

Akikiki
(*Oreomystis bairdi*)

5-Year Review
Summary and Evaluation

U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
Honolulu, Hawaii

5-YEAR REVIEW
Species reviewed: Akikiki (*Oreomystis bairdi*)

TABLE OF CONTENTS

1.0	GENERAL INFORMATION	Error! Bookmark not defined.
1.1	Reviewers	Error! Bookmark not defined.
1.2	Methodology used to complete the review:	Error! Bookmark not defined.
1.3	Background:	Error! Bookmark not defined.
2.0	REVIEW ANALYSIS	Error! Bookmark not defined.
2.1	Application of the 1996 Distinct Population Segment (DPS) policy	Error! Bookmark not defined. not defined.
2.2	Recovery Criteria	Error! Bookmark not defined.
2.3	Updated Information and Current Species Status	Error! Bookmark not defined.
2.4	Synthesis	Error! Bookmark not defined.
3.0	RESULTS	Error! Bookmark not defined.
3.1	Recommended Classification:	Error! Bookmark not defined.
3.2	New Recovery Priority Number:	Error! Bookmark not defined.
3.3	Listing and Reclassification Priority Number:	Error! Bookmark not defined.
4.0	RECOMMENDATIONS FOR FUTURE ACTIONS	Error! Bookmark not defined.
5.0	REFERENCES	Error! Bookmark not defined.
	Signature Page	

5-YEAR REVIEW

Akikiki/Oreomystis bairdi

1.0 GENERAL INFORMATION

1.1 Lead Regional Office:

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(503) 231-6868

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Cooperating Field Office(s):

N/A

Cooperating Regional Office(s):

N/A

1.2 Methodology used to complete the review:

This review was conducted by staff of the Pacific Islands Fish and Wildlife Office of the U.S. Fish and Wildlife Service (USFWS), beginning in August 2017. The review was based on the final rule listing this species; the final critical habitat designation; the draft recovery plan; peer reviewed scientific publications; unpublished field observations by the USFWS, State of Hawaii, and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information. The evaluation of the status of the species was prepared by Michelle Clark, Fish and Wildlife Biologist and reviewed by Megan Laut, Animal Recovery Coordinator. The document was then reviewed by the Gregory Koob, Conservation and Restoration Team Manager.

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2015a. Endangered and threatened wildlife and plants; 5-year status reviews of 133 species in Hawaii, Oregon, Idaho, and Washington. Federal Register 80(30): 8100-8103.

1.3.2 Listing history

Original Listing

FR notice: USFWS. 2010a. Endangered and threatened wildlife and plants; determination of endangered status for 48 species on Kauai and designation of critical habitat, final rule. Federal Register 75(70): 18960–19165.

Date listed: April 13, 2010

Entity listed: Species

Classification: Endangered

Revised Listing, if applicable

FR notice: N/A

Date listed: N/A

Entity listed: N/A

Classification: N/A

1.3.3 Associated rulemakings

N/A

1.3.4 Review History:

This is the first 5-year review for this species. The USFWS's final listing rule was published on April 13, 2010 (USFWS 2010a). The species was listed as *Oreomystis bairdi*. Public availability of the recovery outline for *Oreomystis bairdi*, included in the recovery outline for the Kauai Ecosystem, was published in 2010 (USFWS 2010b). A draft recovery plan is in preparation (USFWS 2012, in prep).

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

At the start of the 5-year review, the Recovery Priority Number proposed for *Oreomystis bairdi* is 1 (USFWS 2016).

1.3.6 Current Recovery Plan or Outline

Name of plan or outline: USFWS. 2010b. Recovery outline for the Kauai ecosystem. U.S. Fish and Wildlife Service, Portland, Oregon. 43 pages.

Date issued: June 17, 2010

Dates of previous revisions, if applicable: N/A

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

☒ *Yes*

☐ *No*

2.1.2 Is the species under review listed as a DPS?

☐ *Yes*

☒ *No*

2.1.3 Was the DPS listed prior to 1996?

☐ *Yes*

☐ *No*

2.1.3.1 Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 policy standards?

☐ *Yes*

☐ *No*

2.1.3.2 Does the DPS listing meet the discreteness and significance elements of the 1996 DPS policy?

☐ *Yes*

☐ *No*

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?

☐ *Yes*

☒ *No*

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

☐ *Yes*

☒ *No*

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

_____ *Yes*

_____ *No*

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?

