were noted between 1890 and 1910, a period when other native bird populations declined, presumably because of mosquito-borne diseases. Seasonal movement may have increased exposure to diseases. In addition, ‘alalā are susceptible to toxoplasmosis spread by the parasite’s obligate host, domestic cats (*Felis catus)*
- Habitat degradation. Habitat conversion by human activity as well as by grazing ungulates has severely degraded former ‘alalā habitat. These changes may have limited food or nesting resources and may have increased the vulnerability of ‘alalā to predation by ‘io. Currently, little suitable habitat exists for the species.
- Population size. Small populations are plagued by a variety of potentially irreparable problems which fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios.
- Captive-breeding. There is some evidence that captive-reared birds lack important foraging and predator-avoidance behaviors.

CONSERVATION ACTIONS: The ‘alalā has been legally protected by the State of Hawai‘i since 1931 and was listed as federally endangered in 1967. A captive propagation program was established in 1973; crows are now housed at the Keauhou Bird Conservation Center and the

Maui Bird Conservation Center. The ‘Alalā Recovery Team was formed to facilitate the species recovery, and a related second group, the ‘Alalā Partnership, was formed to facilitate program implementation on private lands. Between 1993 and 1998, 27 captive-raised juvenile ‘alalā were released at McCandless Ranch. Of these, 21 died in the wild and six were recaptured and returned to the captive flock. Predator control was ongoing during the release program. Intensive field studies of the wild population and released juveniles were conducted between 1992 and 2002. In 1999, the Kona Forest Unit of Hakalau Forest National Wildlife Refuge was acquired, with the goal of restoring habitat in the core of the species’ historic range. Recent release efforts were made from 2016 to 2019 in the Pu'u Maka’ala Natural Area Reserve on Hawai’i Island. This is a fenced area, free of ungulates, creating a dense understory containing many plants suitable for ‘alalā to eat. This set of releases showed improvements and were considered successful due to birds surviving for multiple years and one pair observed nesting. ‘Alalā mortalities increased in 2020 due to predation from ‘io or Hawaiian hawk (*Buteo solitarius*) and other factors, ultimately causing the remaining individuals to be brought back into captivity. Future plans for ‘alalā releases include a release on Maui within the Kipahulu Forest Reserve where birds can live without the presence of ‘io and new findings from the release can apply to future releases on Hawai’i island. Additionally, efforts have be made to research ‘io behavior to help inform site selection for Hawaii’ island.

Restoration of future re-introduction sites is ongoing and re-introductions are expected to occur in the near future. In addition to the above efforts, ‘alalā likely will benefit from management activities to conserve other endangered forest birds on the island of Hawai‘i including fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future management specific to the ‘alalā should include the following:

- Continue restoration of future reintroduction areas.
- Maintain and increase the captive flock without further loss of genetic diversity.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: The captive flock is monitored. When re-introduction occurs, wild populations will be intensively monitored.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the ‘alalā include the following:

- Review all data from studies on captive and wild populations.
- Determine methods to increase the reproductive output of captive individuals.
- Conduct field studies to determine if understory restoration will reduce the ability of ‘io to prey on ‘alalā.
- Establish a set of habitat criteria that must be met prior to release of birds at a particular site.
- Develop methods to habituate captive-raised individuals to respond appropriately to mammalian and avian predators, and sources of toxoplasmosis.

- Determine potential reintroduction sites on other islands.

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Photo: Jim Denny

Forest Birds

ʻAnianiau or Lesser ʻamakihi

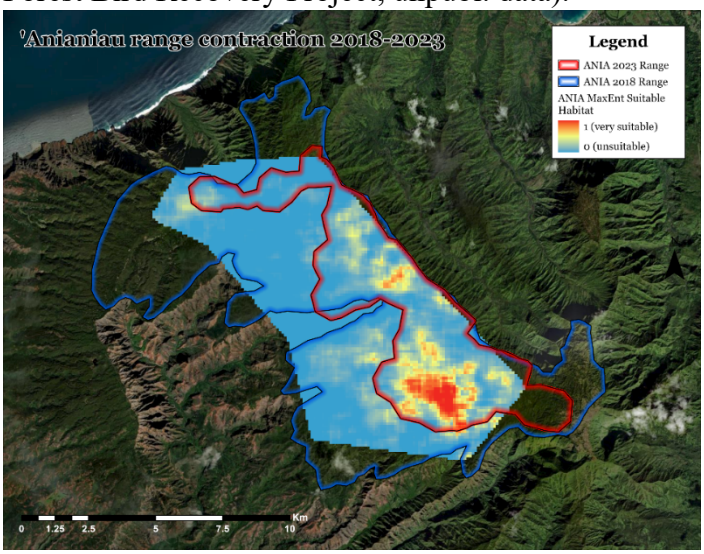
Magumma (Hemignathus) parva

SPECIES STATUS:
State Recognized as Endemic
NatureServe Heritage Rank G2—Imperiled
IUCN Red List Ranking—Endangered

SPECIES INFORMATION: The ʻanianiau is the smallest Hawaiian honeycreeper (Family: Fringillidae). Endemic to Kauaʻi, the ʻanianiau also is one of the most common native birds of the island's high-elevation forests. Adult males are brilliant yellow; females also are yellow, but may be duller, although some bright females have been observed. Constantly on the move, ʻanianiau feed on nectar from ʻōhiʻa (*Metrosideros polymorpha*), ʻōhelo (*Vaccinium* spp.), ʻalani (*Melicope* spp.), and other native and introduced plants. They also glean arthropods from the outer canopy and smaller twigs and branches of ʻōhiʻa and koa (*Acacia koa*) trees as well as from the foliage of shrubs, vines, and the fronds of tree ferns (*Cibotium* spp.). Nectar, spiders, and Lepidoptera larvae compose the bulk of the species' diet. ʻAnianiau are occasionally seen in small flocks, especially at favored nectar sources. Males sing a sweet, high-pitched trill, and predominantly defend breeding territories that may be as small as 9 meters (29.3 feet) in diameter. Both sexes build the open-cup nest, females incubate eggs and brood young, and males provision females, generally away from the nest. No information on post-fledgling behavior or dependency. ʻAnianiau nest success rate in 2012 and 2013 was 0.56 (±0.09, Hammond et al. 2015).

DISTRIBUTION: May occur as low 774 m elevation in native forests of the Kōkeʻe and Alakaʻi regions, but are becoming scarce in the formerregions. However, the lowest elevation detection in 2024 was at 1131 m (KFBRP, unpubl. data). Original range likely included all forested regions of Kauaʻi. **N**otable range contractions of more than 60% occurred between 2018 and 2023 with the 'anianiau now occupying a range of approximately 3648 ha (9014 ac; Kaua'i

Forest Bird Recovery Project, unpubl. data).



ABUNDANCE: In the early 1970s the island-wide ʻanianiau population was estimated at 24,000 ± 3,000 (SE) individuals. The Kauaʻi Forest Bird Survey (2000) estimated the population within the Alakaʻi Wilderness Preserve and Kōkeʻe region at close to 35,000 individuals, with a significant population increase between 1981 and 2000. Although the 2008 surveys suggested that the population appeared stable in its current range, the population was estimated around only 10,000 individuals in 2018 (Paxton et al. 2020). The 2023 surveys suggestedfurther declines e to 3,827 individuals in 2023 (DOFAW, unpublished data). .

LOCATION AND CONDITION OF KEY HABITAT: Mesic and wet forests above 1000 meters (2,000 feet), with the highest densities above 1,200 meters (3,600 feet). These forests are dominated by ʻōhiʻa, koa, ʻōlapa (*Cheirodendron trigynum*), and lapalapa (*C. platyphyllum*). At lower elevations, where the species historically occurred, native habitats are severely degraded. Although public hunting reduces the number of feral ungulates in the most accessible parts of the species' range, hunting is not an effective method to prevent habitat degradation across its entire range. Occupied habitats are largely managed by the State of Hawaiʻi, although a few individuals may occur on private lands around the Plateau.

THREATS:

- Disease. Thirteen of 129 ʻanianiau sampled between 2011 and 2023 tested positive for malarial parasites (*Plasmodium relictum*) in areas where parasites were common in other species. Since malaria is established on the Alakaʻi Plateau, the most likely explanation for this low prevalence is high mortality after infection with malaria. Avian malaria is likely the primary threat to the species. Research comparing mortality between Kauaʻi honeycreepers (ʻanianiau and ʻakikiki) and non-honeycreepers (puaiohi and Kauaʻi ʻelepaio), found that the honeycreepers were much more susceptible to avian malaria (Whitaker 2022).

The rare Maui Parrotbill— Photo by Eric Nishibayasl

- Habitat degradation. The species is tolerant to habitat alteration, but it is most common in undisturbed native forest. Introduction of non-native plants is the most important threat as ‘anianiau density is negatively related to the presence of non-native shrubs.
- Competition. Competition with introduced Japanese white-eyes (*Zosterops japonicus*) may negatively affect ‘anianiau. Non-native insects, especially yellow-jackets (*Vespula pensylvanica*) and ants (*Linepithema humile*), may compete with or prey on the native arthropods on which ‘anianiau feed. The role of non-native insects in native forest ecosystems is unclear.
- Mammalian predators. Rats (*Rattus* spp.), cats (*Felis catus*), Hawaiian short-eared owls (*Asio flammeus sandwichensis*), and barn owls (*Tyto alba*) occur throughout the forests of Kaua’i. Hammond et al. 2015 found evidence of ‘anianiau nest predation in the form of trail camera pictures, egg-shell fragments in the nest and even chick remains.

CONSERVATION ACTIONS: ‘Anianiau likely benefit from actions to conserve other endangered forest birds including establishment of the Alaka‘i Wilderness Preserve, regular surveys of forest bird populations, habitat monitoring, studies of disease and disease vectors, control of feral ungulates through public hunting and fencing, suppression of rats on two A24 trapping grids over approximately 150 ha (470 ac), and public education featuring Kauai’s endangered forest birds. Conservation efforts should include continued protection and management of wildlife sanctuaries and refuges Since the population is declining rapidly, collection of ‘anianiau adults and eggs has been implemented to establish an ex situ insurance population, with three birds currently in human care. .In addition to these efforts, future actions specific to the ‘akeke‘e may include the following:

- Aggressively control ungulates to improve habitat quality, facilitate the recovery of degraded habitat, and potentially reduce breeding habitat for mosquitoes. Control of non-native plants should be part of forest restoration efforts.
- Eradicate or manage mosquito breeding habitat on the Alaka’i Plateau
- Suppress mosquito populations through releases of incompatible or sterile mosquitoes
- Investigate options to eradicate mosquitoes, including use of genetic manipulation.
- Suppress/control rats, feral cats, and barn owls from the Alaka‘i Wilderness Preserve, Na Pali-Kona Forest Reserve, and Kōke‘e State Park
- Prevent the introduction of the small Indian mongoose (*Herpestes auropunctatus*) and other predators.
- Prevent the spread of Rapid Ohia Death on the Alakai Plateau
- Conduct public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the ‘anianiau include:

- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology and success of this poorly known species.
- Investigate techniques for improving survival and reproduction of the captive flock
- Conduct PVAs for both wild and captive flocks
- Investigate the feasibility of ‘anianiau translocation to Hawai’i Island
- Determine species specific avian malaria mortality rate and if potential resistance is passed to offspring. Disease-resistant individuals could be used as founders for new populations.
- Investigate efficacy of other methods of controlling invasive rodents (e.g., different methods of applying rodenticide, snap traps)
- Assess the impact of introduced rodents on food resources (e.g., floral, invertebrates) important to 'anianiau
- Determine if competition with Warbling white-eyes or Japanese Bush-warblers occurs, and if so, its effect on ‘anianiau populations.
- Determine the effects of recently established non-native insects on native arthropods, especially on those arthropods that are part of the species’ diet.
- Determine the status of populations outside of the greater Alaka‘i Swamp region.

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Photo: Eric Nishibayashi

Forest Birds

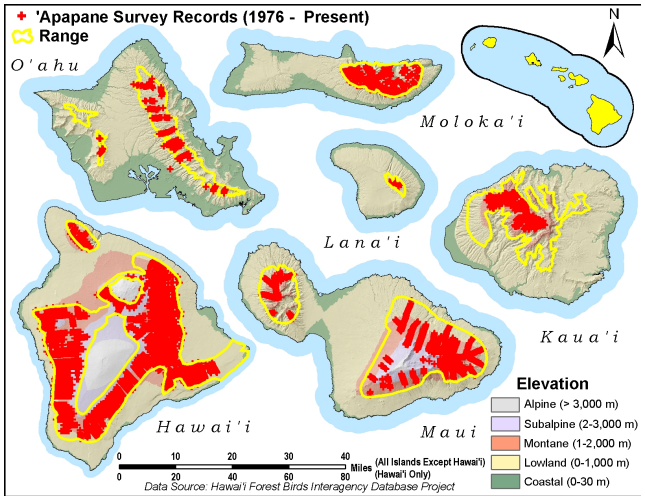
ʻApapane

Himatione sanguinea

SPECIES STATUS:
State Recognized as Endemic
NatureServe Heritage Rank G3—Vulnerable
IUCN Red List Ranking— Least Concern

SPECIES INFORMATION: The ʻapapane is a small, crimson, primarily nectarivorous Hawaiian honeycreeper (Family: Fringillidae) and is an important ʻōhiʻa (*Metrosideros polymorpha*) pollinator. It is the most abundant and widely distributed Hawaiian honeycreeper, and is often seen flying above the canopy in search of patches of flowering ʻōhiʻa. Wide-ranging movements may facilitate disease transmission among native forest birds. ʻApapane often forage in conspecific flocks, likely to overwhelm ʻiʻiwi (*Vestiaria coccinea*) and ʻākohekohe (*Palmeria dolei*), which often defend flower-rich trees. Outside the breeding season, ʻapapane also join mixed-species flocks. They feed on insects, which they glean from outer foliage and twigs in the upper- and mid-canopy. Sexual chasing and courtship feeding often precede nest building, a task shared by both male and female. Pairs defend small territories around nests. Females incubate three eggs and brood young; males feed females away from the nest. Both parents feed nestlings, and fledglings may remain with their parents for up to four months.

DISTRIBUTION: Occurs in native forests above 1,250 meters (4,100 feet) on the islands of Hawaiʻi, Maui, and Kauaʻi. On Oʻahu, occurs in the Koʻolau Range from 300 meters (975 feet) to summit at 946 meters (3,075 feet), and are less common in the Waiʻanae Range above 600 meters (1,950 feet). Rare on Molokaʻi and Lānaʻi. Historically were common at low elevations on all islands with appropriate habitat.



ABUNDANCE: Based on Hawaiian Forest Bird Surveys (1976-1981): 1,080,000 ± 25,000 (95% confidence interval) birds on island of Hawaiʻi, 110,000 ± 9,000 on Maui (86% on Haleakalā), 39,000 ± 5,000 on Molokaʻi, 540 ± 213 on Lānaʻi, and 30,000 ± 1,500 on Kauaʻi (Oʻahu was not included in surveys). On Kauaʻi, populations declined after the 1992 hurricane but have significantly increased since, estimated at

64,972 ± 2,014 (SE) birds in 2000 then at 95,511 in 2023 (95% CI: 85,433-107,052; DOFAW, unpublished data). Rare on Molokaʻi and Lānaʻi.

Maui nui updated numbers-
East Maui- 228,480 ± 19,855 individuals
West Maui- we don't have an updated estimate, but they are the most commonly detected species on counts. 4.53 detections per station.
Lanai- they continue to be detected on Lanai in small numbers, based on surveys from 2023.
Molokai- 81,896 ± 10, 836

LOCATION AND CONDITION OF KEY HABITAT: Mesic and wet forests dominated by ʻōhiʻa and koa (*Acacia koa*), primarily at elevations greater than 1,250 meters (4,100 feet) but can be found as low as 500m (1600ft). The primary reason for this limitation is the high density of cold-intolerant *Culex* mosquitoes, an important disease vector, below this elevation. Occupied habitats also contain kōlea (*Myrsine lessertiana*), naio (*Myoporum sandwicense*), and hapuʻu tree ferns (*Cibotium* spp.). Māmane (*Sophora chrysophylla*) is common in high-elevation foraging habitat. Although much of the species' current range is under State or Federal jurisdiction, habitat protection and restoration efforts vary considerably.

THREATS: Although populations appear stable on the islands of Hawaiʻi, Maui, and Kauaʻi, they are likely susceptible to the same factors that threaten other native Hawaiian forest birds including habitat loss and degradation, predation by introduced mammals, and disease. For ʻapapane the following is of particular concern:

- Disease. Of Hawaii's native forest birds, ʻapapane have the highest prevalence of avian malaria. Individuals infected with avian pox also are more likely to be infected with malaria. Foraging movements may increase their exposure to disease. ʻApapane breed in mid-elevation forests, which suggests some disease resistance.
- Predation. Predation on adults and nests by rats (*Rattus* spp.), cats (*Felis catus*), the small Indian mongoose (*Herpestes auropunctatus*), and owls (*Asio flammeus sandwichensis, Tyto alba*) may limit the species. Likely because they are so abundant, oberservations have been made of direct depredation events by these predators.

CONSERVATION ACTIONS: ʻApapane likely benefited from actions to conserve other endangered forest birds on northeastern Haleakalā, Hakalau Forest National Wildlife Refuge, Hawaiʻi Volcanoes National Park, the ʻŌlaʻa/Kīlauea Watershed Partnership, and Alakaʻi Wilderness Preserve and surrounding areas. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. Future actions specific to the protection of ʻapapane may include the following:

- Control mosquitos and non-native predators across native forest habitat.
- Conduct public education and outreach.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring on all islands.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to ‘apapane include the following:

- Determine if disease-resistant individuals exist and if so, if resistance is passed to offspring. Disease-resistant birds could be used to found of new populations.
- Determine the role of ‘apapane in disease transmission between high- and low-elevation habitats.
- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology, and success of this poorly known species, especially with small populated locations like Lāna'i.

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Picture: Rothschild Collection

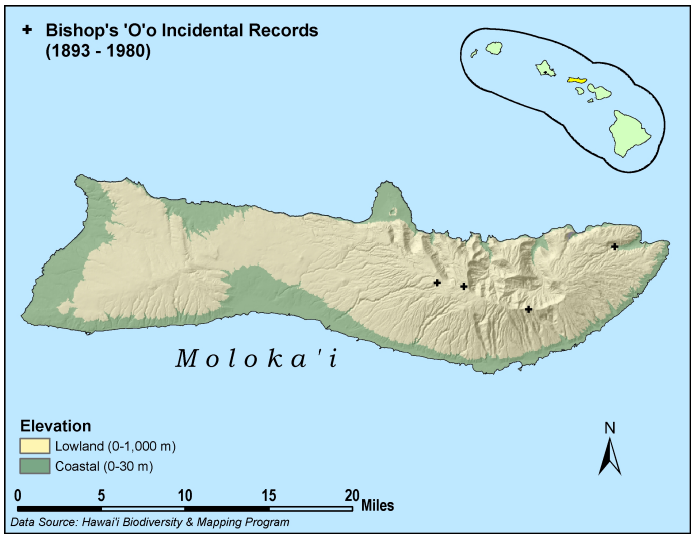
Bishop's ‘ō ‘ō

Moho bishopi

SPECIES STATUS:
Federally Listed as Extinct
State Recognized as Extinct
NatureServe Heritage Rank GH—Possibly Extinct
IUCN Red List Ranking—Extinct
Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: Known only from Moloka‘i, Bishop's ‘ō‘ō is a large, noisy honeyeater (Family: Meliphagidae). This striking species is black with yellow ear patches, under tail coverts, and maxillary tufts; sexes are similar. The bird's vocalizations have been described as varied and "unlike any other native bird." Bishop's ‘ō‘ō appears to be primarily nectavorous, preferring lobelia (Campanulaceae) flowers. Little is known about this species' life history and nothing is known about its nesting biology.

DISTRIBUTION: Unknown. Probably extinct. Historic range of Bishop's ‘ō‘ō likely included all native forests of eastern Moloka‘i**.** Subfossils suggest it may have occurred on Maui. Sightings in the 1980s of a possible ‘ō‘ō species on Maui were never confirmed.



ABUNDANCE: Bishop's ‘ō‘ō was last observed in 1904 and is probably extinct. No information on historical abundance.

LOCATION AND CONDITION OF KEY HABITAT: Unknown. Bishop's ‘ō‘ō occupied the montane forests of eastern Moloka‘i. The areas where the species was last observed are managed by the State of Hawai‘i as a Natural Area Reserve or by private conservation entities (e.g., The Nature Conservancy) as a Natural Area Partnership Preserve.

THREATS: Unknown. However, Bishop's ʻōʻō likely were susceptible to the same factors that threaten other native Hawaiian forest birds including: loss and degradation of habitat, predation by introduced mammals, and disease. For Bishop's ʻōʻō populations, the following likely were of particular concern:

- Disease. The fact that no habitat above 1,250 meters (4,100 feet) occurs on Molokaʻi suggests disease may have played an important role in the species' decline.
- Hunting. Bishop's ʻōʻō were exploited for their feathers, which were used in Hawaiian featherwork articles such as capes and *kāhili* (feather standard). Exploitation may have increased with the introduction of firearms by Europeans.

CONSERVATION ACTIONS: If the species persists, it likely benefits from management activities to conserve other endangered forest birds on eastern Molokaʻi, including the establishment and management of protected areas, regular surveys of forest bird populations, monitoring of habitat conditions, and studies of disease and disease vectors. Should this species be rediscovered, the Rare Bird Recovery Protocol outlined in the U.S. Fish and Wildlife Service (USFWS) *Revised Recovery Plan for Hawaiian Forest Birds* would be implemented, and management in anticipation of that possibility should include continuing to protect and manage wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is likely extinct, there are no research priorities specific to Bishop's ʻōʻō.

