

Focal Species: ‘I‘iwi (*Vestiaria coccinea*)

Introduction: The ‘I‘iwi, with its long curved bill and brilliant scarlet plumage, is an iconic species and is perhaps the most recognized Hawaiian bird. It is a widespread species that occurs on several islands, but it is very susceptible to mosquito-borne diseases and is largely restricted to high elevation native forests. Few conservation actions have been specifically directed at the ‘I‘iwi, but it has benefited from habitat management aimed at several endangered honeycreepers. The ‘I‘iwi has declined recently, especially at lower elevations, and was petitioned for listing under the U.S. Endangered Species Act in 2010. Protection and management of native forests above the current range of mosquitoes is the most important tool in ‘I‘iwi conservation.



‘I‘iwi. Photo Jack Jeffrey

Geographic region: Hawaiian Islands
Group: Forest Birds
Federal Status: Conservation Concern
State status: Endangered on Oahu and Molokai
IUCN status: Vulnerable
Conservation score, rank: 18/20, At-risk
Watch List 2007 Score: RED
Climate Change Vulnerability: High

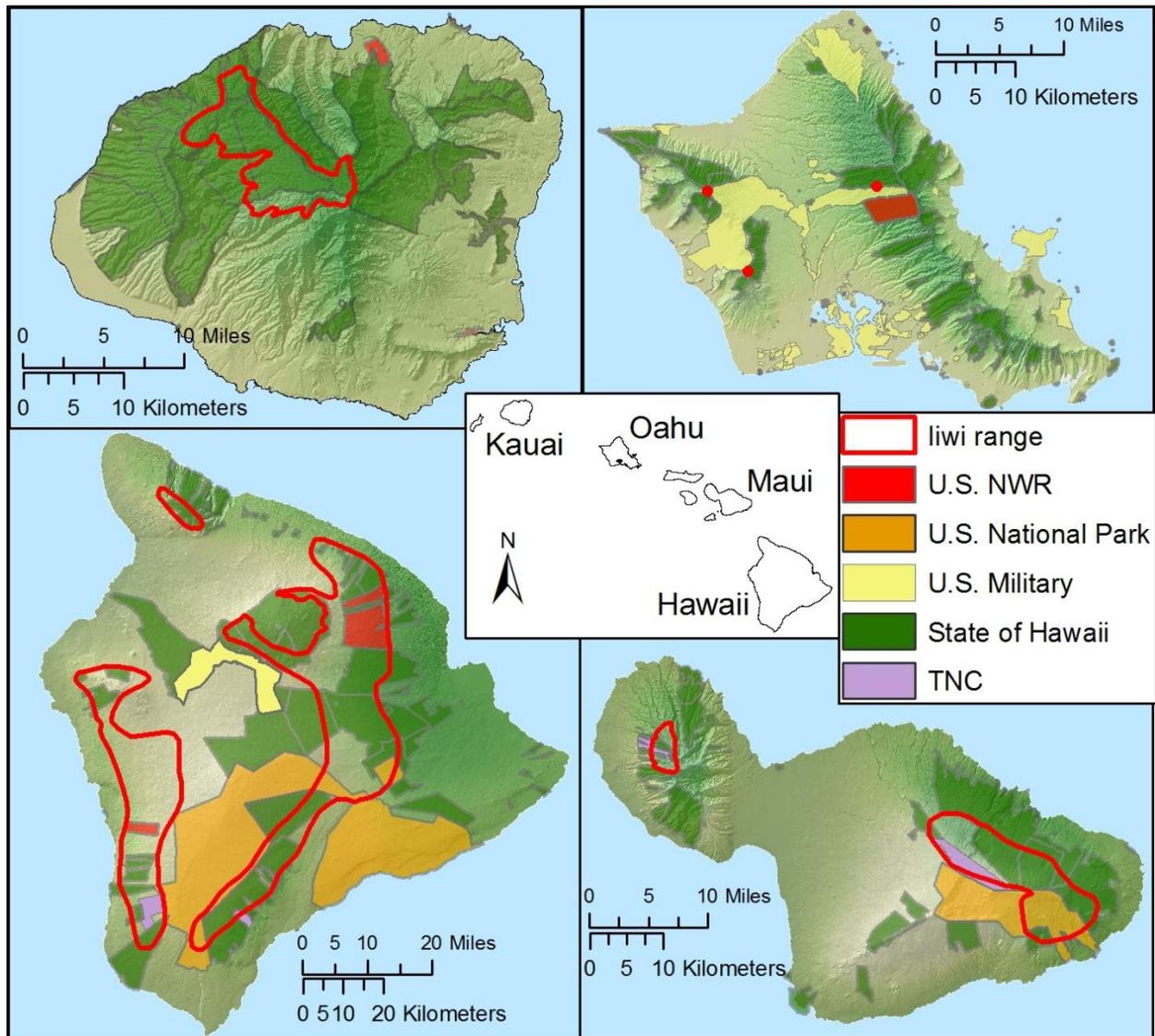
Population Size and Trend: The current ‘I‘iwi population is estimated to be 362,000 birds, with by far the largest number occurring on Hawaii (Table 1). Long-term monitoring indicates that most populations are declining, but numbers at Hakalau Forest National Wildlife Refuge (NWR) and the windward side of east Maui are stable or increasing (Camp et al. 2009, 2010). The Kaua‘i population is declining rapidly (Camp et al. 2009, Gorresen et al. 2009). Very few ‘I‘iwi remain on Oahu and Molokai, where they are observed only rarely.