_____ *Yes*

_____ *No*

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

Recovery criteria in the recovery outline are listed below. These recovery criteria are based on the threats that have caused the decline of akikiki and they include population stability and growth rates, habitat protection, and threat management. A metapopulation as used below is defined as a group of partially isolated populations belonging to the same species among which exchange of individuals occurs. Threats to akikiki include habitat loss and degradation, disease, predation, small population size and natural stochastic events. These factors interact in complex and dynamic ways that are only partly understood. For example, transmission and prevalence of avian diseases and abundance of nonnative predators vary from year to year and from site to site, causing fluctuations in the amount of management needed to ameliorate these threats.

Downlisting Criteria.

Akikiki may be downlisted from endangered to threatened when all four of the following criteria apply.

Criterion 1: A total population of 5,000 birds throughout 75 percent of the recovery area and the species occurs in two or more viable populations or a viable metapopulation that represent the ecological, morphological, behavioral, and genetic diversity of the species.

The criterion has not been met. The current population is estimated to be 468 individuals (95% confidence interval (CI), 231 to 916) (Paxton *et al.* 2016).

Criterion 2: Quantitative surveys show that the number of individuals in each isolated population or in the metapopulation has been stable or increasing for 15 consecutive years, or demographic monitoring shows that each population or the

metapopulation exhibits an average intrinsic growth rate (λ) not less than 1.0 over a period of at least 15 consecutive years; and total population size is not expected to decline by more than 20 percent within the next 15 consecutive years for any reason.

This criterion has not been met; akikiki are in steep decline (Paxton *et al.* 2016) and previously adequate quantitative survey methods are no longer able to precisely estimate abundance (Kauai Forest Bird Recovery Project, pers. comm. 2017). Demographic monitoring has not been adequate to determine average growth rate for this species.

Criterion 3: Sufficient recovery area is protected and managed to achieve Criteria 1 and 2 above.

This criterion has not been met. Akikiki have undergone a dramatic range contraction from 88 square kilometers (34 square miles) in 1973 to less than 39 square kilometers (15 square miles) in 2012 (Scott *et al.* 1986; Paxton *et al.* 2016). Approximately 14 square kilometers (5.4 square miles) have some form of threat abatement occurring (ungulate exclusion, invasive plant removal and/or predator control); however, no areas are being managed for avian disease (Kauai Watershed Alliance and Hawaii Division of Forestry and Wildlife, Kauai Natural Area Reserve Program. pers. comm. 2017).

Criterion 4: The mix of threats that were responsible for the decline of the species have been identified and controlled.

Threats responsible for the decline of akikiki have been identified, but are not adequately controlled.

Akikiki may be delisted when all four of the criteria above have been met for a 30-year period and total population is 8,000 adults.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

The akikiki or Kauai creeper (*Oreomystis bairdi*) is a nonmigratory passerine that was listed as endangered, with critical habitat, on May 10, 2010 (USFWS 2010a). The Recovery Priority number for the akikiki is 1 (based on the USFWS scale of 1 to 18). Critical habitat was designated for the akikiki in six units totaling 6,932 hectares (17,196 acres) on Kauai. This designation includes habitat on State and private land (USFWS 2010a).

The akikiki is a small Hawaiian honeycreeper found only on Kauai, currently in montane-wet ecosystems on the Alakai Plateau (USFWS 2010a; Paxton *et al.* 2016).

The Hawaiian honeycreepers are in the subfamily Drepanidinae of the finch family, Fringillidae (Pratt 2005). The akikiki is 10.9 to 12.2 centimeters (4.3 to 4.8 inches) in length and 11.5 to 17.0 grams (0.39 to 0.58 ounces) in weight. Its head, back, sides, and flanks are dull gray to olive, the throat, breast, belly, and under-tail coverts are white to off-white. The bill is short and slightly down-curved, the tail is short and square-tipped, and the legs, feet, nails, and bill are dull pink. Male and female plumages are identical. Juveniles are similar to adults but are distinguishable by white "spectacles" around the eyes. The song is a short, descending trill. Males and females give a soft "whit" contact call (Foster *et al.* 2000).