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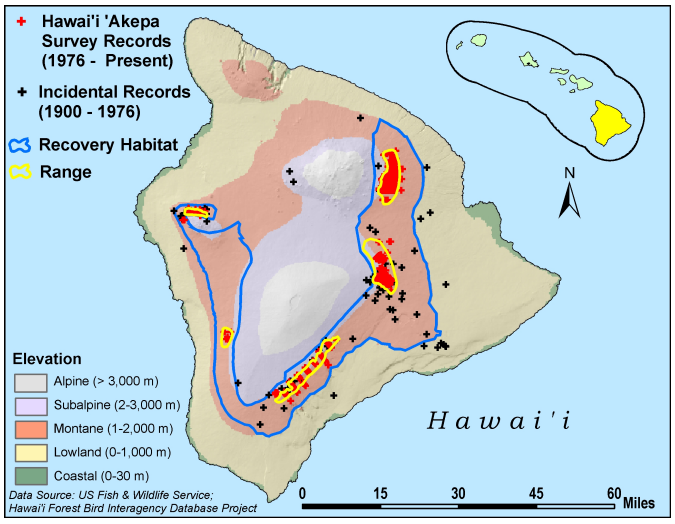
Forest Birds

Hawai‘i ‘ākepa

Loxops coccineus coccineus

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank G1—Critically Imperiled
IUCN Red List Ranking—Endangered
Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: The Hawai‘i ‘ākepa is a small, insectivorous Hawaiian honeycreeper (Family: Fringillidae) endemic to the island of Hawai‘i. ‘Ākepa also are known from Maui (*L. c. ochraceus*) and O‘ahu (*L. c. rufus*); both of which are likely extinct. Currently, all ‘ākepa are considered one species, although they are recognized as critically imperiled at the subspecies level. After three years, males obtain their bright orange adult plumage; subadult plumage is dull brownish orange, although individual variation is high. Females are grayish-green with a yellow breast band. The lower mandible of the ‘ākepa is slightly bent to one side which results in the mandible tips being offset; a characteristic shared with the ‘akeke‘e (*L. caeruleirostris*). The bend can be to the left or right, and depending on the direction of the bend, individuals also possess an accompanying leg asymmetry; the leg opposite the curve in the mandible is slightly longer than the other leg. Together, these adaptations likely improve the species foraging efficiency. They often join mixed-species foraging flocks, particularly those with Hawai‘i creepers (*Loxops mana*). They feed mainly on ‘ōhi‘a (*Metrosideros polymorpha*) leaf clusters, but also on koa (*Acacia koa*) leaves and seed pods, where it uses its bill to pry open leaf and flower buds in search of small arthropods. ‘Ākepa are obligate cavity nesters, with most nests placed in natural cavities found in old-growth ‘ōhi‘a and koa trees. Females build nests, incubate eggs, and brood nestlings, and males deliver food to the female on and off the nest. Both parents feed the young, which remain with their parents for two to three months after fledging.



DISTRIBUTION: Occurs in five disjunct populations above 1,300 meters (4,300 feet) elevation on the windward side of the island of Hawai‘i. Original

range likely included all forested regions of the island.

ABUNDANCE: The Hawaiian Forest Bird Survey (1976-79, 1983), estimated the population at 14,000 ± 2500 (95% confidence interval) birds. The south Kona and Hualālai populations were estimated at 660 ± 250 birds and are apparently declining.

LOCATION AND CONDITION OF KEY HABITAT: Occurs in ʻōhiʻa and ʻōhiʻa/koa forests above 1,300 meters (4,300 feet). Density appears to be related to the number of available cavities, and because cavities primarily occur in older, large trees, old-growth forests may be preferred. The highest density of ʻākepa occurs in the Pua ʻĀkala tract of Hakalau Forest National Wildlife Refuge, which has numerous large trees but a degraded understory. Many areas occupied by the species have been degraded by feral ungulates. Most of the current range of the Hawaiʻi ʻākepa is managed by State and Federal agencies or private conservation partnerships.

THREATS:

- Habitat degradation and loss. Logging and ranching has fragmented and reduced the amount of suitable habitat. Breeding density may be limited by nest-site availability and current levels of food availability may limit populations. In forest fragments, the large trees required for nesting may be more susceptible to windfall and desiccation. The slow growth rate of ʻōhiʻa complicates management for ʻākepa. In addition, habitat fragmentation may prevent or restrict natural re-colonization of former range.
- Disease. The Hawaiʻi ʻākepa is not found below 1,300 meters (4,300 feet), which suggests that it is particularly susceptible to mosquito-borne diseases.
- Predation. Cavity nests may be vulnerable to rat predation, although nest success is high at Pua ʻĀkala in the Hakalau Forest NWR, where rat densities are high.

CONSERVATION ACTIONS: Completed or ongoing actions specific to the Hawaiʻi ʻākepa include: demographic and reproductive studies have determined the importance of old-growth trees for nesting and that the species will use artificial cavities for nesting, and captive propagation techniques have been developed. In addition, Hawaiʻi ʻākepa likely benefit from management activities to conserve other endangered forest birds in Hakalau Forest National Wildlife Refuge, the Kona unit of the Hakalau Forest National Wildlife Refuge, ʻŌlaʻa/Kīlauea Watershed Partnership, Kapāpala Forest Reserve, and Puʻu Waʻawaʻa Wilderness Sanctuary. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future management specific to the Hawaiʻi ʻākepa may include the following:

- Aerially broadcast rodenticides to increase nestling and adult female survival.
- Conduct public education and outreach.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining ecological

requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the Hawai‘i ‘ākepa include:

- Continue studies designed to refine the suitability of artificial cavities and evaluate their potential to facilitate the establishment of new populations.
- Determine the factors affecting the growth form of regenerating ‘ōhi‘a and potential methods for protecting old-growth trees from wind and desiccation.
- Identify disease-resistant individuals. Determining if genetic markers or genotypes are associated with resistance would allow targeted translocations of individuals possessing this genotype into populations lacking disease resistance.

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Photo: Chris Eckart

Forest Birds

Hawai‘i ‘amakihi

Hemignathus virens

SPECIES STATUS:
State Listed Endangered on Lāna‘i
State Recognized as Endemic
NatureServe Heritage Rank G3—Vulnerable

SPECIES INFORMATION: The Hawai‘i ‘amakihi is a small, generalist Hawaiian honeycreeper (Family: Fringillidae). Until 1995, the Hawai‘i ‘amakihi, and the O‘ahu (*H. flavus*) and Kaua‘i ‘amakihi (*H. kauaiensis*) were considered a single species: the common ‘amakihi (*H. virens*). Plumage of all species is similar; males are yellow-green to olive with black lores. Females are generally similar, but duller. All have decurved bills. Plumage of males is bright yellow-green above, and there is some inter-island variation, especially among females. The Hawai‘i ‘amakihi is brighter and smaller than the Kaua‘i ‘amakihi. Hawai‘i ‘amakihi are generalized foragers that glean arthropods from the leaves, blossoms, twigs, branches, and less frequently from tree trunks, ferns, and shrubs. Feeds on nectar predominately from the flowers of ‘ōhi‘a (*Metrosideros polymorpha*), māmane (*Sophora chrysophylla*), and native lobelias (Campanulaceae), but also forages on flowers of a number of other native and non-native plants. They also eat fruit from native and non-native plants, but predominately from pilo (*Coprosma* spp.). Forages alone, in pairs, in family groups, or in mixed flocks. Courtship behavior is somewhat complex and includes courtship chases, advertising displays, and courtship feeding. Pairs remain together for successive breeding seasons. Pair selects nest site; female builds an open-cup nest and lays two or three eggs. Only females incubate eggs and brood nestlings. Males deliver food to females who then feed nestlings. Fledglings are dependent on parents for up to three months. The Hawai‘i ‘amakihi usually raise two broods in a season.

DISTRIBUTION: Occurs as low as 300m and as high as 2,900 meters (1,000 – 9,500 feet) on Hawai‘i, Maui and Moloka‘i; not common below 500 meters (1,625 feet). Widely distributed on Hawai‘i and Maui. Original range likely included all forested regions of the above islands as well as those on Lāna‘i, where it was last seen in 1976.

ABUNDANCE: The Hawaiian Forest Bird Survey (1976-1983) estimated the population at 870,000 ± 5,612 (95% confidence interval) birds on the island of Hawai‘i, 44,000 ± 1,786 birds on east Maui, 3,000 ± 408 on west Maui, and 1,800 ± 357 birds on Moloka‘i. Populations on Hawai‘i and Maui are probably stable; the Moloka‘i population is probably declining.

Updated Maui nui numbers-
East Maui- 77,776 ± 3,694 individuals. Densities have declined in some locations on East Maui.

West Maui- did not have a density estimate in 2020 surveys but continue to be common, but not as widely distributed as ʻapapane on West Maui.
Molokaʻi- 1,085 ± 510 birds.

LOCATION AND CONDITION OF KEY HABITAT: A range of habitats including native shrubland and dry, mesic, and wet forests in montane and subalpine communities. Densities are highest on the island of Hawaiʻi in subalpine ʻōhiʻa scrub in Kaʻū, and in māmane/naio (*Sophora chrysophylla* and *Myoporum sandiwicense*) forests on Mauna Kea. ʻAmakihi also are common in koa (*Acacia koa*) reforestation areas at higher elevations. On Maui, they are common in subalpine dry communities dominated by ʻōhiʻa, māmane, pūkiawe (*Styphelia tamieameiae*) and ʻaʻaliʻi (*Dodonea viscosa*). They also occupy some non-native tree plantations on Maui, near areas where native vegetation persists. Habitat on Molokaʻi is restricted to the ʻōhiʻa forests of the eastern half of the island. The condition of this habitat varies considerably. Much of the species' current range is under State or federal jurisdiction.

THREATS: Although populations appear stable they are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including loss and degradation of habitat, predation by introduced mammals, and disease.

CONSERVATION ACTIONS: Hawaiʻi ʻamakihi likely have benefited from management actions to conserve other endangered forest birds in the native habitat on East Maui, Hakalau Forest National Wildlife Refuge, Hawaiʻi Volcanoes National Park, and the ʻŌlaʻa/Kīlauea Watershed Partnership. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. Future management specific to the Hawaiʻi ʻamakihi may include the following:

- Control mosquitos and non-native predators across native forest habitat.
- Translocate captive-bred individuals to Lānaʻi and Kahoʻolawe.
- Conduct public education and outreach.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Currently, the U.S. Geological Survey's Biological Resources Division is conducting genetic analyses to determine the species' phylogenetic status and examining the relationship between genetic diversity and disease resistance. Additional research priorities include the following:

- Quantify population structure, dispersal patterns, survivorship, nesting phenology and success, especially for Maui and Molokaʻi populations.
- Determine if competition with Japanese white-eyes (*Zosterops japonicus*) occurs, and if so, its effect on Hawaiʻi ʻamakihi populations.

- Conduct translocation experiments using Hawai‘i ‘amakihi to help reestablish this and other Hawaiian honeycreeper populations.

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Photo: Jack Jeffrey

Forest Birds

Hawai‘i creeper

Oreomystis (Loxops) mana

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Ranking G2—Imperiled
IUCN Red List Ranking—Endangered
Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: The Hawai‘i creeper is a small, inconspicuous Hawaiian honeycreeper (Family: Fringillidae) endemic to the island of Hawai‘i. Adults are predominately olive-green above, dull buff below, and have a dark gray mask extending around the eyes; males are brighter. Their similarity to Hawai‘i ‘amakihi (*Hemignathes virens*), Hawai‘i ‘ākepa (*Loxops coccineus coccineus*), and introduced Japanese white-eyes (*Zosterops japonicus*) complicates field identification. Unlike many Hawaiian forest birds, their life history is well known. Outside the breeding season, they frequently join mixed-species foraging flocks and forages over home ranges that average 11 hectares (17.3 acres). They glean insects, spiders, and other invertebrates from the branches, trunks, and foliage of live ‘ōhi‘a (*Metrosideros polymorpha*) and koa (*Acacia koa*) trees. During the breeding season, the species’ home range averages 4 to 7 hectares (10 – 17 acres) and a 10 – 20 meter (33 – 66 feet) territory around the nest is defended. Most nests are open cup structures, but about 15 percent are placed in cavities or in bark crevices. Females build nests, incubate eggs, and brood nestlings. Males deliver food to the female on and off the nest. Both parents feed the young for approximately one month. Hawai‘i creepers re-nest after nest failures and pairs may raise two broods in a season. Nest success is very low, but adults have high annual survival.

DISTRIBUTION: Occurs in four disjunct populations above 1,500 meters (5,000 feet) on the island of Hawai‘i. Historically occurred across the island above 1,070 meters (3,500 feet) elevation.

ABUNDANCE: The Hawaiian Forest Bird Survey (1976-79, 1983), estimated the population at 12,500 ± 2,000 (95% confidence interval) birds. The largest population consisted of 10,000 ± 1,200 birds.

LOCATION AND CONDITION OF KEY HABITAT: Most commonly in mesic and wet forests dominated by ‘ōhi‘a and koa, with a subcanopy of ‘ōlapa (*Cheirodendron trigynum*), pūkiawe (*Styphelia tameiameiae*), ‘ōhelo (*Vaccinium* spp.), ‘akala (*Rubus hawaiiensis*), kōlea (*Myrsine* spp.), kāwa‘u (*Ilex anomala*), and hapu‘u tree ferns (*Cibotium* spp.). Habitat conditions

vary across the species' range, with much of it degraded by grazing ungulates, especially feral pigs. Most of the current range of the Hawai‘i creeper is within the boundaries of State and Federally owned lands.

THREATS:

- Predation. Nest success is very low (11 to 50 percent) and rat (*Rattus* spp.) predation may be partially responsible. Hawai‘i creepers place their nests near the main trunks of trees which may facilitate predation by rats.
- Disease. The Hawai‘i creeper's absence below 1,350 meters (4,500 feet) elevation suggests that it may be particularly susceptible to mosquito-borne avian disease.
- Habitat loss and degradation. Logging and grazing ungulates have reduced, degraded, and fragmented suitable forest habitats. Habitat fragmentation may be a dispersal barrier preventing or restricting recolonization of the species' former range.
- Competition. Competition with Japanese white-eyes(*Zosterops japonicus*) may negatively affect Hawai‘i creepers.

CONSERVATION ACTIONS: Past or ongoing actions specific to the Hawai‘i creeper include studies on productivity, recruitment, and survival, and development of captive propagation techniques. They likely have benefited from actions to conserve other endangered forest birds in the Hakalau Forest National Wildlife Refuge, the Kona unit of the Hakalau Forest National Wildlife Refuge, ‘Ōla‘a/Kīlauea Watershed Partnership, Kapāpala Forest Reserve, and Pu‘u Wa‘awa‘a Wildlife Sanctuary. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. Future management specific to Hawai‘i creepers may include the following:

- Reintroduce the Hawai‘i creeper to managed areas in their former range (e.g., Mauna Loa strip in Hawai‘i Volcanoes National Park).
- Control rodents to enhance nestling and female survival. Aerial broadcast of rodenticides would be the most effective method to treat broad areas.
- Increase public education to engender support for conservation of forest birds.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the Hawai'i creeper include determining the efficacy and health implications of broadcast rodenticide.

References:

IUCN Red List of Threatened Species. 2015. Version 2014.3. Available at: www.iucnredlist.org. (Accessed May 2015).

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Photo: Mark Collins

Forest Birds

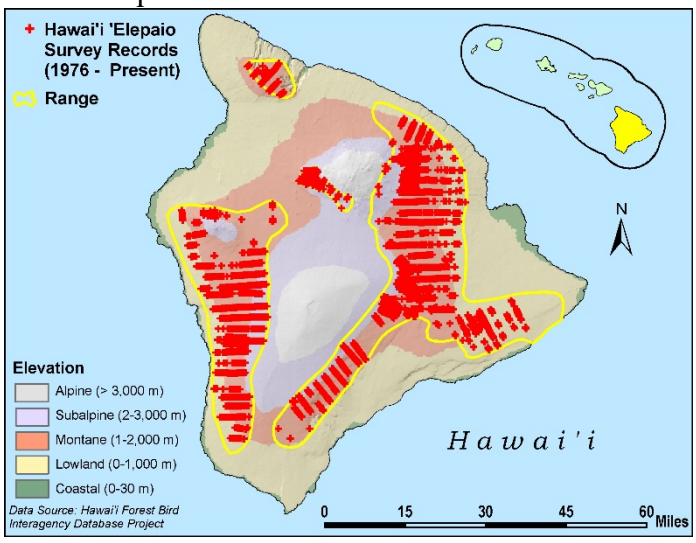
Hawai‘i ‘elepaio

Chasiempis sandwichensis

SPECIES STATUS:
State Recognized as Endemic
NatureServe Heritage Rank G3—Vulnerable
IUCN Red List Ranking—Vulnerable
Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: The Hawai‘i ‘elepaio is a small, adaptable monarch flycatcher (Family: Monarchiade) endemic to the island of Hawai‘i. ‘Elepaio also occur on Kaua‘i (*C. sclateri*) and O‘ahu (*C. ibidis*); the latter is federally listed as endangered. Some scientists recognize three subspecies on the island of Hawai‘i (*C.s. sandwichensis, C. s. ridgewayi,* and *C. s. bryani*). Adults are dark brown above and white below with variable amounts of brown streaking; males have black throats and females have white throats. The bird’s name is derived from its primary song which is a shrill whistle given only by males. ‘Elepaio forage in the air, on the ground, logs, rock crevices, snags, and all parts of trees. They use a diversity of foraging maneuvers likely dependent on habitat type: they capture arthropods by flycatching, glean while perched or hovering, and in direct pursuit, and may prefer ‘ōhi‘a (*Metrosideros polymorpha*) and kāwa’u (*Ilex anomola*) for foraging. Pairs remain together year-round, and long-term pair bonds are common; one pair was together for 11 years. Unlike Hawaiian honeycreepers, both males and females participate almost equally in all aspects of rearing. Finely woven cup nests are built in ‘ōhi‘a and in other trees in proportion to their availability. Clutch size is usually two, and second nests are attempted, often while fledglings from first are still being fed. Young are fed by parents for at least a month, but remain on their natal territory for up to ten months.

DISTRIBUTION: Occurs in most forested areas above 600 meters (2,000 feet). Isolated populations occur in Kohala and on the western slope of Mauna Kea. Historical distribution likely included all forested areas of the island.



ABUNDANCE: The Hawaiian Forest Bird Surveys (1976-79, 1983) estimated the statewide population of all subspecies at more than 270,000 birds. The island of Hawai‘i contains three populations (150,000 birds) of *C. s. ridgwayi*, plus one population each of *C. s. sandwichensis* (63,000) and *C. s. bryani* (2,500).

LOCATION AND CONDITION OF KEY HABITAT: A variety of forest types and elevations, but most common in wet or mesic forests at higher elevations. Highest densities occur in ʻōhiʻa or mixed ʻōhiʻa-koa (*Acacia koa*) forests above 1,100 meters (3,600 feet). Much of the current range is managed by State and federal agencies or private conservation partnerships.

THREATS:

- Predation. On Oʻahu, predation by black rats (*Rattus rattus*) has been implicated in the loss of nests and death of adult females, and rat control in these populations resulted in large increases in nest success and in the survival of adult females.
- Disease. Avian pox reduces nesting success and adult survival. On Oʻahu, annual survival and reproductive success of birds with active pox lesions are lower compared to healthy birds; no information is available on the effect of avian malaria.
- Habitat loss and degradation. Historical habitat loss and degradation, especially at low elevations, is a major cause of declines. In Hakalau Forest National Wildlife Refuge, population densities are lower in degraded, open forests than in intact, dense forests.

CONSERVATION ACTIONS: Hawaiʻi ʻelepaio likely have benefited from management actions to conserve other endangered forest birds species at Hakalau Forest National Wildlife Refuge, Hawaiʻi Volcanoes National Park, Puʻu Lāʻau, and the ʻŌlaʻa/Kīlauea Watershed Partnership. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future management specific to the Hawaiʻi ʻelepaio may include the following:

- Protect and restore high elevation native forests and eliminate feral ungulates and non-native invasive plants.
- Conduct public education and outreach about the benefits of rodent control.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the Hawaiʻi ʻelepaio include the following:

- Continue to screen birds for disease resistance. If resistant birds are identified, translocation and/or captive propagation of these birds may help recover populations.
- Continue to develop techniques for captive propagation.

References:

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VanderWerf EA. 1998. ‘Elepaio (*Chasiempis sandwichensis*). *In* The Birds of North America, No. 344 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Photo: Eric VanderWerf

Forest Birds

‘I‘iwi

Drepanis coccinea

SPECIES STATUS:
Federally Listed as Threatened
State Listed as Endangered on O‘ahu, Moloka‘i, Lāna‘i
State Recognized as Endemic
NatureServe Heritage Rank G4/T1/TH—Apparently Secure/
Critically Imperiled Globally on O‘ahu and Moloka‘i/Possibly Extinct on Lāna‘i
IUCN Red List Ranking—Vulnerable

SPECIES INFORMATION: The ‘i‘iwi is one of the most beautiful of the extant Hawaiian honeycreepers (Family: Fringillidae). Both males and females are vermillion red, with a black tail and wings, and a long, decurved pink bill. Native Hawaiians created feather capes using hundreds of thousands of ‘i‘iwi feathers; such capes signified power and prestige. Like ‘apapane (*Himatione sanguinea*), ‘i‘iwi often fly long distances in search of flowering ‘ōhi‘a (*Metrosideros polymorpha*) trees and are important ‘ōhi‘a pollinators. Their diet consists primarily of nectar from a variety of native and non-native flowers and the presence of non-native flowers may have contributed to increases in some populations. In addition to nectar, ‘i‘iwi also eat small arthropods. Both sexes defend small nesting territories and may defend important nectar resources. Courtship chases and feeding may precede breeding. Nest sites are in terminal branches of ‘ōhi‘a trees and both sexes build the open-cup nest. Only females incubate eggs (typically two) and brood young. Young are mostly provisioned by female; males feed females off the nest. Despite their widespread distribution, little is known about their life history.

