

Focal Species: Kaua'i Rain Forest Honeycreepers:

‘Anianiau (*Magumma parva*)

‘Akikiki or Kaua'i Creeper (*Oreomystis bairdi*)

‘Akeke'e or Kaua'i 'Ākepa (*Loxops caeruleirostris*)

Synopsis: These three species are endemic to Kaua'i and have similar ranges, though the 'Anianiau is more common and widespread. The 'Akikiki and 'Akeke'e have declined dramatically in the past few years and were listed as endangered in 2010. These species had not been closely studied until 2011, and aspects of their biology and threats are being revealed only now. No conservation actions have been directed at these species, but they are expected to benefit from ongoing large-scale habitat management. Climate change and increasing prevalence of mosquito-borne diseases may be a serious threat.



‘Akikiki. Photo Eric VanderWerf.

<p>Geographic region: Kaua'i, Hawaiian Islands</p> <p>Group: Forest Birds</p> <p>Federal Status: 'Akikiki and 'Akeke'e Endangered, 'Anianiau MBTA</p> <p>State status: 'Akikiki and 'Akeke'e Endangered</p> <p>IUCN status: 'Akikiki and 'Akeke'e Critically Endangered, 'Anianiau Vulnerable</p> <p>Conservation score: 17/20, 20/20, 20/20, At-risk</p> <p>Watch List 2007 Score: RED</p> <p>Climate Change Vulnerability: HIGH</p>



‘Akeke'e male. Photo Eric VanderWerf.



‘Anianiau male. Photo Jack Jeffrey.

Population Size and Trend:

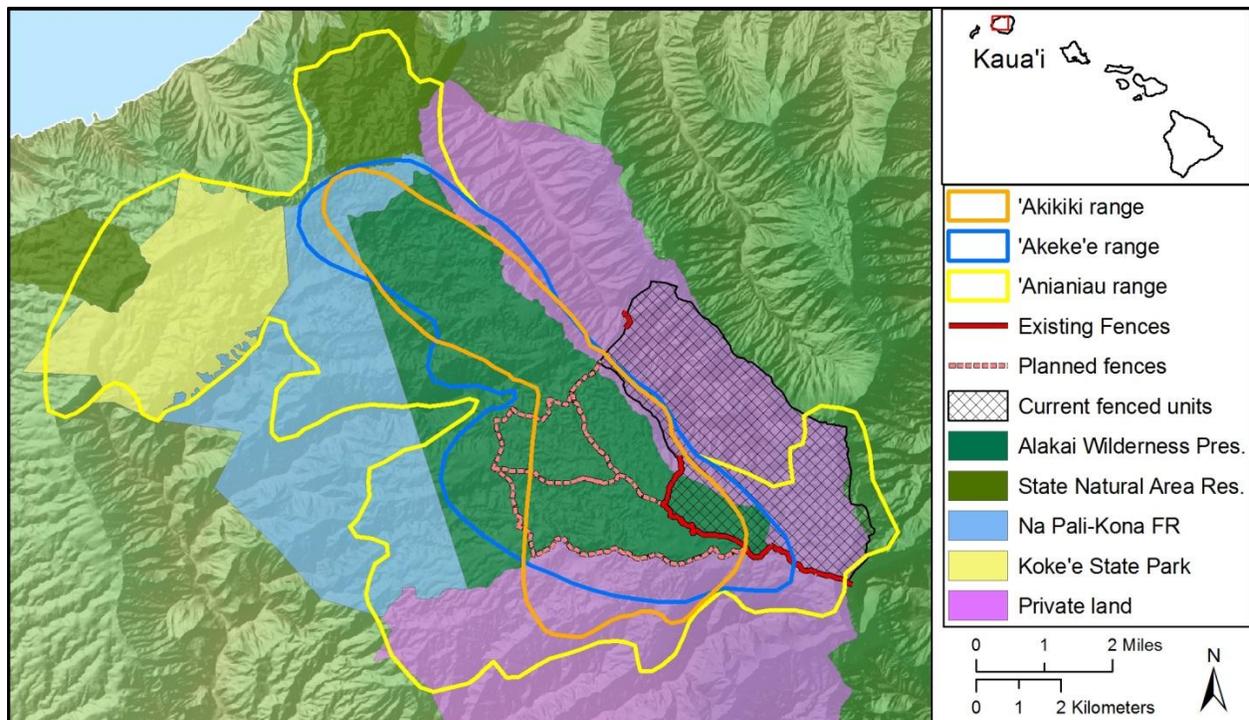
‘Anianiau – The population was estimated at 24,230 ± 1,514 birds in the early 1980s (USFWS 1983), but surveys conducted in 2000, 2005, and 2007 indicated that 'Anianiau densities in the Alaka'i Wilderness Preserve have increased, resulting in a population estimate of about 37,000 birds (Camp et al. 2009, Gorresen et al. 2009). The 'Anianiau is one of the more common native birds found in high elevation forests on Kaua'i.