At the time of European discovery, each of the six main Hawaiian Islands harbored a small, straight-billed, simple-tongued, insectivorous bird. The akikiki was first described as *Oreomyza bairdi* by Stejneger in 1887 (the genus was later changed to *Oreomystis* because *Oreomyza* had been used previously (USFWS 2006a). Subsequent nomenclature has been problematic (reviewed in Pratt 1992; Foster *et al.* 2000). It is currently classified as *Oreomystis bairdi* following Pratt (1992), but its inclusion with the Hawaii creeper in the genus was a matter of ongoing debate (Johnson *et al.* 1989; Pratt 2001). Hawaii Creeper was changed from *Oreomystis mana* to *Loxops mana* in 2013 in the 54th Supplement to the American Ornithologists Union (AOU) Check-list of North American Birds, making *Oreomystis bairdi* a monotypic genus. Additional evidence, particularly molecular, may confirm that the Maui alauahio (*P. montana newtoni*) is the closest living relative of the akikiki (Foster *et al.* 2000).

The akikiki is most common in forests dominated by *Metrosideros polymorpha* (ohia) with a diverse subcanopy (Scott *et al.* 1986). The akikiki was considered common from high to low elevation in native forests in the late 1800s (Perkins 1903), and was described as locally abundant on and near the Alakai Plateau in the early 1960s (Richardson and Bowles 1964). Based on surveys conducted from 1968 through 1973, its distribution was thought to encompass 88 square kilometers (34 square miles) at elevations between 600 and 1,600 meters (1,968 and 5,248 feet), but a survey in 2000 indicated its distribution had decreased to 36 square kilometers (14 square miles) (Scott *et al.* 1986; Tweed *et al.* 2005). From 1968 to 1973, the species was estimated to number $6,832 \pm 966$ birds (USFWS 1983a). In 1981, data from the Hawaii Forest Bird Survey indicated there were approximately $1,650 \pm 450$ akikiki in a 25 square kilometer (9.7 square mile) area of the southeastern Alakai Plateau, in the vicinity of Sincock Bog (Scott *et al.* 1986). The population was estimated to be $1,312 \pm 530$ birds, based on surveys conducted in April and May 2007 (USFWS 2010a). The abundance of the akikiki has thus declined by approximately 80 percent in the last 40 years, and its distribution has been reduced to less than half of its former extent (USFWS 2006a).

The life history of the akikiki is poorly known. Data below have been summarized from Eddinger (1972b) and Foster *et al.* (2000), except where otherwise noted. The akikiki generally forages on trunks, branches, and twigs of live and dead ohia trees, and occasionally forages in subcanopy shrubs. It feeds primarily on insects, insect larvae, and spiders gleaned and extracted from bark, lichens, and moss (Foster *et al.* 2000). Akikiki are usually found in pairs, family groups, and small flocks of 5 to 6 (rarely up to 12) individuals (USFWS 2006a). Akikiki also form mixed-species

flocks with akekee or Kauai akepa (*Loxops caeruleirostris*), anianiau (*Magumma parva*), Kauai amakihi (*Chlorodrepanis stejnegeri*), and Kauai elepaio (*Chasiempis sclateri*), and historically with Kauai akialoa (*Akialoa stejnegeri*), and Kauai nukupuu (*H. hanapepe*) (Perkins 1903; Munro 1944).

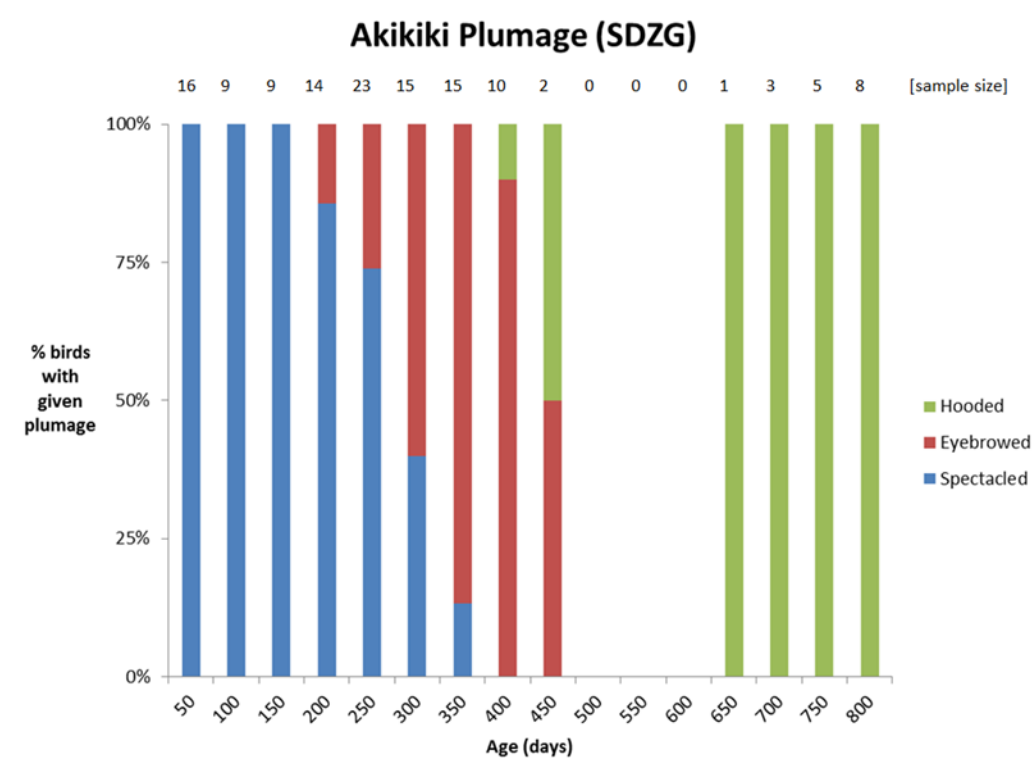
2.3.1.1 New information on the species' biology and life history:

From 2012 to 2014, 20 akikiki nests were monitored to assess basic nesting biology parameters (e.g., brood size; nest height; length of construction, incubation, and nestling periods) and to derive estimates of nesting success and investigate causes of failure. All nests were found in ohia. Mean nest height for akikiki was 11.1 ± 2.3 m standard deviation (SD). Nesting success, calculated using program MARK, was 0.77 ± 0.12 standard error (SE). Three of the 20 akikiki nests failed. One nest failed due to predation and the other two from unknown causes. Double brooding was confirmed in one instance in 2013. Nest sample sizes were small and should be considered with caution; however, these results suggest that low nesting success may not be a primary cause of decline in these species (Hammond *et al.* 2015).

A captive breeding project was initiated for akikiki in 2015. Field observations by Kauai Forest Bird Recovery Project (KFBRP) during egg collection activities from 2015 to 2017 documented that many pairs re-nest following failure (including egg collection) or double brood. For example, in 2017, five pairs attempted three nests; two of them successfully fledged two nests and two successfully raised one nest (eggs were collected from one attempt of four of these five pairs). One pair made two nests in *Cheirodendron* sp. (olapa). This was the first observation of akikiki nesting in a substrate other than ohia (DOFAW unpubl. data). There are currently 39 akikiki in captivity, 11 (10 males and one female) from 2015 collections, seven (two males and five females) from 2016 collections and 21 (11 males, nine females and one still to be determined) from 2017 (Hawaii Endangered Bird Conservation Program, San Diego Zoo Global 2017).

Recent observations of both wild birds and birds in the conservation breeding flock confirm that the facial plumage of all second-year Akikiki is either spectacled or eye-browed, and all third year Akikiki are hooded (Figure 1). These plumage differences help field biologists age and track individual breeding birds (DOFAW and San Diego Zoo Global unpubl. data)

Figure1. Proportion of Akikiki with Spectacled, Eye-browed or Hooded plumage. Based on 41 birds, ages ranging from recent fledglings to just over 2 years.



2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

A new publication by Paxton *et al.* (2016) documents the population decline and range contraction for akikiki and other avifauna on Kauai. The study looked at the average change in density over a 25-year period for both the interior and exterior areas of the Alakai Plateau. Akikiki has declined precipitously, with the 2012 population sizes estimated to be only 468 (95% Confidence Interval, 231 to 916) individuals. This estimate was derived from only three detections of akikiki during the 2012 survey. Unlike in previous surveys (2000, 2005, 2007, and 2008), akikiki was not detected by systematic surveys in the periphery of its range in 2012, although incidental sightings indicate continued but limited occurrence. If current rates of decline continue, extinction is predicted in the coming decades.