DISTRIBUTION: Occurs above 1,250 meters (4,100 feet) elevation on the islands of Hawai‘i, Maui, and Kaua‘i; and may occur at reduced densities below. Relict populations occur on O‘ahu and Moloka‘i. Historically, ‘i‘iwi were common down to low elevations on all the Main Hawaiian Islands.

ABUNDANCE: The ‘I‘iwi (*Drepanis coccinea*) is vulnerable to disease and habitat loss due to Rapid Ohia Death and appears to be declining in many areas; as such it was listed as threatened by U.S. Fish & Wildlife Service in October 2017. The following island population estimates are based on Paxton et al. (2013): 543,009 ± 26,697 (95% confidence interval) birds on island of Hawai‘i, 50,252 ± 3,437 individuals on East Maui, 176 ± 74 on West Maui, and 2,551 ± 617 on Kaua‘i. However, preliminary data from 2023 suggests the Kaua’i population declined to 161 (95% CI: 47-304), with a range of only 492 ha (1215 ac);DOFAW, unpublished data). They have not been detected on Moloka’i since 2010. O‘ahu supports a population of less than 50 birds. The population is declining in certain locations, but shows evidence of increases in some areas of

Hawai'i,Island and East Maui. , but the species' wide-ranging foraging complicates population estimates and the determination of long-term trends.

LOCATION AND CONDITION OF KEY HABITAT: Mesic and wet forest dominated by ʻōhiʻa and koa (*Acacia koa*). Loss and degradation of habitat and high densities of cold-intolerant *Culex* mosquitoes, an important disease vector, in lowland areas restrict most birds to elevations above 1,250 meters (4,100 feet). Habitats with the highest ʻiʻiwi densities also support kōlea (*Myrsine lessertiana*), naio (*Myoporum sandwicense*), and hapuʻu tree ferns (*Cibotium* spp.). Māmane (*Sophora chrysophylla*) is common in high-elevation foraging habitat. Although much of the species' current range is under State or Federal jurisdiction, habitat quality and habitat protection and restoration varies considerably.

THREATS: Although populations appear stable on the islands of Hawaiʻi and Maui, they are drastically declining on Kaua'i and likely susceptible to the same factors that threaten other native Hawaiian forest birds, including habitat loss and degradation, predation by introduced mammals, and disease. For ʻiʻiwi, the following is of particular concern:

- Disease. ʻIʻiwi are very susceptible to avian malaria and avian pox. Nine of ten individuals died within 37 days after receiving a single bite from mosquitoes infected with *Plasmodium*. Individuals infected with pox also are more likely to be infected with malaria. Because the highest points on Molokaʻi and Oʻahu are below 1,250 meters (4,100 feet), this susceptibility likely explains the severe population declines noted on these islands. Foraging movements may increase their exposure to disease.

CONSERVATION ACTIONS: ʻIʻiwi likely have benefited from actions to conserve other endangered forest birds on northeastern Haleakalā, Hakalau Forest National Wildlife Refuge, Alakaʻi Wilderness Preserve and surrounding areas, Hawaiʻi Volcanoes National Park, and the ʻŌlaʻa/Kīlauea Watershed Partnership. Future actions specific to the protection of ʻi'iwi may include the following:

- Control mosquitoes across native forest habitat.
- Aggressively control ungulates to improve habitat quality, facilitate the recovery of degraded habitat, and potentially reduce breeding habitat for mosquitoes. Control of non-native plants should be part of forest restoration efforts.
- Eradicate or manage mosquito breeding habitat in areas where 'i'iwi occurInvestigate options to eradicate mosquitoes, including use of genetic manipulation.
- Suppress/control rats, feral cats, and barn owls in areas where 'i'iwi occur
- Prevent the introduction of the small Indian mongoose (*Herpestes auropunctatus*) and other predators on Kaua'i
- Prevent the spread of Rapid ʻōhiʻa Death in prime i'iwi habitat
- Conduct public education and outreach.
- Continue protection and management of wildlife sanctuaries and refuges.
- Collection for conservation breeding program, especially of the Kaua'i population
- Supplementation of the Kaua'i population via translocation from other islands

MONITORING: Continue forest bird surveys and habitat monitoring on all islands.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats (*Rattus* spp.) and feral cats (*Felis catus*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to ʻiʻiwi include the following:

- Determine if disease-resistant birds exist, and if so, determine if resistance is passed to offspring. Disease-resistant birds could be used to establish new populations.
- Determine the role of ʻiʻiwi in transmitting disease between low and high elevations.
- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology and success of this poorly known species.
- Investigate genetic structure and disease prevalence of populations in mid-to- lower elevations, such as the population within West Maui, which had individuals translocated from East Maui in 2001.
- Study the genetics of the Kaua'i population to determine how it may differ since Kaua'i population has the greatest distance separating it from other islands' populations.
- Investigate efficacy of other methods of controlling invasive rodents (e.g., different methods of applying rodenticide, snap traps)
- Assess the impact of introduced rodents on food resources (e.g., floral, invertebrates) important to 'i'iwi

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USFWS 2023? New recovery plan for iiwi

VanderWerf EA, Rohrer JL. 1996. Discovery of an ʻIʻiwi population in the Koʻolau Mountains of Oʻahu. ʻElepaio 56:25–28.

Picture: Rothschild Collection

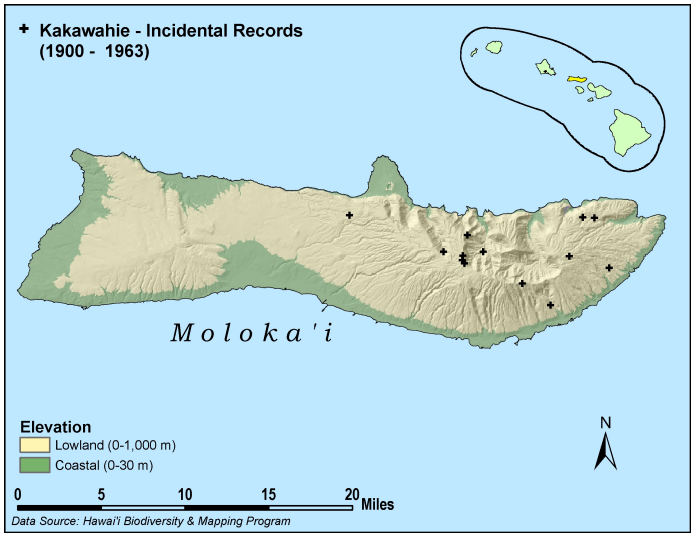
Kākāwahie or Moloka‘i creeper

Paroreomyza flammea

SPECIES STATUS:
Federally Listed as Extinct
State Listed as Extinct
State Recognized as Endemic
NatureServe Heritage Rank GH—Extinct
IUCN Red List Ranking—Extinct
Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: The kākāwahie, or Moloka‘i creeper, is a small, sexually dichromatic, insectivorous Hawaiian honeycreeper (Family: Fringillidae) endemic to the forests of eastern Moloka‘i. Males are scarlet red; females are a dull rusty color. The species’ Hawaiian name translates as “woodchopping” and apparently describes the species chipping call. Kākāwahie forage in groups, gleaning invertebrates from leaves, bark, and epiphytes in wet ‘ōhi‘a (*Metrosideros polymorpha*) forests. Little is known about the species’ breeding biology, but it is assumed to be similar to that of the Maui creeper (*P. montana*). First described in 1889, the last bird was observed less than 100 years later.

DISTRIBUTION: Unknown. Probably extinct. Last observed on the west rim of Pelekunu Valley. Kākāwahie were common in native forests of eastern Moloka‘i at the end of the 19th century. Original range likely included all forested regions of Moloka‘i.



ABUNDANCE: Unknown. The last kākāwahie was observed in 1963 and the species is probably extinct.

LOCATION AND CONDITION OF KEY HABITAT: Unknown. Was known to occur in wet ‘ōhi‘a (*Metrosideros polymorpha*) forests from low to high elevations, and other heavily wooded native

areas of eastern Moloka‘i. The areas where the species was last observed are managed by the State as Natural Area Reserves or by The Nature Conservancy.

THREATS: Unknown. However, kākāwahie likely were susceptible to the same factors that threaten other native Hawaiian forest birds, including habitat loss and degradation, predation by introduced mammals, and disease. For kākāwahie, the following likely was of particular concern:

- Disease. This species rapid decline and the fact that no habitat above 1,250 meters (4,100 feet) occurs on Moloka‘i suggests disease may have played an important role in the species’ decline.

CONSERVATION ACTIONS: If the species persists, it likely benefits from actions to conserve other endangered forest birds of eastern Moloka‘i including the establishment of the protected areas, regular surveys of forest bird populations, habitat monitoring, and studies of disease and disease vectors. Should this species be rediscovered, the Rare Bird Recovery Protocol outlined in the U.S. Fish and Wildlife Service (USFWS) *Revised Recovery Plan for Hawaiian Forest Birds* would be implemented, and management in anticipation of that possibility should include continued protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue Forest bird surveys and habitat monitoring on all islands.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is likely extinct, there are no research priorities specific to kākāwahie.

References:

Baker PE, Baker H. 2000. Kākāwahie (*Paroreomyza flammea*) and O‘ahu alauahio (*Paroreomyza maculata*). *In* The Birds of North America, No. 503 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

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Rothschild Collection

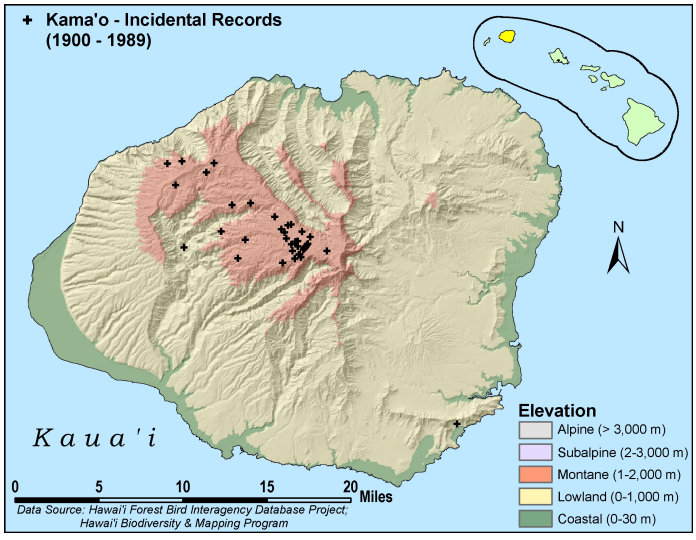
Kāma‘o
or large Kaua‘i thrush

Myadestes myadestinus

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank GH – Possibly Extinct
IUCN Red List Ranking — Extinct
Revised Recovery Plan for the Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: The kāma‘o, or large Kaua‘i thrush, is one of two Hawaiian solitaires (family: Turdidae) endemic to Kaua‘i. The species was noted for flying upward, singing a few loud notes, and then suddenly dropping into the understory. Like all adult Hawaiian solitaires, the kāma‘o has olive-brown and gray plumage, but it lacks the white-eye ring and pinkish legs of the smaller puaiohi or small Kaua‘i thrush (*M. palmeri*). The species’ complex song is composed of a melodic series of liquid warbles, trills, and whistles, and is often heard before dawn and after dusk. The diet is reported to consist of fruits and berries, particularly the bracts of ‘ie‘ie (*Freycinetia arborea*). Life history characteristics are mostly unknown, but are presumed similar to the ‘ōma‘o (*M. obscurus*). Breeding is thought to occur in spring, although no nest has been described.

DISTRIBUTION: Has not been observed below 1,100 meters (3,500 feet) since the mid-1960s. If the species persists, it is concentrated in the uppermost regions of the Alaka‘i Wilderness Preserve. Historically was found in moist forests near sea level on northern Kaua‘i as well as upland, interior mountain forests.



ABUNDANCE: Probably extinct. The Hawaiian Forest Bird Survey (1981), estimated the population at 24 ± 30 (SE) individuals. The last kāma‘o was observed in 1989, and

was not observed during the 2000 Kauaʻi Forest Bird Survey. Historically, the kāmaʻo was extremely common.

LOCATION AND CONDITION OF KEY HABITAT: Most recent sightings were in open canopy forests of ʻōhiʻa (*Metrosideros polymorpha*) and ʻōlapa (*Cheirodendron* spp.). Based on the diet and life history of the ʻōmaʻo, a diverse understory including epiphytes, tree ferns, and fruiting plants such as ʻieʻie, ʻōhā wai (*Clermontia* spp.), and ʻōhelo (*Vaccinium* spp.) would likely be high-quality habitat. Because ʻieʻie, an important food plant, does not do well in high-elevation forests, if the species persists it may be restricted to marginal habitat. The area where the species was last observed is managed by the State of Hawaiʻi as a Wilderness Preserve.

THREATS: Kāmaʻo are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including loss and degradation of habitat, predation by introduced mammals, and disease. For kāmaʻo, the following are of particular concern:

- Disease. Mosquito-borne disease is probably the most important factor in the decline of the kāmaʻo. Pox lesions were noted on this species in mid-19th century.
- Habitat degradation. The presence of native forest with abundant fruit-bearing plants below the species current range demonstrates that habitat degradation cannot entirely explain the species extirpation from lowland areas. However, several invasive plants and feral pigs (*Sus scrofa*) have degraded the understory of many native forests.
- Competition. Non-native birds, especially ecologically similar species (e.g., white-rumped shama [*Copsychus malabaricus*]), may have contributed to the species' decline.
- Predation. If kāmaʻo, like many solitaires, are cavity or low platform nesters, their nests would be very susceptible to rats (*Rattus* spp.).
- Non-native arthropods. Recently introduced non-native insects, especially yellow jackets (*Vespula pensylvanica*) and Argentine ants (*Linepithema humile*), may compete with the kāmaʻo's native arthropod prey or disrupt the pollination of the species' food plants. Introduced herbivorous insects also could reduce the abundance of food plants.

CONSERVATION ACTIONS: If the species persists, it likely benefits from efforts to conserve other endangered forest birds on Kauaʻi, including the establishment of the Alakaʻi Wilderness Preserve, regular surveys of forest bird populations, habitat monitoring, studies of disease and disease vectors, and public education efforts featuring Kauai's endangered forest birds. In addition to these efforts, future management specific to the recovery of the kāmaʻo may include:

- Aggressively control ungulates to improve the quality of kāmaʻo habitat and facilitate the recovery of degraded, but potential, habitat. Control of non-native plants should be part of forest restoration efforts.
- Conduct eradication of rats and feral cats from the Alakaʻi Wilderness Preserve.
- Prevent introduction of the small Indian mongoose (*Herpestes auropunctatus*) and other possible predators.
- Conduct public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is likely extinct, there are no research priorities specific to kāmaʻo.

References:

Foster JT, Tweed EJ, Camp RJ, Woodworth BL, Adler CD, Telfer T. 2004. Long-term population changes of native and introduced birds in the Alakaʻi swamp, Kauaʻi. Conservation Biology 18:716-725.

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Picture: Rothschild Collection

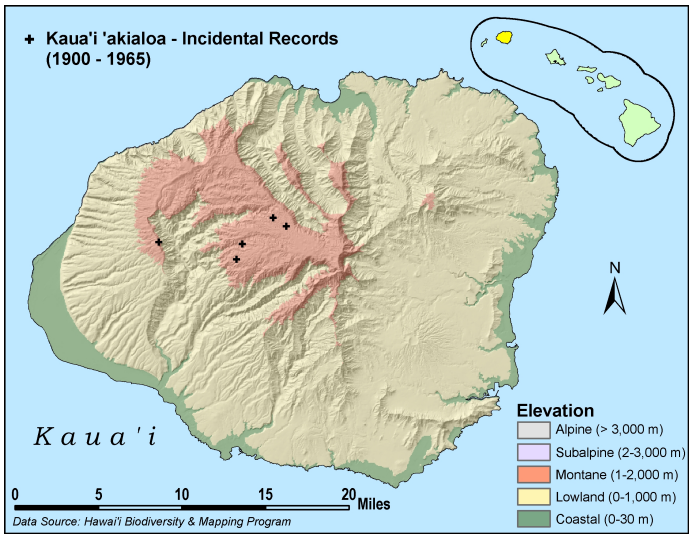
Forest Birds

Kaua‘i ‘akialoa

Hemignathus procerus

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank GX—Presumed Extinct
IUCN Red List Ranking—Extinct
sed Recovery Plan for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: The Kaua‘i ‘akialoa is perhaps the most morphologically specialized of the Hawaiian honeycreepers (Family: Fringillidae) having a decurved bill that is up to half the length of their body. Both sexes are mostly olive-green; males being somewhat brighter, slightly larger, and have a longer bill. The life history of the Kaua‘i ‘akialoa is poorly known and mostly based on observations from the turn of the last century. The species principally foraged for arthropods on the trunks and branches of ‘ōhi‘a (*Metrosideros polymorpha*) and koa (*Acacia koa*) trees, and hapu‘u tree ferns (*Cibotium* spp.) by using its bill to probe bark cervices, decaying wood, epiphytes, and organic matter; observed to insert its entire bill into crevices. Foraging behavior has been described as being similar to that of a woodpecker or creeper. They also took nectar from ‘ōhi‘a and lobelia (Campanulaceae) flowers. Nothing is known about its breeding biology. ‘Akialoa also occurred on the islands of Hawai‘i, O‘ahu, and Lāna‘i. Some scientists consider each island population as a separate species, others lump all into a single, polytypic species. Regardless, none have been observed for at least 60 years.



DISTRIBUTION: Unknown. Probably extinct. The Kaua‘i ‘akialoa was last seen in the Alaka‘i swamp. Original range likely included all forested regions of Kaua‘i.

ABUNDANCE: Unknown. Last observed in 1969, and is probably extinct. Extensive surveys in 1989, 1994,

1996, 2000, 2005, and 2006 did not detect the species. Historically, the species was reported to be fairly common.

LOCATION AND CONDITION OF KEY HABITAT: Unknown. In the late 1800s, the Kauaʻi ʻakialoa occurred in most forests on Kauaʻi from between 200 and 1,500 meters (650 – 4,875 feet) elevation. The species was last observed in the Alakaʻi Wilderness Preserve.

THREATS: Causes of the decline of this species are unknown. However, ʻakialoa likely were susceptible to the same factors that threaten other native Hawaiian forest birds, including loss and degradation of habitat, predation by introduced mammals, and disease. For Kauaʻi ʻakialoa populations, the following likely was of particular concern:

- Disease. Avian pox lesions are noted in historic accounts and occur on museum specimens. Perkins (1903) noted Kauaʻi ʻakialoa was "grievously affected by…swelling on the legs and feet, as well as on the head at the base of the bill, and on the skin around the eyes."

CONSERVATION ACTIONS: If the species persists, it likely benefits from actions to conserve other endangered forest birds on Kauaʻi, including the establishment of the Alakaʻi Wilderness Preserve, regular surveys of forest bird populations, habitat monitoring, studies of disease and disease vectors, control of feral ungulates through public hunting, and public education efforts featuring Kauai's endangered forest birds. Should this species be rediscovered, the Rare Bird Recovery Protocol outlined in the U.S. Fish and Wildlife Service (USFWS) *Revised Recovery Plan for Hawaiian Forest Birds* would be implemented, and management in anticipation of that possibility should include continued protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is likely extinct, there are no research priorities specific to Kauaʻi ʻakialoa.

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Forest Birds

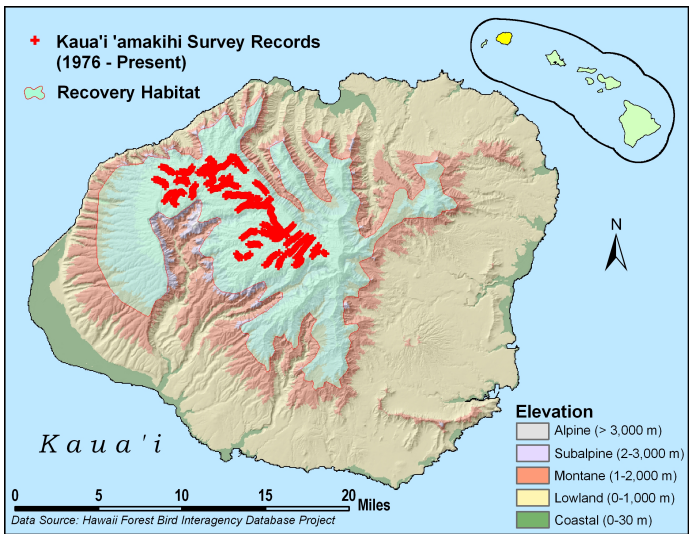
Kaua‘i ‘amakihi

Hemignathus kauaiensis

SPECIES STATUS:
State Recognized as Endemic
NatureServe Heritage Rank G3—Vulnerable
IUCN Red List Ranking—Endangered

SPECIES INFORMATION: The Kaua‘i ‘amakihi is a small, generalist Hawaiian honeycreeper (Family: Fringillidae) endemic to the island of Kaua‘i. Until 1995, the Kaua‘i ‘amakihi, Hawai‘i (*H. virens*), and O‘ahu ‘amakihi (*H. falvus*) were considered a single species: common amakihi (*H. virens*). The plumage of all species is similar; males are yellow-green to olive with black lores. Females are generally similar, but duller. All have decurved bills. The Kaua‘i ‘amakihi is the dullest of the three species, is larger and has a longer, heavier and more decurved bill than the other species. They glean arthropods from branches and trunks as well as leaves, often hanging upside down to examine the underside of branches. Also probes bark crevices for food items, pierces the bases of ‘ōhi‘a (*Metrosideros polymorpha*) flowers for nectar, and feeds on the fruit of native and non-native plants. Males display (i.e., rapidly move around the female and sing), chase, and feed females prior to breeding. Both sexes build the nest, typically in a non-blooming ‘ōhi‘a tree, although the female does most of the construction while the male sings in adjacent trees. Kaua‘i ‘elepaio nests are lower than most other forest bird species on Kaua’i at 5.1 $\pm$ 2.0 m, (n = 40, range 1.3–8.4 m; Hammond et al. 2015). Females incubate a clutch of three eggs and brood nestlings at night and during inclement weather. Both parents feed nestlings. The mean incubation period of Kaua‘i ‘elepaio is 19.7 $\pm$ 1.5 d (n = 23, range = 17–23 and the mean nestling period is 15.0 $\pm$ 1.2 d (n = 24, range = 13–17 d, for a otal nesting period of 35 d (Hammond et al. 2015). Fledglings are accomplished fliers. No information on post-fledgling behavior or parental dependency. Although weather has been implicated in nest failure, nest survival probability is high (0.63 $\pm$ 0.08), but of nests that fail, predation is the cause in 60% of cases (Hammond et al. 2015).

