‘I‘iwi
(Drepanis coccinea)

5-Year Review
Summary and Evaluation

U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
Honolulu, Hawai‘i

5-YEAR REVIEW

Species reviewed: ʻIʻiwi (*Drepanis coccinea*)

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5-YEAR REVIEW
‘I‘iwi/*Drepanis coccinea*

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional or Headquarters Office: Region 1
Lead Field Office: Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu,

Name of Reviewer(s):
Jay Nelson, Fish and Wildlife Biologist, PIFWO
John Vetter, Animal Recovery Coordinator, PIFWO
Lauren Weisenberger, Acting Recovery Team Manager, PIFWO

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 on April 5, 2023. The review was based on a review of current, available information. The evaluation by Jay Nelson, Fish and Wildlife Biologist, was reviewed by the Animal Recovery Coordinator before submission to the Recovery Team Manager.

1.3 Background:

On August 25, 2010, the Service (we) received a petition dated August 24, 2010, from Noah Greenwald, Center for Biological Diversity, and Dr. Tony Povilitis, Life Net, requesting that the ‘i‘iwi be listed as an endangered or threatened species and that critical habitat be designated under the Endangered Species Act of 1973, as amended (Act). We published a 90-day finding for the ‘i‘iwi in the Federal Register on January 24, 2012 (USFWS 2012). Based on that review, we found that the petition presented substantial information indicating that listing the ‘i‘iwi may be warranted, and we initiated a status review of the species. A thorough review of the taxonomy, life history, and ecology of the ‘i‘iwi (*Drepanis coccinea*), Species Status Report, was published in December 2016, and is available online at https://ecos.fws.gov/ServCat/DownloadFile/166536 (USFWS 2016a). On September 20, 2016 (USFWS 2016b), we announced a 12-month finding on the petition to list the ‘i‘iwi as a threatened species under the Act. On September 20, 2017 (USFWS 2017) we published a final rule that determined threatened status under the Act, for the ‘i‘iwi (*Drepanis coccinea*), a bird species from the Hawaiian Islands.

1.3.1 FR Notice citation announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2021. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 77 species in Oregon, Washington, Idaho, and Hawaii. Federal Register 86(120):33726-33728.

1.3.2 Listing history

Original Listing
FR notice: 82 FR 43873
Date listed: September 20, 2017
Entity listed: Species
Classification: Threatened

Revised Listing, if applicable
FR notice: N/A
Date listed: N/A
Entity listed: N/A
Classification: N/A

1.3.3 Associated rulemakings: On December 28, 2022 (USFWS 2022a) we proposed to designate critical habitat for the federally threatened ʻiʻiwi (*Drepanis coccinea*) under the Endangered Species Act of 1973, as amended. In total, approximately 275,647 acres (111,554 hectares) on the islands of Kauaʻi, Maui, and Hawaiʻi, in the State of Hawaiʻi, fall within the boundaries of the proposed critical habitat designation. We also announced a public informational meeting and public hearing and the availability of a draft economic analysis of the proposed critical habitat designation.

The ʻiʻiwi was included in the Recovery Plan for 50 Hawaiian Archipelago Species signed on December 14, 2022 (USFWS 2022b).

1.3.4 Review History:
ʻIʻiwi (*Drepanis coccinea*), Species Status Report (2016).

1.3.5 Species' Recovery Priority Number at start of this 5-year review: 11

1.3.6 Current Recovery Plan or Outline
Name of plan or outline: Recovery Plan for 50 Hawaiian Archipelago Species
Date issued: December 14, 2022
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?
__x__ ***Yes****, go to section 2.1.2.*
_____ ***No****, go to section 2.2.*

2.1.2 Is the species under review listed as a DPS?
____ ***Yes****, go to section 2.1.3.*
__x__ ***No****, go to section 2.1.4*

2.1.3 Was the DPS listed prior to 1996?

____ ***Yes****, give date and go to section 2.1.3.1.*

____ ***No****, go to section 2.1.4.*

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

____ ***Yes,*** *provide citation and go to section 2.1.4.*

____ ***No****, go to section 2.1.3.2.*

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

____ ***Yes****, discuss how it meets the DPS policy, and go to section 2.1.4.*

____ ***No****, discuss how it is not consistent with the DPS policy and consider the 5-year review completed. Go to section 2.4., Synthesis.*