Table 1. Summary by island of ‘I‘iwi population size, range, and overall trend.

	Kaua‘i	Oahu	Moloka‘i	Lana‘i	Maui	Hawai‘i
Population	4,000	<10	<10	Extirpated	18,000	340,000
Range	101 km ²	?	?	Extirpated	223 km ²	~2,000 km ²
Trend	Declining	Declining	Declining	Extirpated	Increasing	Stable

Range: ‘I‘iwi occur primarily above 1,250 m elevation on the islands of Hawai‘i, Maui, and Kaua‘i. They occur below 1,000 m in some areas, but at much lower densities. On Hawai‘i, ‘I‘iwi are widespread in both windward and leeward regions. On Maui, ‘I‘iwi are largely restricted to the windward (northeastern) slope of Haleakala Volcano; a few birds may persist on west Maui. On Kaua‘i, ‘I‘iwi have declined in range recently and are now restricted to the higher portions of the ‘Alaka‘i Plateau (Gorresen et al. 2009). Relict populations may occur on O‘ahu and Moloka‘i. On O‘ahu, up to six ‘I‘iwi were seen at Schofield Barracks in 1996 (VanderWerf and Rohrer 1996), but numbers dwindled to zero by December 2002. The last sightings on O‘ahu occurred at Palikea in 2009 and 2010, in both cases a single second-year bird was seen, suggesting possible breeding on the island. On Moloka‘i the last observation was in

2004 (Gorresen et al. 2009). Historically, ‘I‘iwi were common on all the main Hawaiian Islands, even at low elevations (Perkins 1903).



Essential Biology: The ‘I‘iwi is a medium-sized (16-20 g), mostly nectarivorous Hawaiian honeycreeper. Males and females are scarlet red, with a black tail and wings, and a long, decurved pink bill (Fancy and Ralph 1998). Juveniles are yellow mottled with black. ‘I‘iwi give a variety of loud, squeaky or gurgling calls and sometimes mimic other birds. During the breeding season ‘I‘iwi are often found in pairs, after breeding they may form small flocks.

‘I‘iwi are found in wet and mesic forests dominated by ‘ōhi‘a (*Metrosideros polymorpha*) and koa (*Acacia koa*), with the best habitat also containing kōlea (*Myrsine lessertiana*), naio (*Myoporum sandwicense*), and tree ferns (*Cibotium* spp.). ‘I‘iwi also forage in high-elevation dry forests dominated by māmane (*Sophora chrysophylla*), but breeding is uncommon in that habitat (Fancy and Ralph 1998). ‘I‘iwi may fly long distances in search of flowering ‘ōhi‘a and māmane trees and are important ‘ōhi‘a pollinators (MacMillen and Carpenter 1980, Ralph and Fancy 1995, Kuntz 2009). Their diet consists of nectar and insects taken from a variety of native

and non-native flowers (Fancy and Ralph 1998). Common native species used for foraging include 'ōhi'a, koa, māmane, naio, kōlea, 'akala (*Rubus hawaiiensis*), 'alani (*Melicope* spp.), kanawao (*Broussaisia arguta*), koki'o ke'oke'o (*Hibiscus arnottianus*), and several lobelias. Nectar from the invasive banana poka (*Passiflora mollissima*) is a food source in some areas (Fancy and Ralph 1998). Individuals will defend 'ōhi'a trees with abundant flowers. 'I'iwi are very mobile, making long flights (up to 15 km per day) in search of nectar resources (Fancy and Ralph 1995, Kuntz 2009). These long distance flights have not been observed recently and migrations into the mosquito range may be detrimental (Hart et al. 2011). It has been suggested that the curved bill of the 'I'iwi is adapted to take nectar from curved lobelia flowers (Smith et al. 1995).