‘Akikiki – Recent population size estimates of the 'Akikiki have been variable. Estimates based on 2005 and 2007 surveys were 1,364 ± 401 and 1,312 ± 530 birds, respectively (Hawaii

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Division of Forestry and Wildlife [DOFAW] and U.S. Geological Survey [USGS], unpubl. data), but based on surveys conducted in 2008 the population was estimated at 3,568 (95% CI 2,369 – 5,011) (Camp et al. 2009, Gorresen et al. 2009). These estimates should be viewed with caution, however, because they are based on a small number of observations, resulting in wide confidence intervals around estimates. Density estimates for the ‘Akikiki have fluctuated more than any other native bird on Kaua‘i, and it is difficult to ascertain whether these fluctuations are real or the result of sampling error.

‘Akeke’e – The current population is estimated to be $3,111 \pm 591$ (SE) birds, based on surveys conducted in 2008 (DOFAW and USGS, unpubl. data). The estimated population has declined from $7,839 \pm 704$ birds in 2000 and $5,669 \pm 1003$ birds in 2005 (DOFAW and USGS, unpubl. data). Camp et al. (2009) reported an estimate of 7,887 birds (95% CI 5,220-10,833), but this number is known to be an over-estimate because it was based on extrapolation of density to an area of 127 km², which is larger than the species’ actual range.



Range:

‘Anianiau – The ‘Anianiau is endemic to Kaua‘i, where it occurs in native forest above 600 m in elevation on the Alaka‘i Plateau, in valleys of the Nā Pali Coast, and in Kōke‘e State Park; a small, isolated population also occurs in the Makaleha Mountains (Lepson 1997, Gorresen et al. 2009). In the 1970’s, the species was found in non-native and native forest below 100 m in valleys on the Nā Pali Coast (USFWS 1983). The range of ‘Anianiau was about 200 km² in the 1980s, approximately 15% of its original range (Lepson 1997), and it has declined since then.

‘Akikiki – The ‘Akikiki is endemic to Kaua‘i, where it is restricted to the Alaka‘i Plateau. The species’ range declined from 88 km² in 1970 to 40 km² in 2008 (USFWS 1983, Scott et al. 1986, Foster et al. 2004, Camp et al. 2009), and appears to be declining farther. Subfossils suggest that

the ‘Akikiki occurred throughout Kaua‘i prior to the arrival of humans; now the species occupies less than 10% of its historic range (Foster et al. 2000, Burney et al. 2001).

‘Akeke’e – The ‘Akeke’e is endemic to Kaua‘i, where it is restricted to the Alaka‘i Plateau. From 1970 to 2000, the geographic range of the Kaua‘i ‘Ākepa was estimated to be approximately 88 km² (USFWS 1983, Foster et al. 2004). Surveys in 2008 failed to find the species in many areas where it was previously observed, indicating a range contraction has occurred, and its range is now estimated to be only 50 km² in eastern Kōke‘e and the upper Alaka‘i (Camp et al. 2009).

Essential Biology:

‘Anianiau – The ‘Anianiau is a small (10 g) Hawaiian honeycreeper with a short, thin bill that is slightly curved. Males are bright yellow; females are duller yellow-green. The legs and feet are pink. The song is a high-pitched trill with repeated elements of 2–3 syllables (e.g., *weesee-weesee-weesee*; Lepson 1997). The most common call is a high-pitched *sweet* or *ps-seet*, given by both sexes, often used as a contact call.

‘Anianiau are most common in mesic and wet native montane forests dominated by ‘ōhi‘a (*Metrosideros polymorpha*), koa (*Acacia koa*), ‘ōlapa (*Cheirodendron trigynum*), ‘ōhi‘a ha (*Syzygium sandwicensis*), kāwa‘u (*Ilex anomala*), and kōlea (*Myrsine lessertiana*), with a diverse understory of native plants including ‘ōhelo (*Vaccinium calycinum*) and kanawao (*Broussaisia arguta*). ‘Anianiau are generalist foragers, gleaning a variety of arthropods, particularly caterpillars and spiders (Eddinger 1970), from the outer canopy and smaller twigs and branches. They also take nectar from a variety of native plants (Lepson 1997).