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

____ ***Yes****, provide citation(s) and a brief summary of the new information; explain how this new information affects our understanding of the species and/or the need to list as DPSs. This may be reflected in section 4.0, Recommendations for Future Actions. If the DPS listing remains valid, go to section 2.2, Recovery Criteria. If the new information indicates the DPS listing is no longer valid, consider the 5-year review completed, and go to section 2.4, Synthesis.*

__x__ ***No****, go to section 2.2., Recovery Criteria.*

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria? *(Note: Some plans may not contain recovery criteria, either because they are older plans, or because criteria could not be determined due to lack of information. These plans may still contain goals or other objectives that provide a benchmark for measuring progress toward recovery and may warrant discussion in this section. If you discuss them here, be sure to distinguish them from formal recovery criteria.)*

__x__ ***Yes****, continue to section 2.2.2.*

____ ***No****, consider recommending development of a recovery plan or recovery criteria in section IV, Recommendations for Future Actions, and go to section 2.3., Updated Information and Current Species Status.*

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?

__x__ ***Yes,*** *go to section 2.2.2.2.*

____ ***No****, go to section 2.2.3, and note why these criteria do not reflect the best available information. Consider developing recommendations for revising recovery criteria in section 4.0.*

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

__x__ ***Yes****, go to section 2.2.3.*

____ ***No****, go to section 2.2.3, and note which factors do not have corresponding criteria. Consider developing recommendations for revising recovery criteria in section 4.0.*

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 (*for threats-related recovery criteria, please note which of the 5 listing factors are addressed by that criterion. If any of the 5-listing factors are not relevant to this species, please note that here*):

Recovery Criteria

For ʻiʻiwi to be considered recovered, the species must maintain viable populations in suitable habitats. Habitats need to be either naturally self-sustaining or actively managed to protect native vegetation and prevent habitat degradation, and other threats to ʻiʻiwi are addressed. The following criteria must be met for the species to be considered for delisting:

Criterion 1: The species occurs in a minimum of four viable populations on three or more islands (i.e., Kauaʻi, Maui, and the island of Hawaiʻi) with at least two populations occurring on the island of Hawaiʻi, one on the windward and one on the leeward side of the island.

Criterion 2: Either (a) surveys conducted at appropriate intervals indicate that the number of individuals in each population in Delisting Criterion 1 is stable or increasing over a period of 25 years, or (b) demographic monitoring shows that each population exhibits an average intrinsic growth rate (lambda) of no less than 1.0 over a period of 25 years.

Criterion 3: Sufficient habitat is protected and managed for long-term persistence to achieve *Delisting Criteria 1* and *2*.

Criterion 4: Threats to the species have been identified and managed; and monitoring of population status and threats is ongoing.

Listing Factors

Factor A (Present or threatened destruction, modification or curtailment of its habitat or range)

ʻIʻiwi depend on areas of intact native ʻōhiʻa (*Metrosideros polymorpha*) forest for foraging and nesting, and are typically found in native forests. Their density is greatest at high elevations where the risk of avian malaria (*Plasmodium relictum*)

is lowest (Ralph and Fancy 1995, p. 740; Camp et al. 2010, pp. 198 and 206; Paxton et al. 2013, p. 28; USFWS 2016, p. 23). Historically, ʻiʻiwi habitat was reduced and fragmented by the clearing of ʻōhiʻa forests by native Hawaiians, and later by American and European settlers, for food crops, sugar production, grazing, and other development, particularly below 4,000 ft (1,250 m) elevation (Scott et al. 1986, pp. 371–373). In the time since human contact, the estimated loss of ʻiʻiwi habitat from intrusion of introduced invasive plants ranges from 52 percent on the island of Hawaiʻi to 85 percent on Oʻahu (Mountainspring 1986, p. 98). Although there is little risk of the remaining high elevation native forest habitat for ʻiʻiwi of being developed or degraded by human activities today, the species' habitat continues to be degraded by nonnative species, plant diseases, and climate change, which likely have synergistic negative effects. Feral nonnative ungulates and invasive nonnative plants are the leading causes of the degradation of remaining native forests throughout Hawaiʻi (USFWS 2016, p. 36). The invasion of low- and middle-elevation Hawaiian forests throughout the main Hawaiian islands by introduced *Psidium cattleyanum* (strawberry guava) and *Falcataria moluccana* (albizia) trees in the last century has converted large areas of remaining low- and mid-elevation ʻōhiʻa forests on all of the main Hawaiian islands to forests dominated by nonnative species (USFWS 2016, p. 42). Further, ʻōhiʻa trees are affected throughout their range by several diseases (e.g., ʻōhiʻa rust and Rapid ʻŌhiʻa Death, ROD) as well as ʻōhiʻa dieback, which is ʻōhiʻa tree death over a period of months or years over large forest areas, possibly related to groups of similar aged ʻōhiʻa trees reaching senescence at same time (Mueller-Dombois 1986). These impacts, together with wildfire, drought, invasive species, and climate change, likely have synergistic negative effects on ʻōhiʻa forests (USFWS 2016, p. 23). Localized drought impacts ʻōhiʻa trees, particularly those growing in less than optimal soil or at the margins of their precipitation tolerance (USFWS 2016, p. 34).