From 2015 to 2017 KFBRP field biologists found 37 distinct breeding territories of akikiki. In the absence of a color-banded population, plumage was used as a

surrogate for an individual's age to estimate turnover (year-to-year differences in pair membership) on these territories over the three years. Sixty-nine male-female combinations were observed on these territories. In most cases both members were after second year (ASY) or adults (62%), indicating that no turnover had occurred and the pair was likely made of the same individuals. However, in the next most common situation, the male was ASY and the female was second year (33%), indicating that the male had persisted on the territory but the female had turned over (perished or dispersed). These preliminary observations bear further investigation, as they may shed light on reasons for decline (DOFAW unpubl. data).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

No new information, but also see section 2.3.2.5 below

2.3.1.4 Taxonomic classification or changes in nomenclature:

No new information.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

Akikiki occupancy increases gradually from west to east across the Alakai Plateau (Behnke *et al.* 2016). The highest known densities of akikiki historically occurred on the plateau at Halepaaki, Halehaha and Mohihi (Foster *et al.* 2004, Camp and Gorresen 2010). These studies indicated that Kawaikoi, the western most study area, supported medium densities of akikiki (Foster *et al.* 2004), but few birds were observed during subsequent surveys in 2005 and 2008 (Camp and Gorresen 2010). Behnke *et al.* (2016) found that detection probability was low ($p = 0.63 \pm 0.40$) for akikiki and occupancy (ψ) was substantially greater at Halepaakai ($\psi = 0.55 \pm 0.21$) than at Kawaikoi and Mohihi ($\psi = 0.02 \pm 0.07$ and $\psi = 0.04 \pm 0.10$, respectively). Akikiki has experienced rapid range contraction since 2000 and are now limited to 39 square kilometers (15 square miles) on the plateau, a reduction of 57% (Paxton *et al.* 2016).

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Akikiki occur primarily in native wet montane forests. Roughly 39 square kilometers (15 square miles) on the Alakai Plateau remains as suitable habitat for

akikiki (Paxton *et al.* 2016). In the eastern edge of the species range, annual rainfall exceeds 13,000 millimeters (512 inches) per year, declining to 2,200 millimeters (87 inches) at the western edge at Na Pali Kona Forest Reserve (Giambelluca *et al.* 2013). The montane wet forest is dominated by *Metrosideros polymorpha* with a subcanopy of *Cheirodendron trigynum*, *Cheirodendron* spp. (lapalapa) and *Syzygium sandwicensis* (ohia ha). The forest understory is occupied by many species of native shrubs and small trees, typically including *Vaccinium calycinum* (ohelo), *Broussaisia arguta* (kanawao), *Clermontia faurei* (oha wai), *Ilex anomala* (kawau), *Myrsine lessertiana* (kolea), *Dubautia* spp. (naenae) and *Leptecophylla tameiameia* (pukiawe). The ground cover consists of various ferns, mosses, herbs and lichens. Lowland habitats have been drastically altered by nonnative plants and feral ungulates (Foster *et al.* 2000).

Akikiki and habitat covariates were surveyed within five study areas on the Alakai Plateau along a gradient of forest conditions (Behnke *et al.* 2016). Occupancy rates increased from west to east along the plateau, but were low throughout the range of akikiki. Canopy height was positively correlated with occupancy for akikiki at Halepaakai, which suggests the damage done by hurricanes in 1982 and 1992 may be one factor restricting these birds to the most intact forest remaining. Invasive plants such as *Hedychium gardnerianum* (Himalayan ginger) were more prevalent in the western portion of the plateau resulting in less native plant cover. Native plant cover is higher in the eastern areas of the plateau where akikiki occupancy is highest, although ground disturbance by feral ungulates was also higher in these areas (Behnke *et al.* 2016).

Habitat management, primarily removal of feral ungulates and invasive plants is occurring in suitable habitat on private and Hawaii Division of Forestry and Wildlife (DOFAW) lands. Over 14 square kilometers (5.4 square miles) of akikiki habitat has been fenced to exclude ungulates and ungulate removal is ongoing at Hono O Na Pali Natural Area Reserve (HNP NAR), Halehaha, Halepaaki and in the East Alakai Protective Fence, which includes the summit of the island at Mt. Waialeale. Since ungulate removal operations began in the East Alakai unit native understory cover increased from 24% to 39% from 2010 to 2016 (The Nature Conservancy in Hawaii, Kauai Program 2017). Invasive plant removal over 13 square kilometers (5 square miles), performed primarily by the Kokee Resource Conservation Program, Kauai Watershed Alliance and HNP NAR staff, has been ongoing at Kawaikoi, Mohihi, Halehaha, Halepaaki and in the East Alakai since 2001. Weed control efforts are focused on the three most habitat degrading weeds, *Hedychium gardnerianum* (Himalayan ginger), *Sphaopteris cooperi* (Australian tree fern) and *Psidium cattleianum* (strawberry guava). Predator control for cats and rats has been ongoing at two sites within the HNP NAR, the western most area on the plateau within the current range for akikiki, since 2014. Predator control operations for rats and mice over 1.5 square kilometers (0.6 square miles) have been ongoing at Halepaakai since 2015 (Kauai Watershed Alliance and Hawaii Division of Forestry and Wildlife, Kauai Natural Area Reserve Program, pers. comm. 2017).