The open cup nest is built by both sexes 3-10 m high in a ‘ōhi‘a tree, either in the crown or on small branches near the trunk. The female incubates the eggs and broods the young, and the male feeds nestlings and provisions the female. Nest construction occurs from February through late May or June. Median clutch size is 3 eggs and young fledge after 18 days. There is no information on post-fledgling behavior, adult or juvenile survival, or movements. Research on nest success and causes of failure is ongoing by the Kauai Forest Bird Recovery Project (KFBRP).

‘Akikiki – The ‘Akikiki is a small (12 g) Hawaiian honeycreeper with a short, pink bill that is slightly curved. Both sexes are olive gray above and off-white below. Juveniles and young birds resemble adults but have white spectacles. The song is a short, descending trill, given infrequently. Males and females give a soft “*whit*” contact call (Foster et al. 2000). They are usually found in pairs or family groups, and may join mixed-species foraging flocks during the non-breeding season.

‘Akikiki are found in wet native montane forests (see ‘Anianiau account for plant species) where they forage on trunks, branches, and twigs of live and dead trees, primarily ‘ōhi‘a and koa, and occasionally in subcanopy shrubs (Foster et al. 2000). They feed on insects, insect larvae, and other arthropods taken from bark, crevices, dead wood, and epiphytes by gleaning, probing, and rarely by excavation (Foster et al. 2000, VanderWerf and Roberts 2008).

The nesting season extends primarily from March-June (Foster et al. 2000), but may occur from January to July in some years (VanderWerf and Roberts 2008). The nest is built 4-12.5 m high in the crown of a ‘ōhi‘a trees and is composed of moss, pieces of bark and lichen, and fine plant fibers (Eddinger 1972a, Foster et al. 2000, VanderWerf and Roberts 2008). Both

sexes help build the nest and feed the nestlings, but only the female has been observed incubating. The male feeds the female during nest construction, incubation, and brooding (Eddinger 1972a, Foster et al. 2000, VanderWerf and Roberts 2008, R. Hammond unpubl. data). Some pairs may attempt to raise two broods in one season (VanderWerf and Roberts 2008). There was no data on nest success, reproductive rates, survival of adults or juveniles, home range size, or movements prior to 2011, but this information is being collected by the KFBRP (L. Behnke and R. Hammond unpubl. data).

‘Akeke’e – The ‘Akeke’e is a small (10-12 g) Hawaiian honeycreeper with an unusual crossed bill. Males are bright yellow below, greenish above, with a yellow forehead and rump and a dark mask. Females are similar but not as bright yellow. The tips of the short, bluish bill are slightly crossed, a characteristic shared with the Hawai’i ‘Ākepa (*L. coccineus*). The tail is notched and longer than in other Hawaiian honeycreepers. The song is a wavering trill that changes in pitch and speed; call notes given by males and females include a soft “sweet” (Pratt et al. 1987, Lepson and Pratt 1997). ‘Akeke’e are most often observed in pairs or family groups.

‘Akeke’e are found in mesic and wet native montane forests (see ‘Anianiau account for dominant plant species) where they forage for insects, insect larvae, and spiders on the outer branches and leaves of ‘ōhi’a trees, and occasionally in other trees and understory shrubs (Lepson and Pratt 1997). Prey is taken primarily by gleaning, and the crossed bill is used to pry open leaf buds and flower buds, similar to the behavior used by crossbills (*Loxia* spp.).

The nesting season extends from March-June (Lepson and Pratt 1997). The nest is built 9-15 m high in the crown of a ‘ōhi’a tree, and is made of moss and lichen, with a lining of fine grasses and bark strips (Eddinger 1972b, Berger 1981, Lepson and Pratt 1997). Both sexes help build the nest, but the female alone incubates the eggs, and both sexes feed the nestlings (Eddinger 1972, Lepson and Pratt 1997, R. Hammond unpubl. data). There was no data on nest success, reproductive rates, survival of adults or juveniles, home range size, or movements prior to 2011, but this information is being collected by the KFBRP (L. Behnke and R. Hammond unpubl. data).

Primary Threats:

These three species share the same threats, although the ‘Anianiau may be less vulnerable because it is more of a generalist than the other species (Banko and Banko 2009).