DISTRIBUTION: Occurs above 600 meters (2,000 feet) in the forests of Waimea Canyon, Nā Pali Plateau, the Alakaʻi Swamp, and Makaleha Mountains. Original range likely included all forested areas of Kauaʻi.



ABUNDANCE: In the early 1970s the population was estimated at 10,743 ± 970 (SE) birds. A survey in the late 1980s estimated 15,000 to 20,000 birds. The Kauaʻi Forest Bird Survey (2000) estimated the population in the Alakaʻi Swamp and Kōkeʻe State Park area at greater than 40,000 birds and reported a significant population increase between 1981 and 2000. However, data from the Alakai Plateau suggest a general decline and possible range constriction since 2008, and in 2023 the population was estimated to be 9,307 (95% CI: 6,852-11,588; DOFAW, unpublished data).

LOCATION AND CONDITION OF KEY HABITAT: Wet and mesic montane forests above 600 meters (2,000 feet) dominated by ʻōhiʻa, koa (*Acacia koa*), ʻōlapa (*Cheirodendron trigynum*), and lapalapa (*C. platyphyllum*). At lower elevations where the species historically occurred, native habitats are severely degraded. Although public hunting reduces the number of feral ungulates in accessible areas of the species' range, it is not effective in preventing habitat degradation. Occupied habitats above Waimea Canyon, in and west of the Alakaʻi Swamp, are managed by the State of Hawaiʻi.

THREATS: Kauaʻi ʻamakihi are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including habitat loss and degradation, predation by introduced mammals, and disease. Although many Kaua'i ʻelepaio tolerate malaria well enough to be captured post-infection, positive malaria status is negatively associated with body condition and the species sometimes shows pox lesios (KFBRP, unpubl. data).

CONSERVATION ACTIONS: Kauaʻi ʻamakihi likely benefit from actions to conserve other endangered forest birds including establishment of the Alakaʻi Wilderness Preserve, regular surveys of forest bird populations, habitat monitoring, studies of disease and disease vectors, control of feral ungulates through public hunting control of feral ungulates through public hunting and fencing, suppression of rats on two A24 trapping grids over approximately 150 ha (470 ac), and education about Kauai's endangered forest birds. Future management specific to the Kauaʻi ʻamakihi may include the following:

- Aggressively control ungulates to improve habitat quality.
- Control non-native plants that degrade native habitat.

- Reduce breeding habitat for mosquitoes on the Alaka'i Plateau
- Suppress mosquito populations through releases of incompatible or sterile mosquitoes.
- Investigate options to eradicate mosquitoes, including use of genetic manipulations.
- Prevent the spread of Rapid Ohia Death on the Alaka'i Plateau
- Suppress/control rats (*Rattus* spp.), feral cats (*Felis catus*), and barn owls (*Tyto alba*) from the Alakaʻi Wilderness Preserve and Koke'e Region.
- Prevent the introduction of the small Indian mongoose (*Herpestes auropunctatus*) and other non-native predators.
- Conduct public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquitoes. Research priorities specific to the Kauaʻi ʻamakihi include the following:

- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology, and success of this poorly known species.
- Conduct studies to investigate the apparent population fluctuations in this species
- Determine the species' susceptibility to avian malaria and avian pox.
- Investigate the impact of rat predation on food resources (e.g., flowers, invertebrates) for ʻamakihi.
- Investigate sub-lethal impacts disease (malaria, pox) on ʻamakihi fecundity
- Determine sources of mosquitoes and investigate methods of mosquito control.
- Determine the effects of recently established non-native insects on native arthropods, especially those that are part of the species' diet.Determine the status of populations outside of the greater Alakaʻi Swamp region.
- Conduct phylogenetic analyses to determine the relationship to other ʻamakihi species.

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Photo: DOFAW

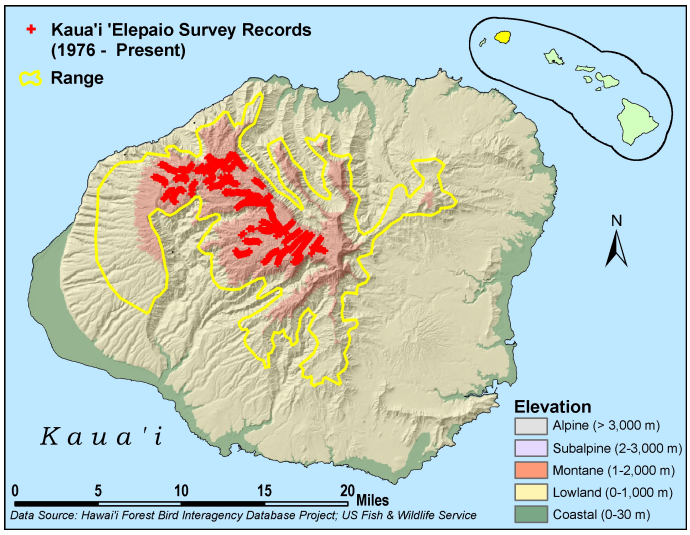
Forest Birds

Kaua‘i ‘elepaio

Chasiempis sclateri

SPECIES STATUS:
State Recognized as Endemic
NatureServe Heritage Rank G2—Imperiled
IUCN Red List Ranking—Vulnerable

SPECIES INFORMATION: The Kaua‘i ‘elepaio is a small, adaptable monarch flycatcher (Family: Monarchiade) endemic to the island of Kaua‘i. ‘Elepaio also occur on the islands of Hawai‘i (*C. sandwichensis*) and O‘ahu (*C. ibidis*); the latter is federally listed as endangered. Adults have a dark grayish brown crown and back and white underparts with a rusty wash on the upper breast. The bird’s name is derived from its primary song which is a shrill whistle given only by males. Like other ‘elepaio on Hawai‘i and O‘ahu, Kaua’i ’elepaio use virtually all available substrates for foraging, including the ground, logs, rock crevices, snags, and all parts of tress. Equally diverse in the use of foraging maneuvers, ‘elepaio capture a wide range of arthropod prey by flycatching, gleaning while perched or hovering, and direct pursuit; foraging maneuvers vary depending on plant species from which prey is being captured and habitat type. For Kaua‘i, there is littleinformation on plant species used, although ‘ōhi‘a (*Metrodiseros polymorpha*) is likely and nests in alani (*Melicope* spp.) are common. On the island of Hawai‘i, pairs remain together throughout the year and long-term pair bonds are common. Unlike Hawaiian honeycreepers, both males and females participate almost equally in all aspects of rearing. Finely woven, cup nests are built in a variety of native and non-native trees. Clutch size is usually two and second nests are attempted, often while fledglings from first are still being fed. Young are fed by parents for at least a month, but remain on their natal territory for up to ten months, which may allow young birds to hone their foraging skills.



DISTRIBUTION: Widely distributed above 600 meters (2,000 feet) elevation, but most common

above 1,100 meters (3,600 feet) elevation on the Alakaʻi Plateau. Original range likely included all forested regions of Kauaʻi.

ABUNDANCE: In 1984, the island-wide population was estimated at 40,000 birds. The 2000 Kauaʻi Forest Bird Survey estimated the population in the Alakaʻi and Kōkeʻe region at nearly 25,000 birds, with no change in the population since 1973. In 2018, the estimated population size was 51,903 birds (95% CI: 29,203-76,403, Paxton et al. 2020). In 2023, the population was estimated around 36,255 (95% CI: 29,894-43,463; U.S. Geological Survey, unpublished data). Unlike other Kaua'i forest bird species, which have experienced steep overall population declines over the last 40 years, reduced Kaua'i 'elepaio densities in Kōkeʻe have been compensated by increased densities in the Alaka'i Wilderness Area during the same time period (DOFAW, unpubl., Paxton et al. 2020). Densities peak in 'ōhiʻa forest between 1,100 and 1,300 meters (3,600 - 4,500 feet).

LOCATION AND CONDITION OF KEY HABITAT: Most common in dense wet 'ōhiʻa forests above 1,100 meters (3,600 feet) elevation; uncommon in the drier forests of Waimea Canyon, the Nā Pali coast, and the wet bogs of Waiʻaleʻale. 'Elepaio are found in some low elevation valleys with a mix of native and non-native tree species. Common non-native trees in this habitat include Java plum (*Syzygium cumini*), coffee (*Coffea arabica*), kukui (*Aleurites moluccana*), and *Albizia lebbeck.* Habitat quality varies considerably. The core of their range, the Alakaʻi Plateau and Kōkeʻe State Park, is managed by the State of Hawaiʻi as Forest Reserve, Wilderness Preserve, and State Park lands.

THREATS: Kauaʻi 'elepaio are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including loss and degradation of habitat, predation by introduced mammals, and disease. For Kauaʻi 'elepaio, the following are of particular concern:

- Disease. Avian pox is known to reduce both nesting success and adult survival. On O'ahu, annual survival and reproductive success of birds with active pox lesions are lower compared to healthy birds; no information on the effect of avian malaria.
- Predation. On Oʻahu, predation by black rats (*Rattus rattus*) have been implicated in the loss of nests and death of adult females and on Hawai'i and Kaua'i, the loss of nests (Banko et al. 2019, Hammond et al. 2015). Rat control in these populations resulted in large increases in nest success and in the survival of adult females. Other predators, including cats (*Felis catus*), Hawaiian short-eared owls (*Asio flammeus sandwichensis*), and barn owls (*Tyto alba*) occur throughout the forests of Kaua'i.

CONSERVATION ACTIONS: Given the increased population densities in the interior of Kaua'i, where most management occurs**,** Kauaʻi 'elepaio likely benefited from management actions to conserve other endangered forest birds including establishment of the Alakaʻi Wilderness Preserve, regular surveys of forest bird populations, monitoring of habitat conditions, eradication of ungulates within ungulate-proof fences, suppression of rats on A24 trapping grids, studies of disease and disease vectors, and public education efforts featuring Kauai's endangered forest birds. In addition to these efforts, future management specific to the Kauaʻi 'elepaio may include the following:

- Eradicate or control rats, feral cats, and barn owls in the Alakaʻi Wilderness Preserve.
- Prevent the introduction of the small Indian mongoose and other possible predators.
- Prevent the spread of Rapid ʻōhiʻa Death on the Alakaʼi Plateau
- Suppress mosquito populations through releases of incompatible or sterile mosquitoes
- Investigate options to eradicate mosquitoes, including use of genetic manipulation.
- Conduct public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquitos. Research priorities specific to the Kauaʻi ʻelepaio include life history studies to quantify population structure, dispersal patterns, survivorship, nesting phenology, and success of this poorly known subspecies.

- Investigate efficacy of other methods of controlling invasive rodents (e.g., different methods of applying rodenticide, snap traps).
- Assess the impact of introduced rodents on food sources important to 'elepaio
- Investigate sub-lethal impacts disease (malaria, pox) on ʻelepaio fecundity

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Picture: Rothschild Collection

Forest Birds

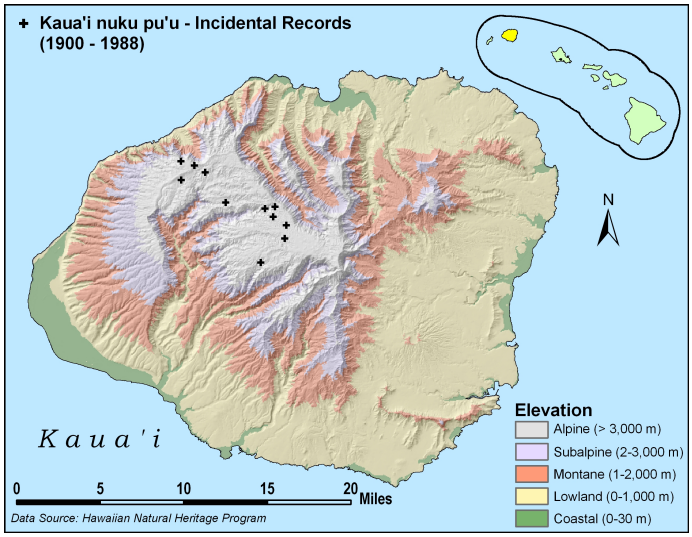
Kauaʻi nuku puʻu

Hemignathus lucidus hanapepe

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank G1T1—Critically Imperiled
IUCN Red List Ranking—Critically Endangered
(Potentially Extinct)
Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: The Kauaʻi nuku puʻu is a large, short-tailed Hawaiian honeycreeper (Family: Fringillidae) with a long, thin decurved bill; the lower mandible is half the length of the upper mandible. Nuku puʻu also are known from Oʻahu (*H. l. lucidus*) and Maui (*H. l. affinis*); the Oʻahu subspecies is certainly extinct. Currently, all nuku puʻu are considered one species, however, ongoing research suggests that populations occurring on the three islands are distinct species. Adult males are olive green with a yellow head, throat, and breast and have a small black mask; females are grayish green above and whitish below. Little is known about the species' life history. Often joins mixed species foraging flocks, especially those with ʻakikiki (*Oreomystis bairdi*). Apparently would creep along tree trunks, especially those of ōhiʻa (*Metrosideros polymorpha*) and koa (*Koa acacia*) trees, searching the bark and dead wood for arthropod prey; also may have taken nectar. Accounts vary regarding bill use. Either hammered surfaces, similar to its congener the ʻakiapōlāʻau (*H. munroi*), or used its upper mandible to fish out prey from crevices, catching them with its tongue and lower mandible. No information on the species' breeding biology, but likely is similar to the ʻakiapōlāʻau.

DISTRIBUTION: Unknown. Probably extinct. All recent Kauaʻi nuku puʻu sightings are from a small area of southwestern Kauaʻi between 610 and 1,220 meters (2,000–4,000 feet) elevation. The species' historic range also appeared very restricted.



ABUNDANCE: Unknown. Probably extinct. There are fewer than a dozen historical records of the Kauaʻi nuku puʻu. Extensive surveys in 1989, 1994, 1996, 2000, and 2005 did not detect the species.

LOCATION AND CONDITION OF KEY HABITAT: Mesic and wet montane forests. Habitat conditions of the species' historic range vary and all presumably support *Culex* mosquitoes. Areas where Kauaʻi nuku puʻu were most recently been observed are managed by the State of Hawaiʻi.

THREATS: Unknown. However, the Kauaʻi nuku puʻu likely was susceptible to the same factors that threaten other native Hawaiian forest birds including habitat loss and degradation, predation by introduced mammals, and disease. For Kauaʻi nuku puʻu, the following likely was of particular concern:

- Disease. The precipitous decline of all nuku puʻu taxa suggests that mosquito-borne diseases played an important role in the species' demise.

CONSERVATION ACTIONS: If the species persists, it likely benefits from management activities to conserve other endangered forest birds on Kauaʻi, including the establishment of the Alakaʻi Wilderness Preserve, regular surveys of forest bird populations, monitoring of habitat conditions, studies of disease and disease vectors, control of feral ungulates through public hunting, and public education efforts featuring Kauai's endangered forest birds. Should this species be rediscovered, the Rare Bird Recovery Protocol outlined in the U.S. Fish and Wildlife Service (USFWS) *Revised Recovery Plan for Hawaiian Forest Birds* would be implemented, and management in anticipation of that possibility should include continued protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-

elevation forests, and developing methods to control mosquito populations. Given that this species is likely extinct, there are no research priorities specific to Kaua‘i nuku pu‘u.

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Forest Birds

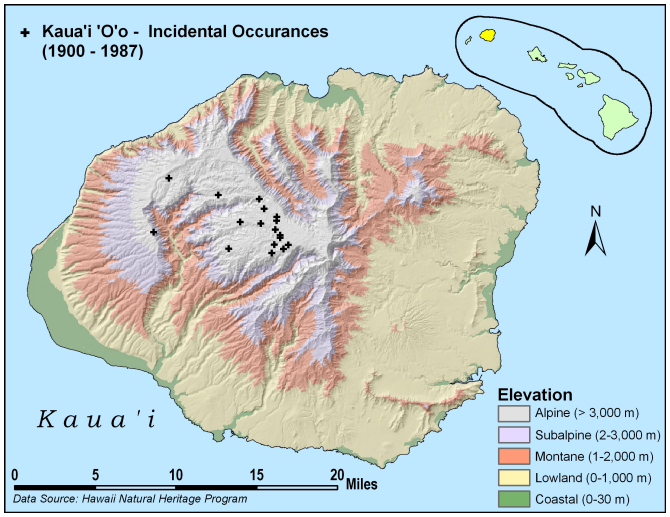
Kauaʻi ʻōʻō

Moho braccatus

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank GH—Possibly Extinct
IUCN Red List Ranking—Extinct
Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: Endemic to its namesake, the Kauaʻi ʻōʻō is the smallest of the five known species of Hawaiian honeyeaters (Family: Meliphagidae), and has the least gaudy plumage of the four Hawaiian species of *Moho*. ʻŌʻō eat a variety of arthropods, snails, ʻōlapa (*Cheirodendron* spp.) fruits, and nectar from the flowers of ʻōhiʻa (*Metrosideros polymorpha*), lobelia, as well as other species. Early naturalists reported the species extensively feeding on the flower bracts of ʻieʻie (*Freycinetia arborea*), a species abundant in lowland forests, but not in upper elevation forests. Little is known about the species' breeding biology. The only known nests were in cavities in large ʻōhiʻa snags.

DISTRIBUTION: Unknown. Possibly extinct. Was last observed in stream valleys of the central Alakaʻi Wilderness Preserve. Historically, the Kauaʻi ʻōʻō occurred in forest habitat throughout the island.



ABUNDANCE: Was last observed in 1987, and may be extinct. Extensive surveys in 1989, 1994, 1996, and 2000 did not detect the species. Was very common up to the end of 19th century.

LOCATION AND CONDITION OF KEY HABITAT: Unknown. The last sightings were in dense ʻōhiʻa forests of the Alakaʻi swamp. Ironically, this habitat may have been low-quality or marginal habitat. ʻIeʻie, an important food plant, common in the lower elevation forests previously occupied by ʻōʻō, is not found in the upper elevations forests where the species was

last observed. Extensive damage to forests by hurricanes in 1982 and 1992 may have further reduced the suitability of high-elevation forests, especially given the species' apparent dependence on large snags for nest sites. The area where the species was last observed is managed by the State of Hawai‘i as a Wilderness Preserve.

THREATS: Unknown. However, the species was likely susceptible to the same factors that threaten other native Hawaiian forest birds, including loss and degradation of habitat, predation by introduced mammals, and disease. For Kaua‘i ‘ō‘ō, the following likely were of particular concern:

- Disease. The precipitous decline of all Hawaiian *Moho* species suggests that disease played a role in this species' decline.
- Hunting. Although other ‘ō‘ō species were historically exploited by Native Hawaiians for their feathers, the role this activity played in the decline of the Kaua‘i ‘ō‘ō is equivocal, but likely minimal given the species' plumage.

CONSERVATION ACTIONS: If the species persists, it likely benefits from management activities to conserve other endangered forest birds on Kaua‘i, including the establishment of the Alaka‘i Wilderness Preserve, regular surveys of forest bird populations, monitoring of habitat conditions, studies of disease and disease vectors, control of feral ungulates through public hunting, and public education efforts featuring Kauai's endangered forest birds. Should this species be rediscovered, the Rare Bird Recovery Protocol outlined in the USFWS *Revised Recovery Plan for Hawaiian Forest Birds* would be implemented, and management in anticipation of that possibility should include continued protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring on all islands.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is likely extinct there are no research priorities specific to Kaua‘i ‘ō‘ō.

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Picture: Rothschild Collection

Forest Birds

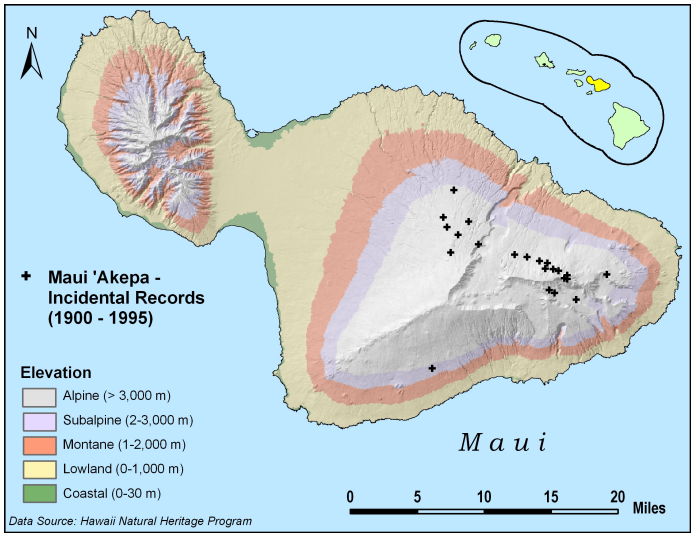
Maui ʻākepa

Loxops coccineus ochraceus

SPECIES STATUS:
Federally Listed as Extinct
State Listed as Extinct
State Recognized as Endemic
NatureServe Heritage Rank G1/TH— Presumed Extinct
IUCN Red List Ranking—Critically Endangered
d Recovery Plan for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: The Maui ʻākepa is a small, insectivorous Hawaiian honeycreeper (Family: Fringillidae) endemic to the island of Maui at the subspecies level. ʻĀkepa also are known from the island of Hawaiʻi (*L. c. coccineus*) and Oʻahu (*L. c. rufus*); the latter subspecies is certainly extinct. Currently, all ʻākepa are considered one species, although they are recognized as critically imperiled at the subspecies level. Adults are less colorful compared to the Hawaiʻi ʻākepa, and there is no information on the plumage sequence of the Maui subspecies. The lower mandible of the ʻākepa is slightly bent to one side which results in the mandible tips being offset; a characteristic shared with the ʻakekeʻe (*L. caeruleirostris*) and the Hawaiʻi ʻākepa. Although almost nothing is known about its life history, the Maui ʻākepa likely forages in a similar manner to the Hawaiʻi ʻākepa, and is most often observed in ʻōhiʻa (*Metrosideros polymorpha*) forests. Although based on a single observation, in stark contrast to the Hawaiʻi ʻākepa, the Maui subspecies apparently builds an open-cup nest in the terminal foliage of ʻōhiʻa trees. Declared extinct by U.S. Fish & Wildlife Service in 2023.