The prevalence of avian malaria on the plateau has increased and is likely due to ongoing changes in temperature, rainfall, and streamflow that affect mosquito abundance and the development of the extrinsic sporogonic parasite (*Plasmodium relictum*). The increase in prevalence is likely the cause of the steep population declines and range contractions for the akikiki and other remaining native forest birds on Kauai. Atkinson *et al.* (2014) compared prevalence of malarial infections in forest birds that were sampled at Kawaikoi Stream, Mohihi Stream and Halepaakai Stream between 1994 and 1997 and again between 2007 and 2013. Changes in the occurrence of mosquito larvae in available aquatic habitats during same time periods were also evaluated. Prevalence of infection in native and non-native forest birds increased significantly at the lower (1,100 m, 10.3% to 28.2%), middle (1,250 m, 8.4% to 12.2%), and upper ends of the plateau (1,350 m, 2.0% to 19.3%). A concurrent increase in detections of *Culex quinquefasciatus* larvae in aquatic habitats associated with stream margins indicates that populations of the vector are also increasing. These increases are at least in part due to local transmission because overall prevalence in *Chasiempis sclateri* (Kauai elepaio), a sedentary native species, has increased from 17.2% to 27.0%. Increasing mean air temperatures, declining precipitation, and changes in streamflow that have taken place over the past 20 years are creating environmental conditions throughout major portions of the Alakai Plateau that support increased transmission of avian malaria.

The impact of climate change on Hawaiian forest birds has been a recent focus of Hawaiian conservation biology and has centered on the links between climate and avian malaria. A recent publication by Fortini *et al.* (2015) elucidates the differential impacts of projected climate shifts on Hawaiian forest bird species with known varying niches, disease resistance, and tolerance, by using a comprehensive database of species sightings, regional climate projections, and ensemble distribution models to project distribution shifts for all species. The model predicts under a likely scenario of continued disease-driven distribution limitation, akikiki are expected to lose all of their range by 2100.

2.3.1.7 Other: N/A

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

- Habitat degradation resulting from the invasion of many nonnative weeds has drastically changed the forest structure and integrity. Two hurricanes

in 1982 and 1992 severely disturbed areas of native forest and made space for the germination and expansion of nonnative plants. Established ecosystem-altering invasive plant species which degrade akikiki habitat include (USFWS 2012, in prep);

- o *Andropogon virginicus* (broomsedge)
 - o *Clidemia hirta* (Koster's curse)
 - o *Digitaria insularis* (sourgrass)
 - o *Erigeron karvinskianus* (daisy fleabane)
 - o *Grevillea robusta* (silk oak)
 - o *Hedychium flavescens* (yellow ginger)
 - o *Hedychium gardnerianum* (Himalayan ginger)
 - o *Lantana camara* (lantana)
 - o *Leucaena leucocephala* (koa haole)
 - o *Melinis minutiflora* (molasses grass)
 - o *Morella faya* (firetree)
 - o *Passiflora tarminiana* (banana poka)
 - o *Psidium cattleianum* (strawberry guava)
 - o *Psidium guayava* (common guava)
 - o *Rubus argutus* (prickly Florida blackberry)
 - o *Rubus rosifolius* (thimbleberry)
 - o *Sphaeropteris cooperi* (Australian treefern)
- Ungulate degradation of habitat – Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) (Cabin *et al.* 2000; Scott *et al.* 2001; USFWS 2006a, 2010a). Degradation of forest habitat has likely played an important role in causing the range contraction of the akikiki. Most of the decline has occurred at lower elevations on the edge of the species' range (Foster *et al.* 2004; Behnke *et al.* 2016), where disturbance and the effects of ungulates and established ecosystem-altering invasive plant species are most severe. Continued habitat degradation from established ecosystem-altering invasive plant species and feral ungulates is likely to continue damaging forest structure and integrity, and thus likely to result in continued loss of habitat.
 - Rapid Ohia Death (ROD) – Currently the *Ceratocystis* fungus which causes ROD is restricted to Hawaii Island. The crowns of infected ohia (*Metrosideros polymorpha*) trees turn yellowish (chlorotic) and subsequently brown within days to weeks; dead leaves typically remain on branches for some time. In the lower Puna district on Hawaii Island, stands infected with ROD have shown greater than 90% mortality within 2 to 3 years. Over 75,000 acres of ohia-dominated forests have been impacted (University of Hawaii at Manoa 2017). Ohia trees make up the largest portion of the canopy in the native wet forests in which akikiki are found. The akikiki generally forages on trunks, branches, and twigs of live and dead ohia trees. They feed primarily on insects, insect larvae, and spiders that they glean and probe from the bark, lichens, and moss. The majority of akikiki nests have been found in ohia (Hammond *et al.* 2015; KFBRP unpubl. data). If ROD becomes established on Kauai, it will further degrade what remains of akikiki habitat