- Disease. Diseases carried by the non-native southern house mosquito (*Culex quinquefasciatus*), particularly avian malaria (*Plasmodium relictum*) and avian pox virus (*Poxvirus avium*), limit the distribution of many native Hawaiian forest birds, including the ‘Akikiki and ‘Akeke’e, and to a lesser extent the ‘Anianiau (van Riper et al. 1986, Atkinson et al. 1995, Atkinson and LaPointe 2009). These species are absent from lower elevations where disease is most prevalent (Walther 1995), and are restricted to colder, high elevation areas where disease transmission is lower. Recent declines in the ranges of these species have occurred at the lower edges (Foster et al. 2004), suggesting disease has contributed to these losses.
- Habitat degradation and loss. These species depend on areas of intact native forest for foraging and nesting, and this habitat has been, and continues to be, degraded by invasive alien plants and feral ungulates, particularly feral pigs (*Sus scrofa*) and goats (*Capra hircus*) (Lepson and Pratt 1997, Foster et al. 2004). Feral ungulates degrade native forest by browsing, causing soil erosion, spreading invasive plant seeds, facilitating invasion by

alien plants, and creating breeding habitat for mosquitoes (Cabin et al. 2000, Scott et al. 2001, USFWS 2006). Invasive alien plants such as kahili ginger (*Hedychium gardnerianum*), strawberry guava (*Psidium cattleianum*), blackberry (*Rubus argutus*), and Australian tree fern (*Cyathea cooperi*) displace native plants and prevent forest regeneration. Declines in the ranges of these species have occurred at their edges (Foster et al. 2004), where disturbance and the effects of feral ungulates and invasive alien plants are most severe, suggesting degradation of forest habitat has played a role in the range contraction of the 'Akikiki and the 'Akeke'e, and perhaps to a lesser extent of the 'Anianiau.

- **Non-native Predators.** Introduced predators can be a serious threat to Hawaiian forest birds, particularly during nesting (Atkinson 1977, VanderWerf 2009). Black rats (*Rattus rattus*), Polynesian rats (*R. exulans*), Norway rats (*R. norvegicus*), and feral cats (*Felis catus*) are present on the Alaka'i Plateau and are potential predators on roosting or incubating adults, eggs, and young. Predation by rats on nests of 'Akikiki and 'Akeke'e was documented in 2012 (R. Hammond unpubl. data). Two species of owls, the native Pueo (*Asio flammeus sandwichensis*) and the introduced Barn Owl (*Tyto alba*), also occur on Kaua'i and are known to prey on forest birds (Snetsinger et al. 1994).
- **Hurricanes.** Major hurricanes struck Kaua'i in 1983 and 1992 and degraded native forests by knocking down large trees, creating gaps into which alien plants could expand, and spreading invasive plants. Large numbers of dead trees killed by hurricane Iniki in 1992 are still visible in several areas where 'Akikiki have declined in abundance or disappeared. (E. VanderWerf pers. obs.).
- **Climate Change.** Rising temperatures associated with climate change may exacerbate the threat of disease by increasing the elevation at which regular transmission of avian malaria and avian pox virus occurs (Reiter 1998, Benning et al. 2002, Harvell et al. 2002, Loiseau et al. 2012). 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). The loss of such a large proportion of suitable habitat would likely result in extinction of the 'Akikiki and 'Akeke'e (Pounds et al. 1999, Still et al. 1999). Disease prevalence has been studied in the range of these species and increases in prevalence of malaria in more common species at several locations suggests that exposure to disease is increasing for 'Akikiki and 'Akeke'e (Atkinson and Utzurrum 2010). Climate data on Kaua'i show a warming pattern at 4,000 ft elevation and a decline in frequency of high water events that could flush mosquito larvae from streams, possibly resulting in an increase in mosquito breeding habitat (T. Giambelluca and C. Atkinson in prep.).
- **Other.** A number of other factors are likely contributing to the decline of the 'Akikiki and 'Akeke'e. The effects of non-native arthropod predators and competitors are completely unknown. Threats may interact with each other and increase their negative impact. For example, birds with malaria may be more susceptible to predation. Single island endemics with small populations are inherently more vulnerable to extinction than widespread species because of the higher risks posed by random demographic fluctuations and localized catastrophes such as hurricanes, fires, and disease outbreaks (Wiley and Wunderle 1994), and potentially genetic issues. A lack of basic life history information has hampered management decisions, although these data are being collected by the KFBRP.