'I'iwi have a long breeding season (November – July) that is tied to the availability of 'ōhi'a flowers (Ralph and Fancy 1994). Males in breeding condition can be found all year, and females with brood patches are found December–July (Eddinger 1970, Kuntz 2009). Both sexes defend a small nesting territory. The open cup nest is built in terminal branches of an 'ōhi'a tree, mostly by the female. Only the female incubates the eggs, typically two, and broods the young. The male provisions the females and feeds the young. Juveniles are dependent on parents for less than four months during which time young birds follow their parents and call incessantly (Fancy and Ralph 1998). 'I'iwi will renest after failure, and some pairs may raise more than one brood per year (Kuntz 2009).

Primary Threats:

- **Disease.** Avian malaria (*Plasmodium relictum*) and avian poxvirus (*Poxvirus avium*), which are transmitted by the non-native southern house mosquito (*Culex quinquefasciatus*), limit the distribution of many Hawaiian forest birds (Warner 1968, van Riper et al. 1986, Atkinson and LaPointe 2009). The malarial parasite and mosquito larvae develop more slowly at colder temperatures, restricting sensitive bird species to cold, high elevation refugia. 'I'iwi are particularly vulnerable to avian malaria (Atkinson et al. 1995); one bite from a mosquito infected with malaria caused mortality in 9 of 10 juvenile 'I'iwi, and 100% of 10 other 'I'iwi bitten more than once died of malaria (Atkinson et al. 1995). One surviving bird developed immunity and survived further challenges from multiple mosquito bites. Despite this, there is little evidence that 'I'iwi populations are developing disease resistance, although the presence of 'I'iwi below 1,000 m in elevation on Oahu suggests they may be disease resistant. The long flights made by 'I'iwi in search of flowering trees may take them into low-elevation forests where mosquitoes are present, resulting in a chronic drain on 'I'iwi numbers even in high elevation reserves.
- **Habitat Loss and Degradation.** Cutting of native forest for logging, cattle ranching, and silviculture of non-native trees has reduced the amount of forest habitat and fragmented it in many areas. Most areas of native forest important to these species have been legally protected in some way, but some “protected” areas receive little or no management and habitat degradation by invasive plants and non-native ungulates remains a problem.
- **Non-native ungulates.** Feral ungulates, including cattle (*Bos Taurus*), feral sheep (*Ovis aries*), mouflon sheep (*O. musimon*), feral goats (*Capra hircus*), and axis deer (*Cervus axis*) have degraded habitat quality by browsing, causing soil erosion, disrupting forest regeneration, spreading alien plant seeds, and facilitating the invasion of alien plants (Cabin et al. 2000, Scott et al. 2001, USFWS 2006). Rooting and wallowing by feral pigs (*Sus scrofa*) has destroyed understory vegetation that provides an important source of

nectar for 'I'iwi, hindered recruitment of native trees, and provided breeding sites for mosquitoes that carry diseases.