DISTRIBUTION: Unknown. Probably extinct. Last sightings occurred on the northeastern slopes of Haleakalā between 1,700 and 2,000 meters (5,500 – 7,000 feet) elevation. Historical distribution is poorly known, but like many Hawaiian forest birds the original range likely included all forested regions of the island.



ABUNDANCE: The Hawaiian Forest Bird Survey (1980), estimated the population at 230 ± 290 (95% confidence interval) individuals, but reliance on auditory detections may have biased this estimate. No ʻākepa were found during the Hawaiʻi Rare Bird Search (1995 - 1999). The last reliable sightings occurred in 1970.

LOCATION AND CONDITION OF KEY HABITAT: Virtually all sightings of the Maui ʻākepa in this century were in wet montane ʻōhiʻa forests on the northeastern slopes of Haleakalā. These forests vary from intact to degraded. Areas where the Maui ʻākepa have most recently been observed are managed by the State of Hawaiʻi or by the National Park Service.

THREATS: Unknown. However, the Maui ʻākepa was likely susceptible to the same factors that threaten other native Hawaiian forest birds including loss and degradation of habitat, predation by introduced mammals, and disease. For Maui ʻākepa, the following was likely of particular concern:

- Disease. The precipitous decline of the Maui and Oʻahu subspecies and the restriction of the Hawaiʻi ʻākepa to high-elevation forests suggests that disease played an important role in the demise of Maui ʻākepa.

CONSERVATION ACTIONS: If the species persists, it likel
conserve other endangered forest birds on northeastern Haleakalā. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring and studies of disease and disease vectors. Should this species be rediscovered, the Rare Bird Recovery Protocol contained in the U.S. Fish and Wildlife Service (USFWS) *Recovery Plan for Hawaiian Forest Birds* would be implemented, and management in anticipation of that possibility should include continued protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is likely extinct, there are no research priorities specific to the Maui ʻākepa.

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Photo: Brooks Rownd

Forest Birds

Maui ‘alauahio or Maui creeper

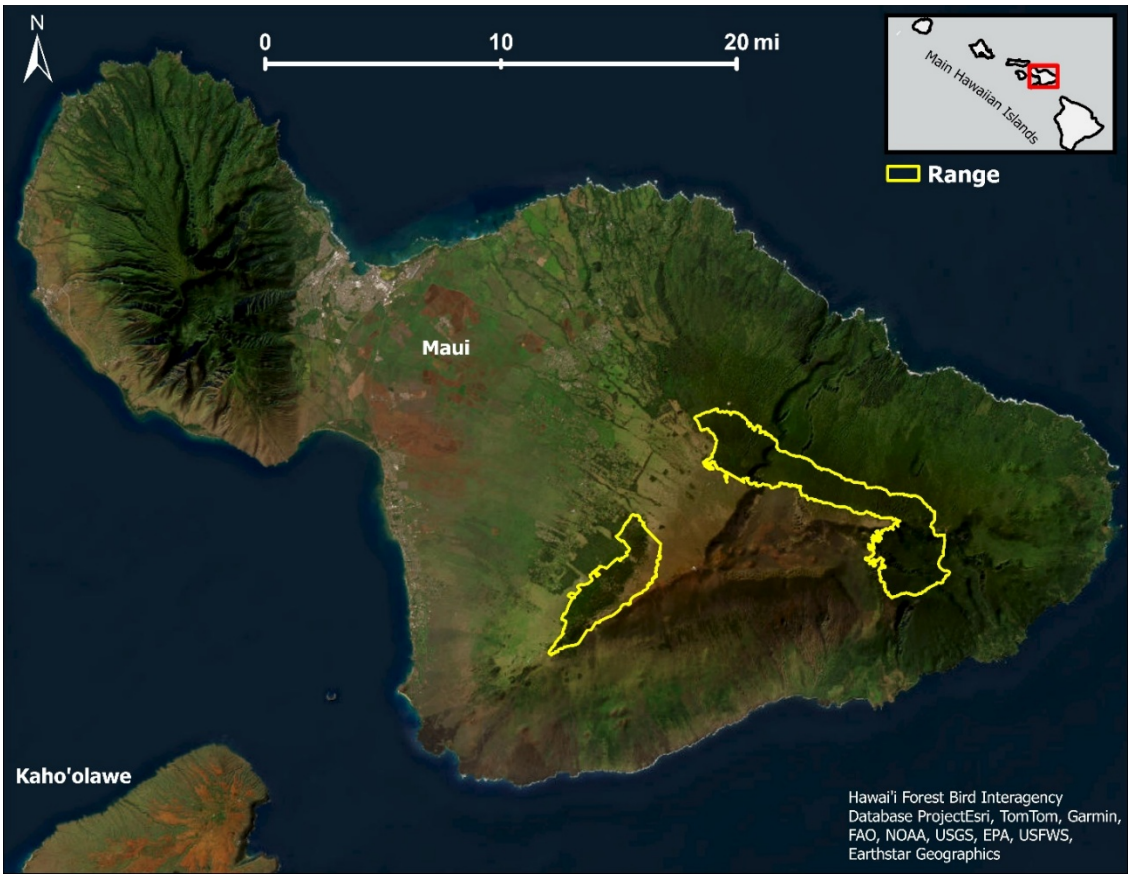
Paroreomyza montana

SPECIES STATUS:
State Recognized as Endemic
NatureServe Heritage Rank G4—Apparently Secure
IUCN Red List Ranking—Endangered

SPECIES INFORMATION: The Maui ‘alauahio, or Maui creeper, is a small insectivorous Hawaiian honeycreeper (Family: Fringillidae) endemic to Maui. The species also occurred on Lāna‘i but was last seen in 1937 and is presumed extinct. Adult males are predominantly olive-green above and have a bright yellow face, throat, and belly; the amount and intensity of yellow varies among individuals. Adult females are similar, but generally not as bright; both have short, fine straight bills. Adult plumage is not attained for several years. The Maui ‘alauahio gleans invertebrates from woody and leafy parts of a variety of plants. Adults defend an approximately 1-hectare (2.5 acre) home range against conspecifics year-round and will chase other birds and predators from the vicinity of their nests. They are socially monogamous and pair for life, although extra-pair copulations have been confirmed through genetic analysis. Females choose the nest site and build open-cup nests. Clutch size is two, and birds will renest after a failure, although double brooding has not been documented. Only females incubate eggs and brood nestlings. They do not breed until their third year, and young birds (i.e., helpers) associate with breeding pairs. Helpers are usually offspring from the previous year and feed the female, nestlings, and fledglings. Family groups can be as many as six individuals. Fledglings are fed for two to three months, and young remain with their parents in family groups for 18 - 20 months. They will make alarm calls when predators are in the area.

DISTRIBUTION: Broadly distributed in native and non-native forest on the slopes of Haleakalā at elevations ranging from 1200 to 2300 meters (3,900- 7,500 feet). . Historically common in West Maui and on Lāna‘i; these populations are now extirpated. Fossil evidence suggests they were common across the south side of East Maui and in lowland forests, but they no longer exist in these locations today. Range is estimated to be 107 square kilometers (41 square miles).

ABUNDANCE: The Hawai’i Forest Bird Survey from 2022 estimated the population at 99,060 ± 9510 individuals (95% confidence interval); however surveys did not include all inhabitated areas, so the population is likely higher. This estimate represents a 41% decrease since 1992.



LOCATION AND CONDITION OF KEY HABITAT: Primarily wet and mesic montane forests dominated by ʻōhiʻa (*Metrosideros polymorpha*), although they also occur in subalpine māmane schrubland (*Sophora chrysophylla*), and in dry and mesic forests dominated by pine (*Pinus* spp.) and eucalyptus (*Eucalyptus* spp.) (e.g., Polipoli State Park and Hosmer Grove); all populations occur above 1200 meters (3,900 feet) elevation. Habitat conditions vary greatly across the species' range. The species' range is managed by the State of Hawaiʻi, (i.e., Forest Reserve and Natural Area Reserve), the National Park Service, and private landowners including The Nature Conservancy. All entities are current members of the East Maui Watershed Partnership. Management efforts vary.

THREATS:

- Predation. Rats (*Rattus* spp.) and mongooses (*Herpestes auropunctatus*) have been observed depredating nests and females. Female behavior of begging near nests may make them particularly susceptible to rats. Additionally, their nests occur lower in the canopy than other honeycreeper species.
- Disease. Susceptibility to avian malaria has been documented, and likely prevents the establishment of populations in lowland areas.
- Habitat degradation. Current fencing around protected areas is not effective in excluding axis deer (*Axis axis*). Currently, deer populations on Maui are growing and threaten to further degrade forests occupied by the ʻalauahio.

CONSERVATION ACTIONS: Maui ‘alauahio likely have benefited from actions to conserve endangered forest birds on northeastern Haleakalā including fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies on disease and disease vectors. In addition, ongoing fencing,ungulate control, and habitat restoration on Department of Hawaiian Homelands at Kahikinui could possibly allow for the re-establishment of a population there in the future. In general, actions should include continued protection and management of wildlife sanctuaries and refuges. Mosquito control implementation will benefit populations and could likely add to an increase in range and population and allow for reintroductions to areas where they used to be found. A possible reintroduction to West Maui could allow for an expansion of range as well as being a safeguard for the species as a whole.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for Hawaiian forest birds include improving methods for controlling rats, mongooses, and feral cats (*Felis silvestris*) in native forests, determining ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquitoes. Research priorities specific to Maui ‘alauahio include development of a translocation protocol to facilitate reintroduction into restored forests. Diet studies to determine overlap with non-native species as well as determining targeted invertebrate recovery.

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Forest Birds

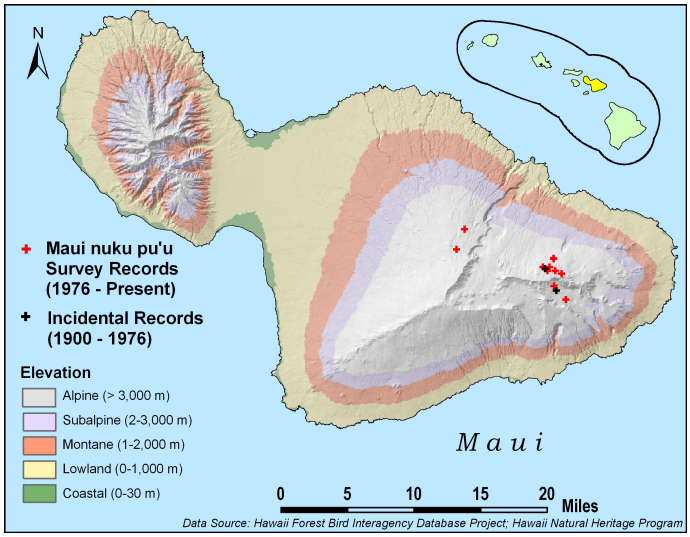
Maui nuku pu‘u

Hemignathus lucidus affinis

SPECIES STATUS:
Federally Listed as Extinct
State Listed as Extinct
State Recognized as Endemic
NatureServe Heritage Rank G1T1—Presumed Extinct
IUCN Red List Ranking—Critically Endangered (Possibly Extinct)
Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: The Maui nuku pu‘u is a large, short-tailed Hawaiian honeycreeper (Family: Fringillidae) with a long, thin decurved bill; the lower mandible is half the length of the upper mandible. Nuku pu‘u also are known from O‘ahu (*H. l. lucidus*) and Kaua‘i (*H. l. hanapepe*); the O‘ahu subspecies is certainly extinct. Currently, all nuku pu‘u are considered one species, however, ongoing research suggests that populations occurring on the three islands are distinct species. Adult males are olive green with a yellow head, throat, and breast and have a small black mask; females are olive green above and variable yellow-gray below. Little is known about the species’ life history. Often joins mixed species foraging flocks. Apparently would creep along large ‘ōhi‘a (*Metrosideros polymorpha*) limbs searching epiphytes, moss, bark, and dead wood for arthropod prey; may also have taken nectar. Hammered bark with lower mandible, similar to its congener the ‘akiapōlā‘au (*H. munroi*), and used its upper mandible to fish out prey from excavations. No information on the species’ reproduction, but is likely similar to ‘akiapōlā‘au. Declared extinct by U.S. Fish & Wildlife Service in 2023.

DISTRIBUTION: Poorly known. Probably extinct. Most recent sightings between 1,100 and 2,100 meters (3,600–6,900 feet) elevation in the Kīpahulu Valley and the northeastern slope of Haleakalā. Historic range apparently very restricted, although subfossil evidence suggests the species may have occurred in dry forests.



ABUNDANCE: Unknown. Probably extinct. Based on a single sighting, the Hawaiian Forest Bird Survey (1980), estimated the population at 28 ± 56 (95% confidence interval) individuals. More recent surveys have failed to detect the Maui nuku pu‘u. Historically considered uncommon.

LOCATION AND CONDITION OF KEY HABITAT: Mixed ‘ōhi‘a/koa (*Koa acacia*) forests and mixed shrub montane wet forests between 1,100 and 2,100 meters (3,600–6,900 feet). Historic and fossil evidence indicates that its range was much broader and remnant populations may have been surviving in marginal habitat. Habitat conditions of the species’ former range vary. Areas where nuku pu‘u were most recently sighted are managed as a Forest Reserve by the State of Hawai‘i or by the National Park Service.

THREATS: Unknown. However, the Maui nuku pu‘u was likely susceptible to the same factors that threaten other native Hawaiian forest birds including loss and degradation of habitat, predation by introduced mammals, and disease. For Maui nuku pu‘u, the following was likely of particular concern:

- Disease. The precipitous decline of all nuku pu‘u taxa suggests that disease played an important role in the species’ decline.

CONSERVATION ACTIONS: If the species persists, it likely benefits from actions to conserve other endangered forest birds on northeastern Haleakalā. These efforts include the establishment of the 3,000 hectares (7,500 acres) Hanawī Natural Area Reserve in 1986, the formation of the East Maui Watershed Partnership, fencing, ungulate and small mammal control, forest restoration, habitat monitoring and studies of disease and disease vectors. Should this species be rediscovered, the Rare Bird Recovery Protocol in the U.S. Fish and Wildlife Service (USFWS) *Recovery Plan for Hawaiian Forest Birds* would be implemented, and management in anticipation of that possibility should include continued protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is likely extinct, there are no research priorities specific to Maui nuku pu‘u.

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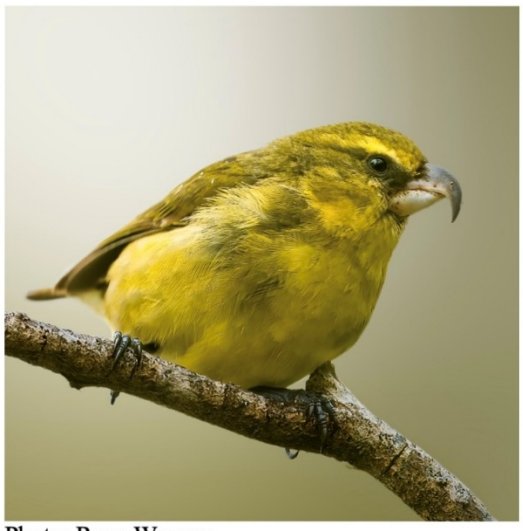


Photo: Ryan Wagner

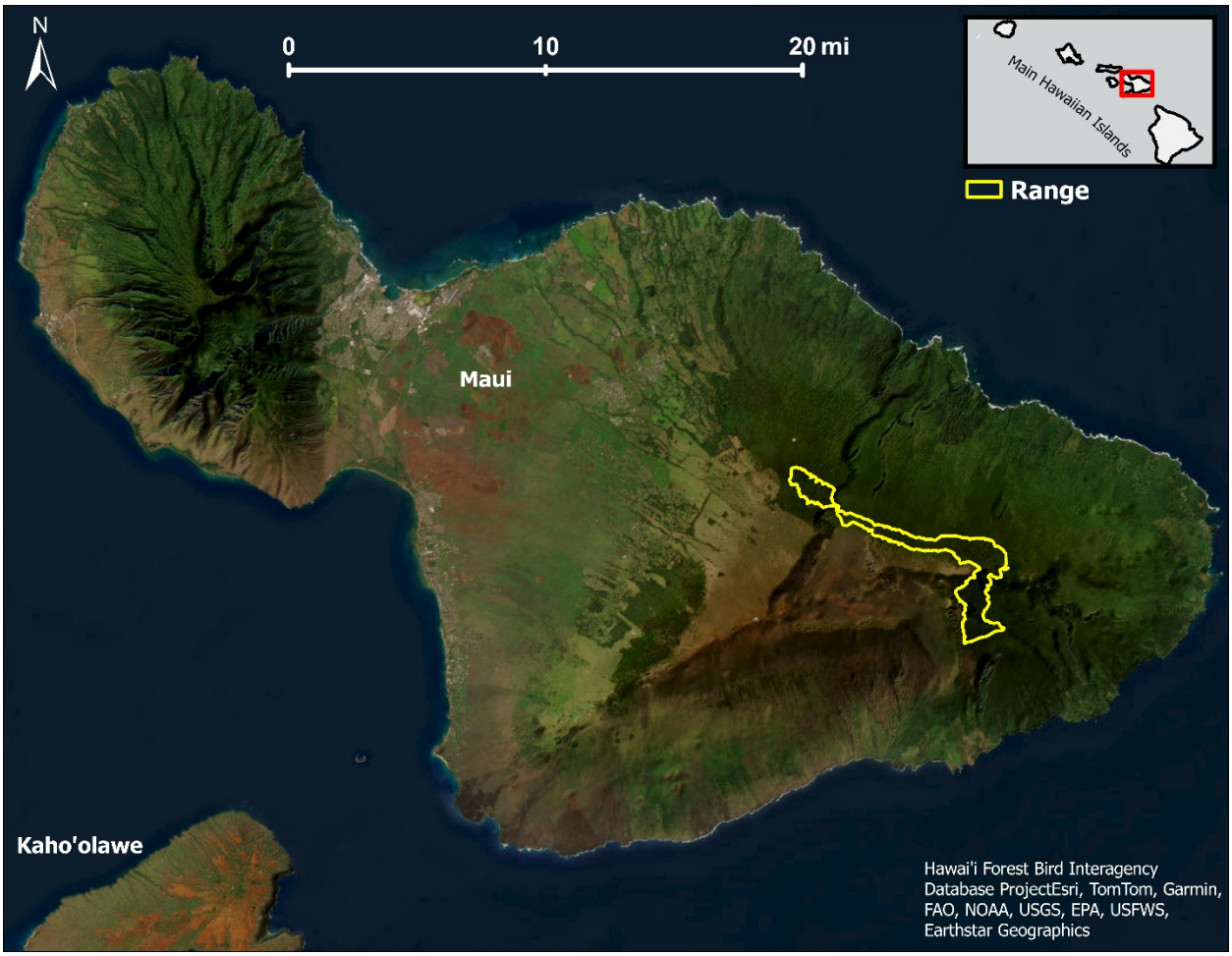
Forest Birds

Kiwikiu or Maui parrotbill

Pseudonestor xanthophrys

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank G1—Critically Imperiled
IUCN Red List Ranking— Critically Endangered
Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: The kiwikiu or Maui parrotbill is a Hawaiian honeycreeper endemic to Maui, with a short tail and a relatively large, parrot-like bill. Adults are mostly olive-green above with a yellow breast, belly and cheeks, and a bright yellow line above their eyes (i.e., supercilium). Males are typically brighter than females, although individuals vary . Males are larger than females in size and bill. They feed on a variety of shrubs and small trees, especially 'ākala (*Rubus hawaiensis*), kanawao (*Broussaisia arguta*), ʻōhiʻa (*Metrosideros polymorpha*), kōlea (*Myrsine* species), pilo (*Coprosma* species) and Hawai'i greenbrie (Smilax melastomifolia). They use their large parrot-like bills to glean prey from moss-covered branches or chisel, crack, crush, dig, and tear bark and softer wood in search of beetle and Lepidoptera larvae and pupae. They also open fruit in search of insects. Pairs defend relatively large 11.8-to-14.5-hectare year-round home ranges. Females build nests, incubate eggs, and brood young. Clutch size is usually one, and females feed nestlings with food delivered by males. Males feed the fledglings. They will renest after a nest failure but are not known to attempt another nest during the breeding season if the first is successful. Development of bill and acquisition of foraging techniques is prolonged and young remain with parents for 5 to 18 months. Because of this long period of dependency, kiwikiu are often seen in small groups and males can be seen provisioning juveniles from current and previous years. Pairs are typically monogamous and inviduals can live longer than 16 years.



DISTRIBUTION: Restricted to a ~30 square kilometer (11.5 square mile) on the northeastern slopes of Haleakalā between 1,600 and 2,200 meters (5,200 – 7,200 feet). Subfossils indicate they once occurred island-wide including at low elevations and leeward (southeastern) forests and on the island of Molokaʻi.