and have the potential to negatively impact available food (invertebrate) resources.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

Not a threat.

2.3.2.3 Disease or predation:

- Avian malaria and avian pox– Avian diseases, transmitted by mosquitoes (*Culex quinquefasciatus*), specifically pox (*Poxvirus avium*) and malaria (*Plasmodium relictum*), are thought to play a major role in limiting the distribution of akikiki. Akikiki is restricted to higher elevation areas where mosquitoes and the diseases they carry are less prevalent (Scott *et al.* 1986), but mosquitoes have been captured as high as Sincovec's Bog and are likely to occur at the highest elevations on Kauai (D. LaPointe, USGS per. comm). Prevalence of avian malaria in akikiki increased from 0% (0/13) between 1994 and 1997 to 18.2% (2/11) between 2007 and 2013 (Atkinson *et al.* 2014). However, it is impossible to tell from these data whether survival rates of infected akikiki are high or low. Low infection rates could reflect either low transmission rates or high mortality of infected birds (USFWS 2006a).
- Predation from introduced and native species – Predation of nests of akikiki by rats has been documented four times, once by Hammond *et al.* (2015) and three times by the Kauai Forest Bird Recovery Project during egg collection activities in 2015 and 2016. Feral cats (*Felis catus*) are present in the Alakai Plateau, within the current range of akikiki (Tweed *et al.* 2006). Cats are believed to prey on roosting or incubating adults, nests, and young of forest birds. Two species of owls, the native pueo or Hawaiian short-eared owl (*Asio flammeus sandwichensis*) and introduced barn owl (*Tyto alba*), are known to prey on forest passerines (Snetsinger *et al.* 1994).
- Nonnative wasp predation – Western yellowjacket wasps (*Vespula pensylvanica*) are a potential threat as they may compete for food with insectivorous forest birds such as akekee and perhaps kill and eat the nestlings of the listed forest birds (USFWS 2006a).

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Current regulatory mechanisms appear adequate. The akikiki was federally listed as endangered on April 13, 2010 (USFWS 2010a) and thus receives regulatory protection under the Federal Endangered Species Act.

Species listed under the Federal Endangered Species Act are automatically added to the State of Hawaii list of endangered species, and are thus also protected by State regulations.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Invasive species – Nonnative bird competition – It has also been suggested that the akikiki may be negatively impacted by competition from the insectivorous Japanese white-eye (*Zosterops japonicas*) (Mountainspring and Scott 1985).

Small population size –The lack of genetic diversity poses potential that is likely with a small population size poses problems (Caughley and Gunn 1996). Species that are endemic to a single island and highly localized, such as the akekee, are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a single population by random demographic fluctuations and localized catastrophes such as fires, hurricanes and disease outbreaks.

Climate change – Climate change poses a threat to the akikiki by causing an increase in elevation at which regular transmission of avian malaria occurs (Benning *et al.* 2002; Atkinson *et al.* 2014; Fortini *et al.* 2015). Experimental evidence has shown that the malarial parasite does not develop in birds below 13 degrees Celsius (55 degrees Fahrenheit) and field studies have found that maximum malaria transmission occurs where mean ambient summer temperature is 17 degrees Celsius (63 degrees Fahrenheit; La Pointe 2000). Between 13 and 17 degrees Celsius, malaria transmission is limited and usually associated with warmer periods, such as El Nino events (Feldman *et al.* 1995). There are no forested areas on Kauai where mean ambient temperature is below 13 degrees Celsius, meaning all areas are currently subject to malaria at least periodically. Downscaled end-of-century climate projections for Hawaii based on a moderate A1B emission scenario (Intergovernmental Panel on Climate Change 2000) suggest an average 2.6 degrees Celsius warming in areas that Hawaiian forest birds currently inhabit (Zhang *et al.* 2011). Under this scenario and continued disease-driven distribution-limitation, akikiki are expected to lose all of their range by 2100 (Fortini *et al.* 2015).