- **Invasive non-native plants.** Invasive plants have invaded native forests and reduced habitat quality in all but the most remote areas on each island. Some of the worst invasive plants are strawberry guava (*Psidium cattleianum*), blackberry (*Rubus argutus*), gorse (*Ulex europaeus*), banana poka (*Passiflora mollissima*), holly (*Ilex aquifolium*), Christmasberry (*Schinus terebinthifolius*), kahili ginger (*Hedychium gardnerianum*), Australian tree fern (*Cyathea cooperi*), kikuyu grass (*Pennisetum clandestinum*), fountain grass (*Pennisetum setaceum*), and *Eucalyptus* spp. 'I'iwi may forage on some non-native plants, but the decrease in floral diversity that often results from invasion by alien plants is problematic for 'I'iwi because it can reduce nectar availability at different seasons.
- **Non-native Predators.** Although there is little direct evidence of predation on 'I'iwi, rats (*Rattus* spp.), cats (*Felis silvestris*), small Indian mongooses (*Herpestes auropunctatus*), and Barn Owls (*Tyto alba*) are known to be predators of other Hawaiian forest birds (Atkinson 1977, Snetsinger et al. 1994, VanderWerf 2009).
- **Climate Change.** An increase in prevalence of avian malaria in response to rising temperatures has already been reported at Hakalau Forest NWR on Hawai'i (Freed et al. 2005) and in two areas of the 'Alaka'i Plateau on Kaua'i (Atkinson and Utzurrum 2010). At Hakalau, malaria prevalence in 'I'iwi increased from 0% in 1988-1992 to 8% in 2001-2002. Global climate change will likely continue to exacerbate the threat of disease by increasing the elevation at which regular transmission of avian malaria and avian pox virus occurs (Reiter 1998, Harvell et al. 2002, Hay et al. 2002). On Kaua'i, which has little area over 1,500 m, malaria transmission already can occur at least periodically across all parts of the island, and GIS simulations have shown that an increase in temperature of 2°C, which is a conservative figure based on recent data (IPCC 2007), would allow regular disease transmission in 85% of the area where it is now only periodic (Benning et al. 2002).

Conservation Actions to Date:

In August 2010, the Center for Biological Diversity petitioned the USFWS to list the 'I'iwi under the Endangered Species Act because of climate change and disease, its declining population, and a lack of sufficient protection of existing regulatory mechanisms. In January 2012, the USFWS announced it had determined that the petition presented sufficient information indicating that listing may be warranted and would initiate a 12-month review of the species' status.

Few conservation actions have been specifically directed at the 'I'iwi, but protection and management of native forests in general and actions aimed at several endangered forest birds also has benefitted the 'I'iwi. On Hawai'i, fencing, ungulate removal, invasive plant control, and native forest restoration at Hakalau Forest NWR have contributed to a growing 'I'iwi population (Camp et al. 2010). Other important habitat for 'I'iwi on Hawai'i has been protected and managed to varying degrees by several agencies and organizations, including the USFWS in the Kona Forest NWR, the National Park Service (NPS) in the Kahuku and Mauna Loa Strip sections of Hawaii Volcanoes National Park, the Three Mountain Alliance in the Ola'a-Kilauea Management Area and other areas, The Nature Conservancy (TNC) in the Kona Hema Preserve, and the Hawai'i Natural Area Reserve System (NARS) and Division of Forestry and Wildlife (DOFAW) in the Pu'u Wa'awa'a State Forest Bird Sanctuary, Pu'u O'umi, Manukā, and Pu'u Maka'ala natural area reserves, and several forest reserves. Fencing and removing ungulates

from Palila (*Loxioides bailleui*) critical habitat by the DOFAW will benefit 'I'iwi by allowing regeneration of high elevation māmane (*Sophora chrysophylla*) forest and increasing the availability of nectar over a wider range of elevations (see Palila species profile for more details). On Maui, fencing, removal of ungulates, and control of alien plants by the NPS in Haleakalā National Park, the Hanawī NAR, and TNC in Waikamoi Preserve has resulted in a growing 'I'iwi population (Camp et al. 2009). On Kaua'i, invasive alien plant control has been conducted by TNC and the Kōke'e Resource Conservation Program. The Kaua'i Watershed Alliance (KWA) recently completed strategic ungulate fencing to protect an 810-ha (2,000-acres) management unit in the southeastern 'Alaka'i Wilderness Preserve and adjacent private lands; ungulates have almost been eradicated from this area. The KWA also has ambitious plans for three more fenced units that would protect an additional 1,215 ha (3,000 acres) of habitat important to the 'I'iwi in the 'Alaka'i Wilderness Preserve (see the Kaua'i honeycreepers profile for more details). On O'ahu, there have been no actions directed specifically at 'I'iwi, but management by the U.S. Army Natural Resources Program, including fencing, ungulate removal, and invasive plant control, at Palikea and Schofield Barracks would benefit any remaining 'I'iwi. Similarly, on Moloka'i management at Kamakou Preserve and adjacent areas by TNC has protected 'I'iwi habitat.