ABUNDANCE: The Hawaiʻi Forest Bird Survey from 2022 estimated the population at 157 ± 67 (95% confidence interval) birds, a 71% decline in population since 2001

LOCATION AND CONDITION OF KEY HABITAT: Mid-to-upper-elevation montane wet forests dominated by ʻōhiʻa, and in a few mesic areas dominated by ʻōhiʻa and koa (*Acacia koa*), with a dense, diverse native understory and subcanopy of ferns, sedges, epiphytes, shrubs, and small to medium trees. Most of the range is managed by the National Park Service, State of Hawaiʻi, The Nature Conservancy (TNC). Their range exists within the East Maui Watershed Partnership. .

THREATS:

- Low reproduction. Unlike many Hawaiian honeycreepers, kiwikiu have low annual fledgling production. This results from a low reproductive potential (one fledgling per

year) coupled with low reproductive success due to habitat limitations and weather. This life history characteristic may be related to their very specialized foraging strategy. Regardless, the species is susceptible to factors that reduce population size.

- Disease. Despite the availability of seemingly suitable habitat below 1,600 meters (5,200 feet), kiwikiu are not found in these areas, suggesting that disease may be restricting populations to higher elevations. Furthermore, nearly all of the kiwikiu died of avian malaria during the 2019 translocation to the southeast slope of Haleakalā, even though the kiwikiu had come from and were taken to mid-to high elevation forest, which was typically known for lower disease rates, suggesting that disease in these forests is higher than previously thought.
- Predation. Predation on adults and nests by rats (*Rattus* spp.), cats (*Felis silvestris*), the small Indian mongoose (*Herpestes auropunctatus*), and owls (*Asio flammeus sandwichensis, Tyto alba*) may limit the species. High rat densities have been reported in the Hanawī area, which also supports a large proportion of the kiwikiu population.
- Habitat loss. Historical accounts suggest that kiwikiu favored koa for foraging. Logging and ranching have resulted in the loss of large areas of mesic koa forest, and their current range is restricted to wet forests where koa density is relatively low and wet weather can lead to nest failure. Thus like many endangered Hawaiian forest birds, kiwikiu may be restricted to suboptimal habitat.
- Habitat degradation. Damage to understory vegetation by feral pigs (*Sus scrofa*) likely reduces habitat suitability and may contribute to reduced food availability and low reproductive success. Habitat degradation also may increase exposure of nests to inclement weather.
- Population size. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios and stochastic factors include natural disasters. Habitat fragmentation exacerbates demographic and genetic problems.

CONSERVATION ACTIONS: The kiwikiu benefits from management efforts to conserve other endangered forest birds on northeastern Haleakalā, such as the establishment of the 3,000 hectare (7,500 acre) Hanawī Natural Area Reserve in 1986, the formation of East Maui Watershed Partnership and Maui Forest Bird Recovery Project, fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. Future actions specific to the recovery of the kiwikiu may include the following:

- Develop and deploy mosquito control techniques as soon as possible to reduce the mosquito vector of avian disease.
- Capture enough birds with a suitable age structure and sex ratio to establish a viable captive population. Continue to evaluate and adaptively manage captive care in an effort to maintain wild behaviors and encourage parental breeding behaviors. If/when mosquito control is deployed on Maui and meets efficacy success criteria, release worthy candidates back on Maui. In 1997, a captive breeding program was initiated. As of 2024, 8 kiwikiu are in captive care at the Maui Bird Conservation Center and efforts are ongoing to continue bringing suitable individuals into holding to prevent outright extinction in the wild from avian disease.

- Protect and restore habitat in high-elevation disease-free areas.
- Implement fencing and ungulate control in low-elevation habitat from the Hanawī Natural Area Reserve to TNC's Waikamoi Preserve, to facilitate the recovery of the understory and subcanopy vegetation and eventually result in high-quality kiwikiu habitat. Once mosquito control has been implemented, this could be a possible location for kiwikiu to reestablish a population.
- Establish a continuous corridor of suitable habitat around Haleakalā by connecting conservation lands on the southern and western parts of the mountain. Restoration of koa forests to this area would be a key element to this effort.
- Restore, fence, and eradicate ungulates from the remnant mesic koa forests on the State Forest Reserve and Department of Hawaiian Home Lands in the Kahikinui region of southern Haleakalā. Restoration of this area would be a cost-effective starting point to providing the kiwikiu with high-quality habitat for future reintroductions.
- Conduct public outreach and education about the importance of invasive species control and forest restoration. Incorporate Hawaiian knowledge and practices in conservation strategies
- Continue protection and management of wildlife sanctuaries and refuges.
- Develop and deploy new tools and evaluate above approaches.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats, mongooses, and feral cats in native forests, determining ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquitoes. Research priorities specific to the kiwikiu include the following:

- Evaluate the effect of predator control on reproduction and survival of kiwikiu.
- Further refine captive breeding techniques and evaluate experimental reintroduction sites. Evaluation should include mosquito surveys and determination of disease prevalence in lower elevation sites and possible sites on other islands.
- Investigate invertebrate communities where kiwikiu do not currently inhabit to design and implement large-scale restoration. Diet studies to determine overlap with non-native species as well as determining targeted invertebrate recovery.

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Picture: Rothschild Collection

Forest Birds

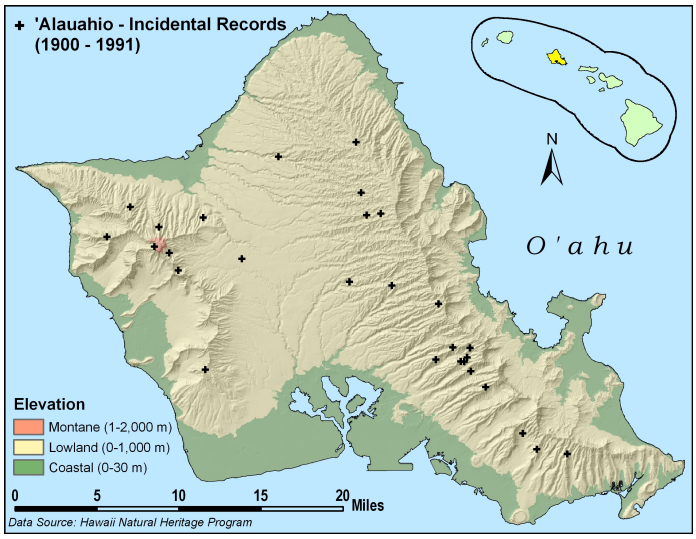
O‘ahu ‘alauahio

Paroreomyza maculata

SPECIES STATUS:
Federally Listed as Endangered
States Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank GH—Possibly Extinct
IUCN Red List Ranking—Critically Endangered (Possibly Extinct)
Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: The O‘ahu ‘alauahio is a small, sexually dichromatic, insectivorous Hawaiian honeycreeper (Family: Fringillidae) endemic to O‘ahu. Males are olive-green above with bright yellow underparts and forehead, females are grayish-green above and yellowish-white below. The plumage of this species is very similar to that of the O‘ahu ‘amakihi (*Hemignathus flavus*). The song of the O‘ahu ‘alauahio has never been described. The O‘ahu ‘alauahio is insectivorous and forages by methodically searching and probing the bark of large branches and tree trunks. Like other Hawaiian creepers, ‘alauahio joins foraging flocks during non-breeding seasons. Little is known about the life history or breeding biology of the species, but it is likely similar to that of the Maui creeper (*P. montana*).

DISTRIBUTION: Unknown. Probably extinct. Historical range is poorly known as it was likely declining when first discovered, but it historically occurred in both the Ko‘olau and Wai‘anae ranges.



ABUNDANCE: Unknown. Probably extinct. The last well-documented sighting was of two birds in 1985. O‘ahu was not included in the Hawai‘i Rare Bird Search in the late 1990s, so it is possible that the O‘ahu ‘alauahio still exists in remote valleys.

LOCATION AND CONDITION OF KEY HABITAT: Unknown. Once occupied mid-elevation forests of ‘ōhi‘a (*Metrosideros polymorpha*) and koa (*Acacia koa*). Historically, it was reported to prefer large koa trees, but

they also were reported in areas without koa. All recent observations occurred in mixed koa/ʻōhiʻa forest between 300 and 600 meters (1,000 – 2,000 feet). Forests where the Oʻahu ʻalauahio historically occurred are largely managed by the State of Hawaiʻi, the U.S. Fish and Wildlife Service (USFWS), or the U.S. Military.

THREATS: Unknown. However, the Oʻahu ʻalauahio likely were susceptible to the same factors that threaten other native Hawaiian forest birds including habitat loss and degradation, predation by introduced mammals, and disease. For Oʻahu ʻalauahio, the following was likely of particular concern:

- Disease. The fact that no habitat above 1,250 meters (4,100 feet) occurs on Oʻahu, and that historical accounts report the species only above 350 meters (1,500 feet) suggests that disease played an important role in the species' decline.

CONSERVATION ACTIONS: Unfortunately, few forest birds remain on Oʻahu, and little if any, specific management is directed at forest birds other than the Oʻahu ʻelepaio (*Chasiempis sandwichensis ibidis*). The Oʻahu Forest National Wildlife Refuge in the Koʻolau Range is near some of the most recent sightings, but whether the species still exists in the area is unknown. Should this species be rediscovered, the Rare Bird Recovery Protocol outlined in the USFWS *Recovery Plan for Hawaiian Forest Birds* would be implemented, and management in anticipation of that possibility should include continued protection and management of wildlife sanctuaries and refuges.

MONITORING: Initiate regular forest bird surveys and habitat monitoring on Oʻahu.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is likely extinct, there are no research priorities specific to Oʻahu ʻalauahio.

References:

Baker PE, Baker H. 2000. Kākāwahie (*Paroreomyza flammea*) and O'ahu alauahio (*Paroreomyza maculata*). *In* The Birds of North America, No. 503 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

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U.S. Fish and Wildlife Service. 2006. Revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service.

Forest Birds

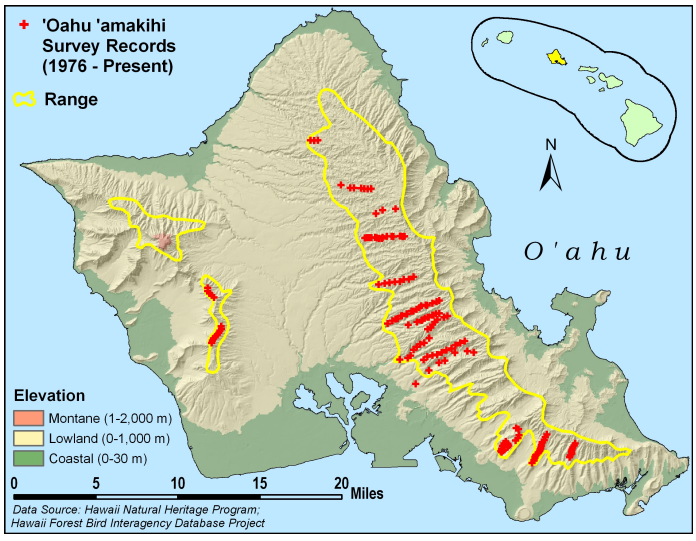
O‘ahu ‘amakihi

Hemignathus flavus

SPECIES STATUS:
State Recognized as Endemic
NatureServe Heritage Rank G3—Vulnerable
IUCN Red List Ranking—Vulnerable

SPECIES INFORMATION: The O‘ahu ‘amakihi is a small, generalist Hawaiian honeycreeper (Family: Fringillidae) endemic to the island of O‘ahu. Until 1995, the O‘ahu ‘amakihi, and the Hawai‘i (*H. virens*) and Kaua‘i amakihi (*H. kauaiensis*), were considered a single species: the common ‘amakihi (*H. virens*). Plumage of all species is similar; males are yellow-green to olive with black lores. Females are similar, but duller. All have decurved bills. The plumage of some male O‘ahu amakihi is variable in having yellow above eyes and more yellow breasts, and compared to the other species, female O‘ahu ‘amakihi have two dull wing bars. The O‘ahu ‘amakihi is brighter and smaller than the Kaua‘i ‘amakihi. O‘ahu ‘amakihi are generalized foragers that take arthropods from a variety of trees and substrates. The species often gleans arthropods from leaves and twigs, less frequently from larger branches and trucks. Feeds on nectar and fruit from a variety of native and non-native plants and has been observed eating sap from koa (*Acacia koa*) trees. Only three nests have been found; thus, the species’ reproductive biology is poorly known, but is likely similar to Hawai‘i ‘amakihi.

DISTRIBUTION: Occurs in two disjunct populations between 50 and 300 meters (180 – 1,000 feet), although is most numerous above 200 meters (650 feet). In recent years, range has increased to include some residential areas. Original range likely included all forested regions of O‘ahu.



ABUNDANCE: A 1991 survey conducted by the State of Hawai‘i Division of Forestry and Wildlife estimated the O‘ahu ‘amakihi population at between 20,000 and 60,000 individuals. Audubon Christmas bird

counts from 1958 to 1985 documented a decrease in detections. Despite this, populations may be increasing in some areas.

LOCATION AND CONDITION OF KEY HABITAT: Occurs in a variety of habitats from very wet forests in the Koʻolau Mountains to dry forests in the Waiʻanae Mountains. They are more common in sheltered forests in valleys at middle elevations. Unlike other Hawaiian passerines, the range of the Oʻahu ʻamakihi extends to low-elevation forest dominated by non-native plant species. Among introduced forests, ʻamakihi are most abundant in areas dominated by guava (*Psidium guajava*) or kukui (*Aleurites moluccana*). Most of the species' range is managed by the U.S. Fish and Wildlife Service, U.S. Army, and the State of Hawaiʻi.

THREATS: Although Oʻahu ʻamakihi populations appear stable, they are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including habitat loss and degradation, predation by introduced mammals, and disease. For Oʻahu ʻamakihi, the following is of particular concern:

- Fire. Non-native plants and military training activities often result in wildfires that threaten Oʻahu ʻamakihi habitat on military lands.

CONSERVATION ACTIONS: Oʻahu ʻamakihi likely have benefited from management activities to conserve other endangered forest birds including the establishment of the Oʻahu Forest National Wildlife Refuge in the Koʻolau mountains, rat control directed at protecting nesting Oʻahu ʻelepaio (*Chasiempis sandwichensis ibidis*), fencing and ungulate control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future management specific to the Oʻahu ʻamakihi may include the following:

- Conduct public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Initiate regular forest bird surveys on Oʻahu and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Because the Oʻahu ʻamakihi appears to be surviving and possibly thriving in disturbed habitat and at elevations below the point where mosquitoes commonly occur, they provide potentially important research opportunities. Research priorities specific to the Oʻahu ʻamakihi include the following:

- Quantify the population structure, dispersal patterns, survivorship, nesting phenology, and success. Studies comparing life history characteristics between native and non-native habitats would be particularly useful.
- Identify and study disease-resistant populations, focusing on the genetic basis of resistance.

References:

IUCN Red List of Threatened Species. 2015. Version 2014.3. Available at: www.iucnredlist.org. (Accessed May 2015).

Lindsey GD, VanderWerf EA, Baker H, Baker PE. 1998. Hawai'i (*Hemignathus virens*), Kaua'i (*Hemignathus kauaiensis*), O'ahu (*Hemignathus chloris*) and greater 'amakihi (*Hemignathus sagittirostris*). *In* The Birds of North America, No. 360 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Photo: DOFAW

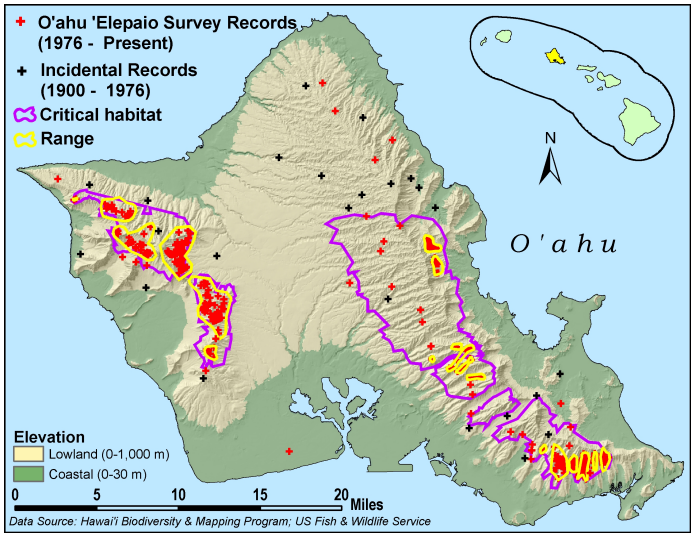
Forest Birds

O‘ahu ‘elepaio

Chasiempis ibidis

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank G1—Critically Imperiled
IUCN Red List Ranking—Endangered
Revised Recovery Plan for Hawaiian Forest Birds —USFWS 2006

SPECIES INFORMATION: The O‘ahu ‘elepaio is a small, adaptable monarch flycatcher (Family: Monarchiade) endemic to the island of O‘ahu. Other species of ‘Elepaio occur on Kaua‘i (*C. sclateri*) and the island of Hawai‘i (*C. sandwichensis*). Males and females are dark brown above and white below with variable light brown streaks on breast and conspicuous white wing bars, tail feather tips, and throat. Both sexes have variable amounts of blacking markings, but males tend to have more. The bird’s name is derived from its primary song which is a shrill whistle given only by males. On the island of Hawai‘i, ‘elepaio use virtually all available substrates for foraging including the ground, logs, rock crevices, snags, and all parts of tress. Equally diverse in the use of foraging maneuvers, ‘elepaio capture a wide range of arthropod prey by flycatching, gleaning while either perched or hovering, and direct pursuit; foraging maneuvers vary depending on plant species from which prey is being captured, and habitat. O‘ahu ‘elepaio use a variety of native and non-native trees for foraging. Pairs remain together throughout the year, and long-term pair bonds are common. Breeding season on O‘ahu is January through July compared to March through August on the island of Hawai‘i. Unlike Hawaiian honeycreepers, both males and females participate almost equally in all aspects of rearing. Finely woven cup nests are built in a variety of native and non-native trees. Clutch size is usually two and second and third nests are attempted after failures, but rarely is a second nest attempted if the first is successful. Fecundity is low even in areas were



predators are controlled. Young are fed by parents for at least a month, but remain on their natal territory for up to ten months which may allow young birds to hone their foraging skills.

DISTRIBUTION: Occurs in the Koʻolau Range between 100 to 550 meters (325 – 1,800 feet) elevation, and in the Waiʻanae Range between 500 to 850 meters (1,625 – 2,775 feet) elevation. Dispersal between the ranges is unlikely. Each subpopulation consists of several populations; the amount of dispersal among these is likely low. Original distribution likely included all forested areas of Oʻahu.

ABUNDANCE: In 2013, the population was estimated at 1,261 (95% confidence interval = 1,205-1,317) birds. It had previously been estimated at 1,200 to 1,400 birds. Although Audubon Christmas bird counts from the 1960s through the 1980s provided strong evidence of a dramatic population decline, numbers are now so low that the rate of decline since the 1990s cannot be determined.

LOCATION AND CONDITION OF KEY HABITAT: Occurs in a variety of forest types and across a range of elevations, primarily in valleys and particularly those with tall riparian vegetation, a continuous canopy, and dense understory. Common native plant species where ʻelepaio occur include papala kēpau (*Pisonia umbellifera*), lama (*Diospyros sandwicensis*), māmaki (*Pipturus albidus*), kaulu (*Sapindus oahuensis*) and ʻālaʻa (*Pouteria sandiwicensis*). Common introduced plants in ʻelepaio habitat include strawberry guava (*Psidium cattleianum*), common guava (*P. guajavai*), kukui (*Aleurites moluccana*), mango (*Mangifera indica*), and Christmas berry (*Schinus terebinthifolius*). Oʻahu ʻelepaio are not found in very wet forests, on windswept summits, or in very dry scrubland. Much of their current range is managed by the U.S. military or by the State of Hawaiʻi.

THREATS: Oʻahu ʻelepaio are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including loss and degradation of habitat, predation by introduced mammals, and disease. For Oʻahu ʻelepaio, the following threats are of particular concern:

- Predation. Predation by black rats (*Rattus rattus*) have been implicated in the loss of nests and death of adult females. Rat control in Oʻahu populations resulted in large increases in nest success and in survival of adult females.
- Low reproductive potential. The species' low annual productivity, even in quality habitat, makes it very susceptible to factors that reduce population size.
- Disease. Avian pox (*Poxvirus avium*) reduces both annual survival and reproductive success of birds with active pox lesions compared to healthy birds; no information on the effect of avian malaria (*Plasmodium relictum*).
- Population size. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios and stochastic factors include natural disasters. Habitat fragmentation exacerbates demographic and genetic problems.
- Fire. Wildfires resulting from military activities threaten two populations.

CONSERVATION ACTIONS: Conservation efforts already undertaken to protect the Oʻahu ʻelepaio include the following: listing as an endangered species by both the U.S. Fish and Wildlife Service (USFWS) and the State of Hawaiʻi, the initiation of long term population and demographic surveys which have identified the most serious threats to its survival, and ongoing rat control at the Honolulu Forest Reserve (DOFAW), at Schofield Barracks West Range and Mākua Military Reservation (U.S. Army Environmental Division), in Honouliuli Preserve (DOFAW) and in Lualualei Valley (U.S. Navy and USDA). In addition, the Oʻahu ʻelepaio also benefits from management activities designed to conserve other endangered forest birds including the establishment of the Oʻahu Forest National Wildlife Refuge in the Koʻolau Mountains, fencing and ungulate control, forest restoration, habitat monitoring and studies on disease and disease vectors. In addition to these efforts, future management specific to the Oʻahu ʻelepaio should include the following:

- Continue and expand rat control.
- Protect remaining forests on Oʻahu, including through fire prevention.
- Conduct public outreach about the importance and benefits of rodent control.
- Continue demographic studies, especially in the largest populations.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the Oʻahu ʻelepaio include the following:

- Identify disease resistance and transmission patterns. If resistant individuals are identified, translocation and/or captive propagation of these individuals may help recover populations.
- Determine genetic population structure.
- Identify areas most suitable for re-introduction of populations or for creation of habitat dispersal links between existing populations.
- Continue efforts to develop techniques for captive propagation using surrogate species (e.g., Hawaiʻi ʻelepaio (*Chasiempis sandwichensis sandwichensis*)).