2.4 Synthesis

Based on the recent surveys in 2012, akikiki has declined dramatically since it was listed as endangered in 2010 to 468 (95% CI: 460-1547) individuals. Akikiki have undergone a dramatic range contraction from 88

square kilometers (34 square miles) in 1973 to less than 39 square kilometers (15 square miles) in 2012 (Scott *et al.* 1986; Paxton *et al.* 2016). For these reasons and those elucidated above, the akikiki meets the definition of endangered as it remains in danger of extinction throughout its range.

3.0 RESULTS

3.1 Recommended Classification:

☐ **Downlist to Threatened**
☐ **Uplist to Endangered**
☐ **Delist**
 ☐ Extinction
 ☐ Recovery
 ☐ Original data for classification in error
☒ **No change is needed**

3.2 New Recovery Priority Number: No change.

Brief Rationale:

3.3 Listing and Reclassification Priority Number: N/A

Reclassification (from Threatened to Endangered) Priority Number: ____
Reclassification (from Endangered to Threatened) Priority Number: ____
Delisting (regardless of current classification) Priority Number: ____

Brief Rationale:

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Avian malaria and pox / mosquito vector control. Implement landscape-level control of the mosquito vector (*Culex quinquefasciatus*) by using existing and developing technologies such as *Wolbachia* to control populations and bio-pesticides to treat larvae. Continue to investigate novel technologies to confront mosquito vectors and mosquito-borne pathogens in the Hawaiian Islands.

Biosecurity. Implement a statewide interagency biosecurity plan to prevent ROD and other detrimental non-native species from becoming established on Kauai (Hawaii Department of Agriculture, 2017). An effective biosecurity plan requires a comprehensive approach that includes:

- Pre-border policies and processes to prevent invasive species

from making their way to the state of Hawaii

- Border policies and processes that support inspecting incoming items to ensure minimal risk of pest entry into the state
- Post-border policies and processes that support detecting and responding to new incursions of invasive species and controlling established invasive species wherever possible

Captive Propagation and Reintroduction Programs. Augmentation of natural dispersal and recolonization of recovering habitat through reintroduction of captive-bred akikiki in selected areas is desirable. Such reintroductions may increase the range of the species and the probability that the species will survive future catastrophes such as hurricanes or disease outbreaks.

Habitat Protection and Management. Habitat protection and management should continue to occur in areas in which akikiki occupancy is the highest. Prospects for recovery lie in maintaining and restoring forest habitat by developing, testing, and applying broad-scale habitat restoration measures, including: minimizing populations of feral ungulates through a combination of hunting, fencing, snaring, and possibly development of lethal non-toxicant devices for use in areas inaccessible to hunters or in areas closed to hunters; controlling the encroachment of invasive plants and insects through tested bio-control and where feasible, mechanical and chemical measures; and continuing enforcement of State and Federal laws that protect against destructive human activities and development.

Predator Control. A need exists to develop, test, register, and apply toxicants for control of feral cats and introduced rodents in remote forested habitat. Prevention of additional introductions of exotic plants, insects, mammals (especially the mongoose [*Herpestes auropunctatus*], currently a resident on other Hawaiian islands) and nonnative birds that may act as predators, on or competitors with, native birds is necessary.

Population Surveys, Monitoring. Continued monitoring of the status of forest bird populations and their habitats is necessary to measure the effectiveness of management actions such as those listed above. Future research should assess post-fledging, juvenile, and adult survival as potential causes of population declines. Determining which demographic parameters currently have the largest negative impact on the population is imperative for guiding effective management actions to conserve these species.

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U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of
Akikiki (*Oreomystis bairdi*)

Current Classification: E

Recommendation resulting from the 5-Year Review:

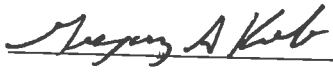
- ☐ Downlist to Threatened
- ☐ Uplist to Endangered
- ☐ Delist
- ☒ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By:

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Date 9/5/17