Planning/Research Needs:

- Investigate whether 'I'iwi are developing disease resistance in the lower-elevation portions of their range. Evolution of malaria resistance has been documented in the Hawai'i 'Amakihi (Woodworth et al. 2005, Foster et al. 2007).
- Determine if genetic markers or specific phenotypes are associated with disease resistance or tolerance. If disease-tolerant individuals can be identified, they could be used in translocations to establish new populations or to augment existing populations that lack disease tolerance.
- Conduct surveys of potential mosquito breeding habitat and continue to monitor prevalence of avian malaria and avian pox virus. Malaria prevalence increased over the past 15 years in the range of 'I'iwi on Hawai'i (Freed et al. 2005) and Kaua'i (Atkinson and Utzurrum 2010), but the location of mosquito breeding sites is not well known in some areas. If mosquito breeding sites can be located, it may be possible to treat or eliminate them.
- Capture 'I'iwi on O'ahu and collect blood samples to test for malarial antibodies.
- Continue monitoring 'I'iwi abundance by conducting periodic range-wide surveys using established methods (Camp et al. 2009), and expand monitoring efforts to include more frequent surveys of low density areas and along elevational gradients. Conducting surveys more frequently and in more areas would improve estimates of detection probability, leading to more accurate and precise measures of range and abundance and greater ability to determine trends.
- Determine if sufficient native understory plants are available in ungulate-free forests to minimize the need for 'I'iwi to make long-distance searches for nectar.
- Conduct life history studies to quantify demography, including dispersal patterns, survivorship, and nesting phenology.

5-Year Conservation Goals:

- Complete the species status review and, if warranted, list the 'I'iwi under the U.S. Endangered Species Act and the Hawai'i endangered species list.

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- Continue and expand native forest restoration and management to include all areas that are important to the 'I'iwi by ensuring that existing fences are maintained, constructing new fences, removing feral ungulates, and controlling invasive alien plants.
- Acquire or legally protect and then manage additional areas of high elevation native forest.
 - Devise methods of minimizing or mitigating the effects of climate change on the 'I'iwi, particularly the anticipated increase in transmission of mosquito-borne diseases.
 - Increase public support for forest bird conservation through outreach.

Conservation Actions: Because the 'I'iwi is so sensitive to avian disease, protection and management of high elevation forests is essential to its conservation. Long-term monitoring has shown that 'I'iwi populations were stable to increasing in areas where ungulate removal and habitat restoration are occurring, but declining in areas where no management is conducted (Camp et al. 2009, 2010).

- Habitat Management.
 - Complete ungulate removal within the KWA fence in the eastern 'Alaka'i.
 - Support efforts by the KWA to fence and remove ungulates from three management units encompassing 1,215 ha (3,000 acres) in the Alaka'i Wilderness Preserve.
 - Fence and remove ungulates from the Hono O Nā Pali Natural Area Reserve and select parts of the Na Pali-Kona Forest Reserve.
 - Continue to control invasive alien plants in the Koke'e/'Alaka'i area.
 - Complete fences around the Kahikinui FR and Nakula NAR on Maui, eradicate feral ungulates, control invasive plants, and restore native forest.
 - Repair fences and remove feral pigs from all management units at Hakalau Forest NWR. Hakalau was formerly pig-free but fences were not adequately maintained because of funding and staffing shortfalls and pigs reinvaded, compromising decades of habitat restoration work.
 - Continue forest restoration at Hakalau Forest NWR. Over 500,000 trees have been planted at Hakalau since 1987.
 - Fence parts of the Ka'u FR, eradicate ungulates, control invasive plants, and outplant native species. Ka'u supports the second largest expanse of native forest in Hawai'i but it has been degraded and is in need of management (State of Hawai'i 2012).
 - Eradicate ungulates, control invasive plants, and outplant native species in the Kahuku section of Hawai'i Volcanoes National Park adjacent to the Ka'u FR.
 - Remove ungulates, control invasive plants, and outplant native species in the part of the Kona Forest NWR that was fenced in 2012.
 - Remove feral ungulates and banana poka and other invasive plants from Pu'u Wa'a Wa'a State Forest Bird Sanctuary.
 - Restore forest connectivity on eastern Mauna Kea by fencing and removing ungulates in the Kanakaleonui corridor owned by the Department of Hawaiian Homelands between Hakalau Forest NWR and Palila Critical Habitat.
- Habitat Protection. Support acquisition of McCandless Ranch lands currently for sale adjacent to the Kona Forest NWR on Hawai'i.
- Disease. Determine mosquito distribution within 'I'iwi range, especially on Kaua'i, and identify any mosquito breeding sites that could be managed. Monitor prevalence of avian malaria in 'I'iwi and identify disease-resistant individuals. Fencing and feral pig removal also will reduce disease prevalence by reducing breeding habitat for mosquitoes.