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VanderWerf EA, Rohrer JL, Smith DG, Burt MD. 2001. Current distribution and abundance of the O'ahu ʻelepaio. Wilson Bulletin 113:10-16.

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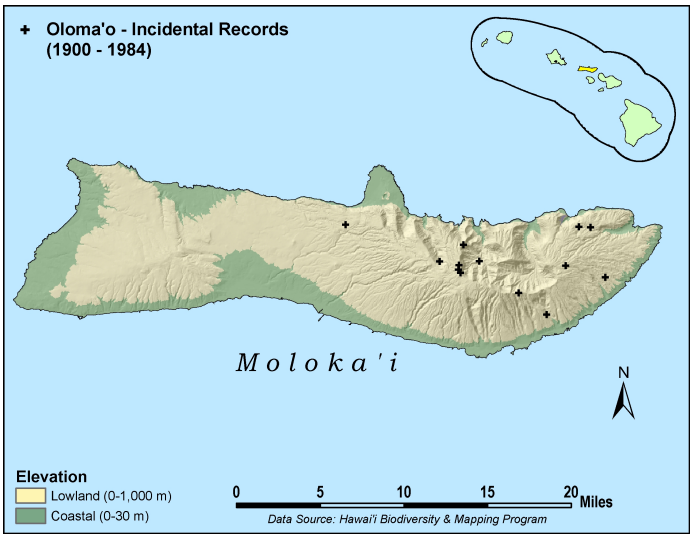
Oloma‘o

Myadestes lanaiensis rutha

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank GH
—Known Only from Historical Occurrences
IUCN Red List Ranking—Critically Endangered
(Possibly Extinct)
Revised Recovery Plans for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: The oloma‘o is one of five species of Hawaiian solitaires (family: Turdidae). All adult Hawaiian solitaires have olive-brown and gray plumage. Oloma‘o are prolific singers often singing into the night, and the species engages in song flights. Their song, like that of many thrushes, is melodious. Similar to other Hawaiian solitaires, the species often trembles their wings when perched. Oloma‘o are very philopatric, seldom leaving their small home range. The species feeds on a variety of small fruits and insects. Little is known about their breeding biology, but it is presumed to be similar to the ‘ōma‘o (*M. obscurus*).

DISTRIBUTION: Unknown. Probably extinct. The historic range included the native forests of eastern Moloka‘i and Lāna‘i. Historically the species also may have occurred on Maui, where subfossils of Hawaiian solitaires are abundant.



ABUNDANCE: Probably extinct. Since 1907, oloma‘o have been observed on a dozen occasions, most recently in 1988. The Hawaiian Forest Bird Surveys (1979-1980) estimated the population at 19 ± 38 (SE) individuals. However, oloma‘o were not detected during surveys in the late 1980s and 1990s. There is little information on historical abundance.

LOCATION AND CONDITION OF KEY HABITAT: Unknown. Historically occupied closed, wet and mesic ʻōhiʻa (*Metrosideros polymorpha*) forests across a broad elevation range. The areas where the species was last observed are managed by the State of Hawaiʻi as a Natural Area Reserve or by private conservation entities (e.g., The Nature Conservancy).

THREATS: Unknown. However, olomaʻo likely were susceptible to the same factors that threaten other native Hawaiian forest birds including loss and degradation of habitat, predation by introduced mammals, and disease. For olomaʻo, the following was likely of particular concern:

- Disease. The fact that no habitat above 1,250 meters (4,100 feet) occurs on Molokaʻi or Lānaʻi suggests disease may have played an important role in the species decline.

CONSERVATION ACTIONS: If the species persists, it likely benefits from management activities to conserve other endangered forest birds on eastern Molokaʻi, including the establishment and management of protected areas, regular surveys of forest bird populations, monitoring of habitat conditions, and studies of disease and disease vectors. Should this species be rediscovered, the Rare Bird Recovery Protocol outlined in the U.S. Fish and Wildlife Service (USFWS) *Revised Recovery Plan for Hawaiian Forest Birds* would be implemented, management in anticipation of that possibility should include continued protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species is probably extinct there are no research priorities specific to olomaʻo.

References:

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Wakelee KM, Fancy SG. 1999. ʻOmaʻo (*Myadestes obscurus*), kamaʻo (*Myadestes myadestinus*), olomaʻo (*Myadestes lanaiensis*), and ʻamaui (*Myadestes woahensis*). *In* The Birds of North America, No. 460 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Forest Birds

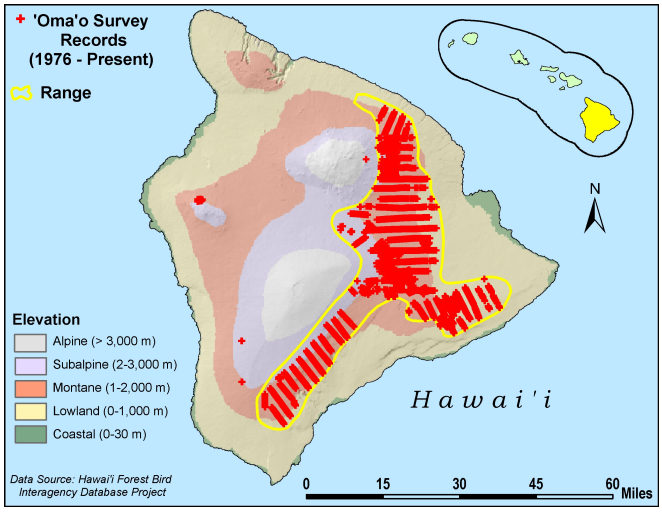
ʻŌmaʻo

Myadestes obscurus

SPECIES STATUS:
State Recognized as Endemic
NatureServe Heritage Ranking G3—Vulnerable
IUCN Red List Ranking—Vulnerable

SPECIES INFORMATION: One of five species of Hawaiian solitaires (family: Turdidae), the ʻōmaʻo is endemic to the island of Hawaiʻi. They often perch silently for long periods and are usually detected by their song; however males perform a flight-song display known as "skylarking." Like all adult Hawaiian solitaires, ʻōmaʻo have drab olive-brown and gray plumage. Diet consists primarily of fruits of native and introduced understory plant species, although they also take koa (*Acacia koa*) flowers from the canopy and prey on invertebrates, including earthworms, snails, spiders, and insects. The life history is well-studied. Both sexes defend small nesting territories. Nests are built by females in a variety of locations (e.g., cavities, trunk forks); females also perform most incubation and brooding. Clutch size is one or two eggs, and double brooding occurs. The young remain in natal territories for four to six months after fledging. A male-biased sex-ratio exists, but its significance to populations is unknown.

DISTRIBUTION: Primarily occurs in two populations on the eastern and southern slopes of the island of Hawaiʻi at elevations greater than 1,000 meters (3,300 feet). A third, smaller population occurs in alpine scrub between 2,000 and 3,000 meters (6,500 – 9,750 feet). Currently occupies about 30 percent of their former range, which historically included habitats between 300 and 3,000 meters (1,000 – 9,750 feet).



ABUNDANCE: The Hawaiian Forest Bird Surveys (1976-79, 1983) estimated the population at 170,000 birds. Based on more recent surveys, populations appear stable and may be increasing below 1,200 meters (3,450 feet).

LOCATION AND CONDITION OF KEY HABITAT: Mesic and wet montane ʻōhiʻa (*Metrosideros polymorpha*) or mixed ʻōhiʻa and koa forests in the Hāmākua, Kaʻū, and Kīlauea districts. These forests support important food plants, including ʻōlapa (*Cheirodendron trigynum*), kōlea (*Myrsine lessertiana*), kāwaʻu (*Ilex anomala*), naio (*Myoporum sandwicense*), pilo (*Coprosma* spp.), pūkiawe (*Styphelia tameiameiae*), ʻōhelo (*Vaccinium* spp.), and ʻākala (*Rubus hawaiiensis*). In the small alpine scrub population on Mauna Loa, pūkiawe, ʻōhelo, kūkaenēnē (*Coprosma ernodeoides*), and ʻaʻaliʻi (*Dodonea viscosa*) are important food plants. Although most of the current range occurs on State and federal lands, habitat conditions vary considerably.

THREATS: ʻŌmaʻo are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including loss and degradation of habitat, predation by introduced mammals, and disease. For ʻōmaʻo, the following are of particular concern:

- Disease. The prevalence of disease in areas tested is low and five ʻōmaʻo exposed to malaria recovered quickly, suggesting a greater disease resistance compared to other native forest birds. However, the species' disappearance from lower elevations is the pattern of decline noted in other Hawaiian birds susceptible to mosquito-borne diseases.
- Predation. Nests are very accessible and vulnerable to predation by rats (*Rattus* spp.). Predation by native raptors also is likely.
- Habitat degradation. ʻŌmaʻo occur at lower densities in degraded habitat. Pigs (*Sus scrofa*) and other ungulates likely destroy important food plants.

CONSERVATION ACTIONS: ʻŌmaʻo likely have benefited from management efforts designed to conserve other endangered forest birds and native habitat at Hakalau Forest National Wildlife Refuge, Hawaiʻi Volcanoes National Park, and the ʻŌlaʻa/Kīlauea Watershed Partnership. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future actions specific to the protection of ʻōmaʻo may include the following:

- Protect and restore native forests above 1,500 meters (4,500 feet), and eliminate feral ungulates and non-native plants.
- Conduct control or eradication of rats and feral cats in areas occupied by ʻōmaʻo.
- Conduct public education and outreach.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to ʻōmaʻo include the following:

- Identify disease-resistant individuals.
- Develop improved techniques to control alien weed species.

References:

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Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

Wakelee KM, Fancy SG. 1999. ‘Oma’o (*Myadestes obscurus*), kama’o (*Myadestes myadestinus*), oloma’o (*Myadestes lanaiensis*), and ‘amaui (*Myadestes woahensis*). *In* The Birds of North America, No. 460 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Photo: Bishop Museum

Forest Birds

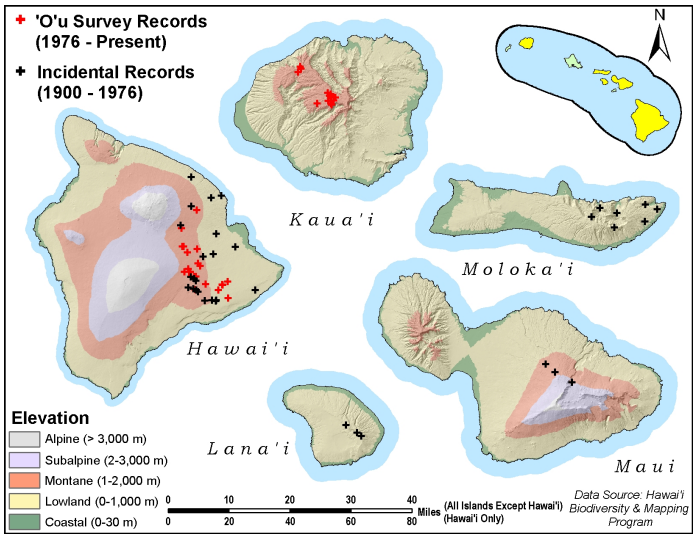
‘Ō‘ū

Psittirostra psittacea

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank G1—Critically Imperiled
IUCN Red List Ranking—Critically Endangered (Possibly Extinct)
Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: The ‘ō‘ū is a heavy-bodied Hawaiian honeycreeper (family: Fringillidae) with a distinctive thick, pink, parrot-like bill. Adults are olive-green with whitish undertail coverts; males have a bright yellow head. Early naturalist noted that ‘ō‘ū had a strong musky odor, which is retained in museum specimens. Like several of Hawaii's nectivorous birds, ‘ō‘ū are strong fliers and ranged widely in search of fruit. ‘Ie‘ie (*Freycinetia arborea*) inflorescences apparently are an important part of the species’ diet, although ‘ō‘ū also feed on the fruits of *Clermontia* spp. as well as other native fruits. Geometrid caterpillars are an important food item during the breeding season. Little is known of the species life history and its nesting and breeding habits have not been described.

DISTRIBUTION: Possibly extinct. Occupied forests between 900 and 1,500 meter (3,000 and 5,000 feet, respectively) elevations on the islands of Kaua‘i and Hawai‘i. Historically widespread, ‘ō‘ū formerly occurred on all the Main Hawaiian Islands in low- to high-elevation forests. They are now presumed extirpated on every island except possibly on Kaua‘i and Hawai‘i.



ABUNDANCE: Possibly extinct. The Hawaiian Forest Bird Surveys (1976-1981) estimated the population at 400 ± 300 (95% confidence interval) birds on the island of Hawai‘i and nine or fewer individuals on Kaua‘i. ‘Ō‘ū have not been detected during more recent surveys, although unconfirmed sightings are occasionally reported.

LOCATION AND CONDITION OF KEY HABITAT: Although known from a range of forest types, all recent observations have occurred in mid-elevation mesic to wet ʻōhiʻa (*Metrosideros polymorpha*) forests with an understory of ʻieʻie (*Freycinetia arborea*), tree ferns (*Cibotium* spp.), ʻōlapa (*Cheirodendron* spp.), kāwaʻu (*Ilex anomala*), kolea (*Myrsine* spp.), and pilo (*Coprosma* spp.). All recent sighting of ʻōʻū have occurred on lands managed by the State of Hawaiʻi.

THREATS:

- Habitat degradation. Pigs (*Sus scrofa*) degrade the understory of wet forest destroying food plants.
- Disease. ʻŌʻū primarily occurred in low- to mid-elevation forests where the effects of mosquito-borne diseases was most severe. The species' foraging movements may have increased their exposure to disease.
- Predation. In addition to potentially depredating nests, rats (*Rattus* spp.) may also compete with ʻōʻū by reducing the availability of fruits.
- Natural disasters. In 1984, a large portion of the Upper Waiākea Forest Reserve was inundated by a lava flow from Mauna Loa. This flow occurred in an area where the most recent observations of the species were noted and destroyed high quality ʻōʻū habitat. In 1982 and 1992, two strong hurricanes struck Kauaʻi, devastating native forest habitat. The ʻōʻū, has not been observed on Kauaʻi since 1992.

CONSERVATION ACTIONS: If the species persists, it likely benefits from management efforts to conserve other endangered forest birds on Hawaii and Kauaʻi. On Hawaiʻi, these activities have included fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. On Kauaʻi, these activities included the establishment of the Alakaʻi Wilderness Preserve, regular surveys of forest bird populations, monitoring of habitat conditions, studies of disease and disease vectors, and public education efforts featuring Kauai's endangered forest birds. Should this species be rediscovered, the Rare Bird Recovery Protocol outlined in the U.S. Fish and Wildlife Service (USFWS) *Recovery Plan for Hawaiian Forest Birds* would be implemented, and management in anticipation of that possibility should include continued protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring on Hawaiʻi and Kauaʻi.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include developing improved methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Given that this species may be extinct, there are no research priorities specific to ʻōʻū.

References:

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Snetsinger TJ, Reynolds MH, Herrmann CM. 1998 ‘O’u (*Psittirostra psittacea*) and Lana’i hookbill (*Dysmorodrepanis munroi*). *In* The Birds of North America, No. 335-336 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

U.S. Fish and Wildlife Service. 2006. Revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service.

Photo: DOFAW

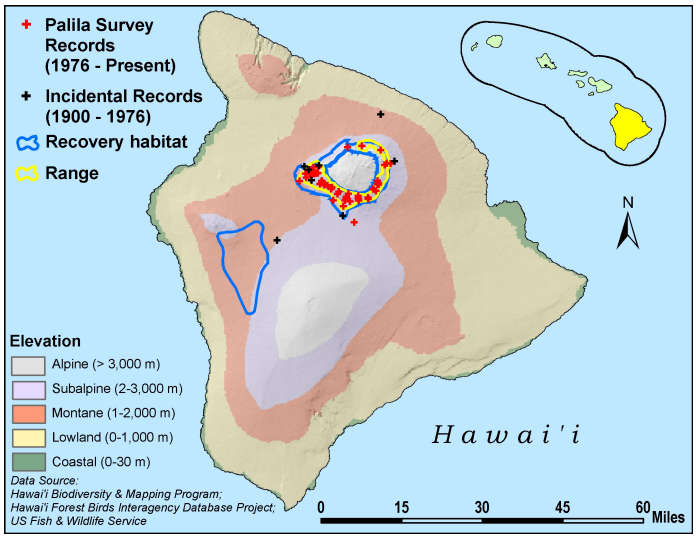
Forest Birds

Palila

Loxioides bailleui

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank G1—Critically Imperiled
IUCN Red List Ranking—Critically Endangered
Revised Recovery Plan for Hawaiian Forest Birds —USFWS 2006
Critical Habitat Designated 1977

SPECIES INFORMATION: The palila is a finch-billed Hawaiian honeycreeper (Family: Fringillidae) whose life history and survival is linked to māmane (*Sophora chrysophylla*), an endemic dry-forest tree in the legume family. Males and females are similar, with a yellow head and breast, greenish wings and tail, a gray back, and white underparts. Males have a black mask, and females have less yellow on the back of their heads and a gray mask. Approximately 90 percent of the palila's diet consists of immature māmane seeds; the remainder consists of māmane flowers, buds, leaves, and naio (*Myoporum sandwicense*) berries. Caterpillars and other insects comprise the diet of nestlings, but also are eaten by adults. Māmane seeds have been found to contain high levels of toxic alkaloids, and palila use particular trees for foraging, suggesting that levels of alkaloids may vary among trees. Individuals will move limited distances in response to the availability of māmane seeds. Palila form long-term pair bonds, and males perform low advertisement flights, sing, chase females, and engage in courtship feeding prior to breeding. Females build nests, usually in māmane trees, and males defend a small territory around the nest tree. Females mostly incubate eggs, brood nestlings and feed young with food delivered by male. First-year males sometimes help a pair by defending the nest and feeding the female and nestlings. Limited genetic testing found no evidence that helpers father the nestlings they were assisting, although more data are needed. Fledglings are dependent on their parents for three to four months, during this time they learn and practice foraging skills.



The availability of green māmane seeds strongly influences the number of nesting attempts in a given year. In poor years, not all pairs will attempt to nest.

DISTRIBUTION: Mostly restricted to the western slopes of Mauna Kea between 2,000 and 2,850 meters (6,500 – 9,250 feet) elevation. Historically, palila were common in all māmane forests. Currently, the species occupies approximately 10 percent of their historical range on the island of Hawai‘i. Subfossil evidence indicates palila also occurred in māmane forest on O‘ahu and Kaua‘i.

ABUNDANCE: Annual surveys between 1998 and 2005 yielded a mean population estimate of 3,268 ± 190 (SE) birds. In 2014, the estimate was 2,070 ± 209 birds. Population estimates are variable among years, which may be an artifact of survey techniques or timing.

LOCATION AND CONDITION OF KEY HABITAT: Restricted to māmane and māmane/naio forests. Densities are highest at 2,300 meters (7,550 feet) with large māmane trees and a high proportion of native shrubs. Up to 96 percent of the population and nearly all successful breeding occurs in a 30 square kilometer (11.5 square mile) area on the southwestern slope of Mauna Kea that has high quality habitat and steep terrain. The latter is important, especially during the breeding season because māmane at different elevations flower and fruit at different times, ensuring that māmane seeds are always available. Most habitat in the species' range is severely degraded by grazing ungulates, particularly mouflon sheep, and the spread of non-native plant species, especially fire-prone grasses. Most of the palila's current range occurs in the Mauna Kea Forest Reserve and is managed by the State of Hawai‘i.

THREATS:

- Feral ungulates. Historically, large numbers of sheep (*Ovis* spp.) grazed on Mauna Kea, reducing the density and productivity of māmane trees, limiting the regeneration of other native plants, and causing soil erosion. More recently the introduction of mouflon sheep has further degraded habitat.
- Invasive plants. Soil disturbance caused by sheep facilitated the spread of invasive plants. Fire-adapted grasses, such as fountain grass (*Pennisetum clandestinum*), are especially problematic in that they increase the risk of fire. Invasive plants also reduce the recruitment of native plants.
- Fire. A single large fire could severely limit food resources for the entire population.
- Predation. Predation by rats (*Rattus* spp.), feral cats (*Felis silvestris*), and the pueo (*Asio flammeus sandwichensis*) is an important factor limiting palila populations. In some areas, black rats (*R. rattus*) and feral cats may be responsible for up to 40 percent of nest failures, and feral cats have been documented preying on adults.
- Disease. Although palila are very susceptible to mosquito-borne diseases, mosquitoes do not occur at the elevations where palila currently occur. However, disease almost certainly contributed to the species' decline and likely prevents palila from recolonizing low-elevation habitat.
- Non-native insects. Yellow jackets and Argentine ants threaten the native caterpillars that nestlings depend on for food.

- Severe weather. The species' current range exposes them to severe weather that results in mortality in some years. Freezing temperatures, heavy rains, droughts, and high winds all can result in egg and nestling mortality.
- Population size. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios and stochastic factors include natural disasters. Habitat fragmentation exacerbates demographic and genetic problems.