Conservation Actions to Date:

The ‘Akikiki was a candidate for listing under the Endangered Species Act since 1994; it and the ‘Akeke’e were listed as endangered in March 2010 in response to a listing petition (VanderWerf and American Bird Conservancy 2007). Weed control has been conducted by The Nature Conservancy and Kōke’e Resource Conservation Program. The Kaua‘i Watershed Alliance (KWA) completed strategic ungulate fence segments in 2010 to protect an 810-ha (2,000-acre) management unit in the southeastern Alaka‘i Wilderness Preserve; 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) in adjacent areas of the ‘Alaka‘i that constitute the core of ‘Akikiki and ‘Akeke’e ranges. Fencing in the Hono O Nā Pali Natural Area Reserve also is being planned. Captive propagation has not been attempted for the ‘Akikiki or the ‘Akeke’e, although the Hawai‘i Creeper (*O. mana*) and the Hawai‘i ‘Ākepa have been bred in captivity by the Zoological Society of San Diego.

Planning/Research Needs:

- 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.
- Little is known about these species, and there is an urgent need for natural history information and basic demographic data. Until 2011, these species had not been the focus of any long-term studies or management actions, and life history information was based on anecdotal observations (e.g. VanderWerf and Roberts 2008). In 2011, the KFBRP began intensive studies of occupancy, nesting biology, reproductive output, survival, movements, habitat use, and home range size in all three species. This information will help managers determine which conservation actions are likely to be most effective and will allow the most efficient use of limited resources.
- Investigate the effectiveness of rodent control and weed control as management tools for these species.
- Continue conducting periodic range-wide surveys to monitor status of these species. Larger sample sizes will improve estimates of detection probability, leading to more accurate and precise measures of abundance and improved ability to measure population trends and efficacy of conservation actions.
- 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 ‘Alaka‘i (Atkinson and Uzzurum 2010), but it is not known where the mosquitoes that transmit malaria breed. If mosquito breeding sites can be located, it may be possible to treat or eliminate them.

5-Year Conservation Goals:

- Manage additional forest habitat by fencing, removing ungulates, and controlling invasive alien plants in a larger portion of the ‘Alaka‘i Wilderness Preserve, the Na Pali-Kona Forest Reserve, and Hono O Nā Pali Natural Area Reserve.
- Complete life history studies and threat assessments.
- Develop threat abatement strategies based on results from life history studies.

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- Develop captive propagation programs, if deemed necessary based on results of life history studies and monitoring, potentially focusing on individuals with disease tolerance.
- Increase public support for forest bird conservation through outreach.

Conservation Actions, 2013-2017:

- Disease. Fencing and feral pig removal will reduce disease prevalence by reducing breeding habitat for mosquitoes.
- 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.
- Non-native Predators. Predation on ‘Akikiki and ‘Akeke’e nests by rats has been documented by the KFBRP, and rat control around known nests could benefit these species. Additional information about frequency of predation and ability to control rats would allow assessment of whether this threat can be managed.

Summary and Estimated Costs of Conservation Actions, 2013-2017:

Conservation Action	Years	Annual Cost	Total Cost
Mosquito surveys	1-2	\$125,000	\$250,000
Disease monitoring	1,5	\$100,000	\$200,000
Regulatory compliance for additional KWA fencing in the Alaka’i Wilderness Preserve	1	\$80,000	\$80,000
Build KWA fence and remove ungulates from 3,000 acres in the Alaka’i Wilderness Preserve	2-5	\$900,000	\$3,600,000
Invasive alien plant control	1-5	\$300,000	\$1,500,000
Continue life history research	1-2	\$150,000	\$300,000
Investigate nest predation and predator control	1-3	\$100,000	\$300,000
Range-wide surveys of ‘Akikiki and ‘Akeke’e	1,5	\$40,000	\$80,000

Potential Partners: Hawai’i Division of Forestry and Wildlife, U.S. Fish and Wildlife Service, Kaua’i Watershed Alliance, University of Hawai’i, Koke’e Resource Conservation Program, U.S. Geological Survey Pacific Island Ecosystems Research Center, Zoological Society of San Diego, Pacific Rim Conservation, American Bird Conservancy, Long Foundation, Alexander & Baldwin Foundation.

Ancillary Species: Management that would benefit these species also would benefit all other native bird species that use forest habitat on the island, including the Pueo or Hawaiian Short-eared Owl (*Asio flammeus sandwichensis*), Kaua’i ‘Elepaio (*Chasiempis sclateri*), Puaiohi (*Myadestes palmeri*), Kaua’i ‘Amakihi (*Hemignathus kauaiensis*), ‘I’iwi (*Vestiaria coccinea*), and ‘Apapane (*Himatione sanguinea*).

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