Summary of 5-year Actions, 2013-2017:

Conservation Action	Years	Annual Cost	Total Cost
Complete regulatory compliance for additional fencing in the Alaka'i Wilderness Preserve, Kaua'i	1	\$80,000	\$80,000
Fence and remove ungulates from 3,000 acres in the Alaka'i Wilderness Preserve, Kaua'i	2-5	\$900,000	\$3,600,000
Invasive plant control in the Koke'e-'Alaka'i area, Kaua'i	1-5	\$250,000	\$1,500,000
Complete fences, remove ungulates, and restore habitat in Kahikinui FR+Nakula NAR	1-5	\$350,000	\$1,750,000
Fence repair/replacement, inspection, and maintenance at Hakalau Forest NWR	1-5	\$200,000	\$1,000,000
Remove feral pigs from fenced units of Hakalau Forest NWR	1-5	\$500,000	\$2,500,000
Control invasive plants at Hakalau Forest NWR	1-5	\$200,000	\$1,000,000
Build fence (~35 km) in Ka'u FR	1-3	\$1,100,000	\$3,300,000
Remove feral ungulates from Ka'u FR and begin habitat management (~4,850 ha)	2-5	\$450,000	\$1,800,000
Remove feral ungulates from Kona Forest NWR	1-3	\$150,000	\$450,000
Control invasive plants at Kona Forest NWR	1-5	\$85,000	\$425,000
Remove ungulates from Pu'u Wa'a Wa'a FBS	1-3	\$75,000	\$225,000
Control invasive plants at Pu'u Wa'a Wa'a FBS	1-5	\$85,000	\$425,000
Continue habitat restoration at TNC Kona Hema Preserve	1-5	\$150,000	\$750,000
Restore forest in the Kanakaleonui corridor on Mauna Kea	1-5	\$300,000	\$1,500,000
Mosquito surveys and disease monitoring on Kaua'i	1-2	\$200,000	\$400,000
Mosquito surveys and disease monitoring on Hawai'i	1-2	\$300,000	\$600,000
Range-wide surveys for 'I'iwi on each island, 1 island per year	1-5	\$50,000	\$250,000

Potential Partners: U.S. Fish and Wildlife Service, National Park Service, U.S. Geological Service Pacific Islands Ecosystem Research Center, Hawai'i Division of Forestry and Wildlife, Department of Hawaiian Homelands, Kaua'i Watershed Alliance, East Maui Watershed Partnership, Leeward Haleakala Watershed Restoration Partnership, Three Mountain Alliance, Mauna Kea Watershed Alliance, University of Hawai'i, Koke'e Resource Conservation Program, The Nature Conservancy of Hawai'i, Kamehameha Schools.

Ancillary Species: Because the 'I'iwi is widespread and occurs on multiple islands, it overlaps in range with all other Hawaiian forest birds. Conservation actions for the 'I'iwi will thus contribute to the conservation of the entire remaining endemic avifauna, including: the Hawaiian Hawk or 'Io (*Buteo solitarius*), Hawaiian Short-eared Owl or Pueo (*Asio flammeus sandwichensis*), Hawaiian Crow or 'Alalā (*Corvus hawaiiensis*), 'Kaua'i 'Elepaio (*Chasiempis sclateri*), O'ahu 'Elepaio (*C. ibidis*), Hawai'i 'Elepaio (*C. sandwichensis*), 'Oma'o (*Myadestes obscurus*), Puaiohi (*M. palmeri*), Maui Parrotbill (*Pseudonestor xanthophrys*), 'Akiapōlā'au (*Hemignathus munroi*), Kaua'i 'Amakihi (*H. kauaiensis*), O'ahu 'Amakihi (*H. chloris*), Hawai'i 'Amakihi (*H. virens*), 'Anianiau (*Magnumma parva*), 'Akikiki or Kaua'i Creeper (*Oreomystis bairdi*), Hawai'i Creeper (*O. mana*), Maui Creeper (*Paroreomyza montana*), Hawai'i 'Ākepa

(*Loxops coccineus*), ‘Akeke‘e or Kaua‘i ‘Ākepa (*L. caeruleirostris*), Crested Honeycreeper or ‘Akohekohe (*Palmeria dolei*), and ‘Apapane (*Himatione sanguinea*).

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