CONSERVATION ACTIONS: Several conservation efforts have been conducted to protect the māmane woodlands for the protection and recovery of the palila. In the first half of the 20th century, 46,000 sheep as well as smaller numbers of feral cattle (*Bos tarus*), goats (*Capra hircus*), and pigs (*Sus scrofa*) were removed from māmane forests. This allowed the regeneration of the māmane trees on which the palila depend. Beginning in the late 1970s, control measures to reduce mouflon sheep numbers were initiated. Considerable research has been conducted on palila, including estimating population size and determining their geographic range, documenting home range size, dispersal behavior, reproductive parameters, limiting factors, and habitat characteristics. Ongoing research mostly focuses on quantifying limiting factors, especially predation, food availability, and genetics, as well as refining māmane restoration techniques. Beginning in 1993, translocations were conducted on an experimental basis to determine if new breeding populations could be established. In 2004, 32 birds were translocated and in 2005, 75 birds were moved. Although most birds return to their natal territory, approximately 25 percent remained at translocation sites. In 1996, a captive propagation program was initiated and palila have successfully bred in captivity. Between 2003 and 2004, 15 captive-raised birds were released into the wild. Initial attempts at outplanting māmane have been successful in areas where competing non-native vegetation is sparse. In addition to the above efforts, palila likely have benefited from management activities to conserve other endangered forest birds in Mauna Kea Forest Reserve and elsewhere on the island of Hawai‘i, including fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future management specific to the palila will likely include the following:

- Stabilize and increase at least one of the small populations using translocation or establish a new self-sustaining population while continuing to intensely manage the primary population. These efforts must include the restoration and regeneration of māmane forest as well as control of mammalian predators and parasitoid wasps that threaten food sources.
- Evaluate sites throughout the species' historical range for potential māmane restoration and re-introduction. These sites should have a range of elevation or rainfall gradients to ensure year-round food availability.
- Develop a comprehensive fire management plan.
- Increase public education and involvement in palila recovery. Volunteer opportunities exist in habitat restoration efforts, monitoring weeds and predators, and education.
- Remove feral sheep and mouflon from palila habitat.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the palila include the following:

- Refine survey methods.
- Further refine techniques to facilitate the establishment of new populations.
- Develop methods to control and eradicate the most harmful non-native plants and non-native insects that threaten native insect food sources.

References:

Banko PC, Johnson L, Lindsey GD, Fancy SG, Pratt TK, Jacobi JD, Banko WE. 2002. Palila (*Loxioides bailleui*). *In* The Birds of North America, No. 679 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Camp RJ, Brinck KW, Banko PC. 2014. Palila abundance estimates and trend. HCSU Technical Report HCSU-053. 18 pp.

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Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2006. Revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service.

Photo: DOFAW

Forest Birds

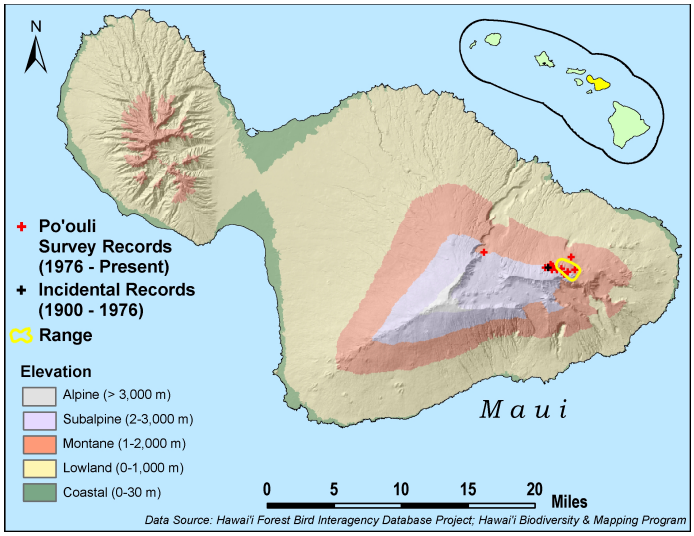
Po‘ouli

Melamprosops phaeosoma

SPECIES STATUS:
Federally Listed as Extinct
State Listed as Extinct
State Recognized as Endemic
NatureServe Heritage Rank: G1 – Presumed Extinct
IUCN Red List Ranking: Extinct
Revised Recovery Plan for Hawaiian Forest Birds - USFWS 2006

SPECIES INFORMATION: The po‘ouli is a stocky Hawaiian honeycreeper (Family: Fringillidae) endemic to Maui that was not discovered until 1973. Po‘ouli have short wings and tail, a finch-like bill, and distinctive plumage. Aptly named “black-faced” in Hawaiian, po‘ouli have a large black face mask, white cheeks, throat, and underparts and brown wings and back; no other Hawaiian forest bird is similarly colored. Although not well-studied, males and females are similar, although females have a grayish throat and breast. Little is known of the species’ life history. Po‘ouli often join mixed species foraging flocks. Forages primarily in the subcanopy and understory on tree branches of native shrubs and trees where they search moss, lichens, and bark for snails and arthropods. Breeding biology is based on observations from a single nesting pair and may be biased because of extremely low population density. For example, territorial behavior has not been observed. Nests are similar to those of other Hawaiian honeycreepers and are placed in ‘ōhi‘a (*Metrosideros polymorpha*) trees. Only the female incubates eggs and broods nestlings; male feeds the female on and off the nest. Last seen in the wild in 2004. Declared extinct by U.S. Fish & Wildlife Service in 2023.

DISTRIBUTION: In 2004, it was restricted to a 1,300 hectare (3,200 acre) area between 1,440 and 2,100 meters (4,750 – 7,000 feet) elevation on the northeastern slope of Haleakalā on Maui. No historical data on range, although fossil evidence indicates that po‘ouli once occurred over a wider geographic range.



ABUNDANCE: The Hawai'i Forest Bird Survey in 1980 estimated the population at 140 ± 280 (95% confidence interval) individuals. As of 2003 there were three known individuals. One captured and brought into captivity in 2004 died in November of that year and the remaining two birds have not been seen since January 2004. The species' poor detectability has hampered attempts to locate additional individuals or estimate population size. The species has been declared extinct.

LOCATION AND CONDITION OF KEY HABITAT: Mixed shrub montane wet forest dominated by ‘ōhi‘a, with an understory dominated by a diversity of small trees and shrubs, many of which are used as foraging substrates (e.g., kanawao [*Broussaissea arguta*], kawa'u [*Ilex anomala*]). Habitat conditions in areas occupied by po‘ouli are variable, but improving. All known individuals occur (red) in the Hanawī Natural Area Reserve which is managed by the State of Hawai‘i.

THREATS: Unknown. However, po‘ouli is likely susceptible to the same factors that threaten other native Hawaiian forest birds, including habitat loss and degradation, predation by introduced mammals, and disease. For po‘ouli, the following are likely of particular concern:

- Habitat degradation. The species appears to prefer areas with low levels of soil and vegetation disturbance and therefore may be particularly sensitive to understory and ground cover damage by feral pigs (*Sus scrofa*).
- Predation. Rats (*Rattus* spp.) are abundant in po‘ouli habitat and may depredate adults and nests.
- Competition. In addition to direct predation on adults and nests, rats also may compete with po'ouli for food resources, especially snails. Also, the non-native garlic snail (*Oxychilus alliarius*) is abundant and preys on native snails.
- Disease: the last known individual that was brought in captivity and later died had chronic avian malaria. It is likely that disease spread from non-native mosquitoes contributed to their extinction.

CONSERVATION ACTIONS: Major efforts to conserve po'ouli include the establishment of the 3,000 hectares (7,500 acres) Hanawī Natural Area Reserve in 1986 to protect the species'

entire known range, and fencing and pig removal has facilitated recovery of the understory. In 1995, the Maui Forest Bird Recovery Project was created to research and protect native Hawaiian forest birds, including the poʻouli. Activities to date include small mammal control, research on optimizing rodent control methods, surveys for native land snails, and banding and collecting blood samples to monitor demography and disease prevalence. In 2002, the team successfully translocated a female poʻouli to the home range of the male, however, she quickly returned to her own home range. In September 2004, one poʻouli was captured in an attempt to establish a captive population but it died in November of the same year. The Hawaiʻi Department of Land and Natural Resources and the U.S. Geological Survey continue to search Hanawī and adjacent habitats for additional birds. In addition, poʻouli populations likely have benefited from management efforts to conserve other endangered forest birds on northeastern Haleakalā including fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies on disease and disease vectors. In addition to these efforts, future management specific to the po'ouli may include the following**:**

- Continue pig and small mammal control efforts.
- Continue efforts to locate and capture the two known individuals and additional birds.
- Conduct public outreach about the importance of pig and rodent control to the remaining forest bird populations on Maui.
- Continue protection and management of wildlife sanctuaries and refuges.
- Implement mosquito control techniques to reduce non-native disease in forest bird populations.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. In addition to the ongoing research on poʻouli outlined above, additional priorities specific to po'ouli include the following:

- Determine the distribution and abundance of the species' prey base to determine if food resource is a limiting factor.

References:

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Pratt TK, Kepler CB, Casey TLC. 1997. Po'ouli (*Melamprosops phaesoma*). *In* The Birds of North America, No. 272 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2006. Revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service. 428 pp.

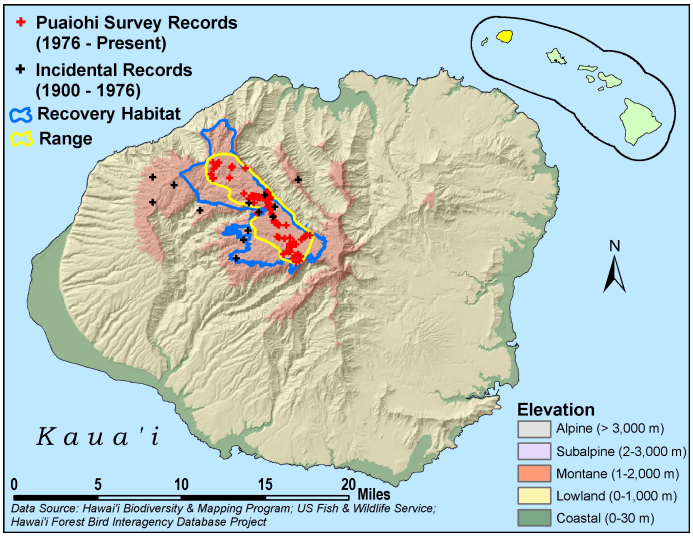
Forest Birds

Puaiohi or Small Kaua‘i thrush

Myadestes palmeri

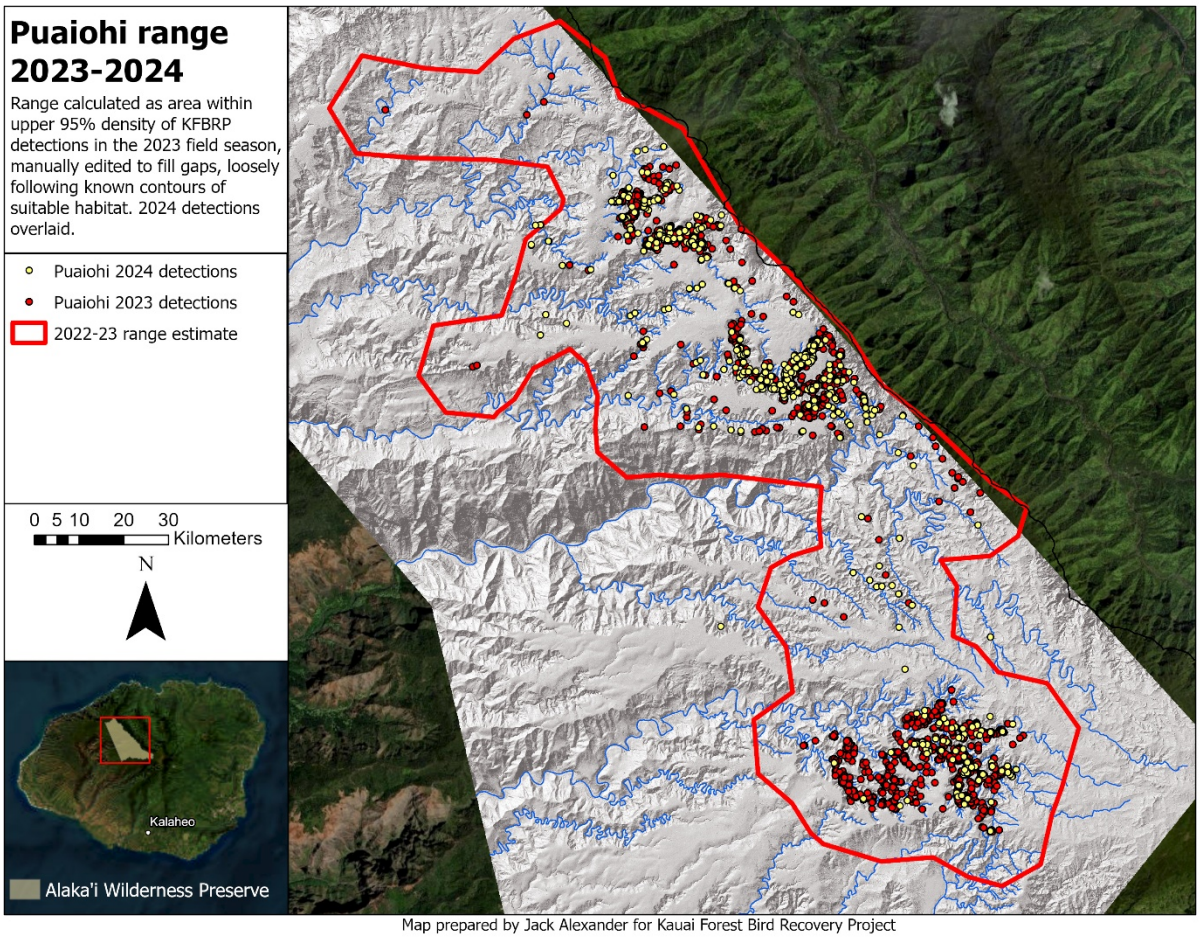
SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank G1—Critically Imperiled
IUCN Red List Ranking—Critically Endangered
Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: The puaiohi, or small Kaua‘i thrush, is the smaller of two solitaires (family: Turdidae) endemic to Kaua‘i, and was the last of the island’s avifauna to be discovered by western ornithologists. In the late 1800s, the puaiohi was considered exceedingly rare, but this assessment was likely due to its cryptic behavior and preference for remote, inaccessible ravines. Adult puaiohi are extremely sedentary and appear to have specific habitat requirements. Of the five Hawaiian solitaires, it is behaviorally, morphologically, and vocally the most divergent. Compared to the kāma‘o, or large Kaua‘i thrush (*M. myadestinus*), the puaiohi has a short tail, and a white eye-ring; in addition, it has a relatively simple song. The species life history is relatively well-known because of recent, intensive studies. Fruit dominates the non-breeding season diet; insects are important during the breeding season. Nests are built by the female in tree cavities or on cliff ledges, and only females incubate eggs and brood young. Breeding peaks from April to June, and re-nesting occurs after failed and successful nest attempts. This behavior, plus a high rate of nest success and a long breeding season, can result in high annual productivity. However, female and juvenile survival is low (0.46 $\pm$ 0.12 and 0.23 $\pm$ 0.06, respectively). Hatch-year and second-year birds (i.e., helpers) are known to assist in nest defense and feeding of related nestlings and fledglings at some sites. Young are very sedentary for two to four days after fledging.



DISTRIBUTION: Restricted to a < 20 square kilometer (7.6 square mile) area on the southern and central plateau of the Alaka‘i Wilderness Preserve. Currently

occurs above 1,050 meters (3,450 feet), which is similar to its upper limit historically. It is more likely to occur in streams between 1,140 and 1,340 meters with large numbers of tall, steep cliffs than in less incised streams. Prehistorically occurred at sea level.



Map prepared by Jack Alexander for Kauai Forest Bird Recovery Project

All known streams above 1,050 meters on the Alakai Plateau, Kauaʻi, which represents the best estimate of the entire puaiohi range.

ABUNDANCE: The most recent surveys in 2011-2013 and subsequent modeling estimated the population at 494 (95% confidence interval: 414-580, Crampton et al. 2017) individuals. Occupancy during these surveys ranged from 0.12 to 0.81 on 12 streams across the range, and has been relatively consistent since 2012 on four streams that were resurveyd in 2024 (KFBRP, unpubl. data) Densities peaked at 16 breeding pairs per square kilometer (0.62 square miles), but varied across streams. This species has been considered rare since the late 1800s.

LOCATION AND CONDITION OF KEY HABITAT: Puaiohi seem somewhat tolerant of avian malaria, so it is not clear what is restricting them to higher elevations—perhaps loss and degradation of habitat (see below). Occurs in deeply dissected, steep-walled ravines supporting wet montane forest dominated by ʻōhiʻa (*Metrosideros polymorpha*) and ʻōlapa (*Cheirodendron* spp.). Their former range included mesic areas dominated by ʻōhiʻa and koa (*Acacia koa*). These

areas are now largely dominated by introduced plant species including fire tree (*Myrica faya*) and strawberry guava (*Psidium cattleianum*). Densities are very low even in apparently suitable habitat. The entire known range of this species is within the Alakaʻi Wilderness Preserve and Na Pali Kona Forest Reserve, which are and is managed by the State of Hawaiʻi. However, models predict that low numbers of puaiohi occur on private lands adjacent to these areas, which is supported by opportunistic observations when traveling near property boundaries.

THREATS:

- Disease. In 1995-1997, seven puaiohi were tested for disease; none carried malarial (*Plasmodium relictum*) antibodies. Since 2011, 35/181 puaiohi have tested positive for malarial antibodies (KFBRP, unpubl. data).. Survival of puaiohi that tested positive was similar to that of puaiohi that tested negative, indicating a possible resistance to or tolerance of malaria.
- Predation. Two years of field data indicate that rats (*Rattus* spp.) were responsible for 14 to 22 percent of nest failures, as well as mortality of three adult females. Subsequent studies documented at least ten other instances of predation on adults at the nest, and the lower survival of females (0.46 ± 0.12) compared to males (0.71 ± 0.09) is indicative of predation on females at the nest. In 2020, cat (*Felis cattus)* predation of a puaiohi nest in a cliff alcove was documented. Fledglings typically spend their first days out of the nest within 2 meters (6.5 feet) of the ground, which makes them vulnerable to feral cats and rats. Cats have become more common in the Alaka'i in the last 10 years, following the new fence lines.Competition. Several non-native birds, including the introduced Warbling white-eyes (*Zosterops japonicus*), melodious laughing thrush (*Copsychus malabaricus*), and white-rumped shama (*Copsychus malabaricus*), occupy the same habitat and may compete with the puaiohi for food and nest resources. Shama have been observed nesting in nest boxes erected to promote puaiohi nesting on at least two occasions. Preliminary dissection of fecal samples indicate that Japanese white-eyes eat primarily small non-native fruits, whereas puaiohi eat native fruits almost exclusively. Fecal samples of shama and laughing thrush have not been obtained.
- Habitat degradation. Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) have facilitated the invasion of non-native plants into puaiohi habitat. The establishment of these plants has altered the structure of these forests, especially the ground and shrub layer, and especially in the western part of the puaiohi's range where it is now exceedingly rare. Hurricanes in 1982 and 1992 further altered and degraded the forests of Kauaʻi, including those within the Alakaʻi Wilderness Preserve.
- Non-native arthropods. Recently introduced non-native insects, especially yellow jackets (*Vespula pensylvanica*) and Argentine ants (*Linepithema humile*), may compete with the puaiohi's native arthropod prey or disrupt the pollination of the species' food plants. Introduced herbivorous insects also could reduce the abundance of food plants.
- Natural disasters. Hurricanes in 1982 and 1992 likely caused the death of an unknown number of individuals.

CONSERVATION ACTIONS: In 1995, an intensive field ecology and behavior study was initiated. The results from this study are the basis for the current management actions for the species. Using captive propagation and re-introduction techniques developed using the ʻōmaʻo

(*M. obscurus*), a captive breeding flock of puaiohi was established in 1996. Between 1999 and 2012, 222 captive-bred puaiohi were released into the wild on Kaua'i. Initially, the program was successful, with several captive-raised birds documented successfully breeding, but in later releases, survival and recruitment was lower. From 2005 to 2010, captive-bred birds released as hatch years had survival of 0.26 ± 0.21, and captive-bred birds released as adults had even lower survival (0.05 ± 0.06). Overall, only 20 released birds were observed paired up, nesting, and raising at least 24 chicks to fledging. Given these results, and the apparent stability of the wild population, this program was discontinued, and the remaining captive puaiohi were released at Halepa'akai in 2016 and 2017. PVA results published in 2018 (Fantle-Lepczyk et al.) indicates rat control would be the most effective management strategy to increase puaiohi abundance, primarily by increasing female and juvenile survival.

In addition, puaiohi likely have benefited from management activities to conserve other endangered forest birds including the establishment of the Alaka'i Wilderness Preserve, regular surveys of forest bird populations, monitoring of habitat conditions, control of feral ungulates through public hunting and fencing, suppression of rats on two A24 trapping grids over approximately 150 ha (470 ac), studies of disease and disease vectors, and public education efforts featuring Kauai's endangered forest birds. In addition to these efforts, future management specific to the recovery of puaiohi will likely include the following:

- Systematically control rats using registered rodenticides or traps in puaiohi nesting habitat over a larger area than currently under protection.
- Aggressively control ungulates to improve habitat quality and facilitate recovery of degraded, but potential, habitat.
- Control non-native plants as part of forest restoration efforts.
- Suppress rats,feral cats and barn owls (*Tyto alba*) in the Alaka'i Wilderness Preserve and Kokee Region.
- Reduce breeding habitat for mosquitoes on the Alaka'i Plateau,
- Suppress mosquito populations through releases of incompatible or sterile mosquitoes.
- Investigate options to eradicate mosquitoes, including use of genetic manipulations.
- Prevent the spread of Rapid Ohia Death on the Alaka'i Plateau
- Prevent the introduction of the small Indian mongoose and other possible predators.
- Conduct public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue puaiohi specific occupancy surveys, nest monitoring, and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to the puaiohi include the following:

- Investigate immediate impacts of acute disease (malaria, pox) on puaiohi survival and sub-lethal impacts on fecundity
- Conduct captive-breeding of disease-resistant birds to establish disease-resistant populations at lower elevations.

- Continue field studies to document survival and dispersal, habitat use, and causes of high female and juvenile mortality.
- Investigate efficacy of other methods of controlling invasive rodents (e.g., different methods of applying rodenticide, snap traps).
- Assess the impact of introduced rodents on food sources important to puaiohi, including fruits and invertebrates.

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