Factor B (Overutilization for commercial, recreational, scientific, or educational purposes)
Overutilization is not known to be a threat to ʻiʻiwi.

Factor C (Disease and Predation)
Disease
ʻIʻiwi, like most Hawaiian honeycreepers, have been greatly affected by introduced diseases, including avian malaria and poxvirus (*Poxvirus* spp.) (Atkinson et al. 1995, entire; USFWS 2016, pp. 44–56). ʻIʻiwi show acute mortality when infected by malaria, and the only disease-free habitats are now limited to high-elevation forests where ambient temperature is low enough to inhibit the reproduction of mosquitoes (*Culex quinquefasciatus*) that transmit the malaria parasite that causes the disease (Atkinson et. al. 1995; LaPointe et al. 2012, p. 217; Liao et al. 2015, p. 4346; Samuel et al. 2015, p. 14). Although research specific to ʻiʻiwi is limited, infection with avian pox, another mosquito-borne disease, can also result in high levels of mortality in native Hawaiian forest birds (Van Riper et al. 2002, pp. 929–942). Seasonal downslope movement of

ʻiʻiwi in pursuit of flowering ʻōhiʻa continually exposes the species to mosquito-borne diseases (Hart et al. 2011, pp. 121–122).

Based on several climate change models projecting future increased temperatures, research indicates that risk to ʻiʻiwi from avian diseases will increase as increasing temperatures allow *Culex* mosquitoes to persist at ever higher elevations (Benning et al. 2002; Fortini et al. 2015, pp. 9–10; Liao et al. 2015, p. 4347). This risk is particularly immediate on Kauaʻi, a lower-elevation island where ʻiʻiwi populations are in steep decline (Paxton et al. 2013, p. 13; Paxton et al. 2016, p. 2; Paxton et al. 2020, p. 8) and mosquitoes are now present at all elevations (Glad and Crampton 2015, entire).

Predation

Three species of nonnative rats occur in Hawaiʻi (Atkinson 1977, pp. 109 and 118; Tomich 1986, pp. 39–40; 41–42). The black rat (*Rattus rattus*) is the most common in wet and mesic forests (Lindsey et al. 1999, p. 100), and because of its arboreal habits is considered the most significant predator on forest birds (Atkinson 1977, pp. 118 and 122; Tomich 1986, p. 39). Predation of eggs, nestlings, and incubating adults by nonnative rats is known to significantly affect several species of Hawaiian forest birds with some evidence of impact to the ʻiʻiwi (USFWS 2016, pp. 56–57). Based on a study at the Hakalau Forest National Wildlife Refuge (NWR), rat control can contribute to a greater number of ʻiʻiwi fledglings (Lindsey et al. 2009, pp. 280–282). Similar results were documented for the Hawaiʻi ʻelepaio (*Chasiempis sandwichensis*) and ʻapapane (*Himatione sanguinea*) for the same study. Feral cats (*Felis catus*) are a known predator of many Hawaiian bird species but are not known to prey on ʻiʻiwi, although they occur and prey on other forest birds in areas where ʻiʻiwi occur. ʻIʻiwi nests, typically placed high in the terminal branches of ʻōhiʻa trees, are not likely to be accessible to cats (USFWS 2016, p. 57). Hawaiian hawk or ʻio (*Buteo solitarius*) is known to prey on Hawaiian forest birds, although there are no reported instances of ʻio preying specifically on ʻiʻiwi (Griffin 1985, p. 142).

Factor D (Inadequacy of existing regulatory mechanisms)

Loss of habitat and introduction of harmful nonnative species is an ongoing threat due to inadequacy of existing regulatory mechanisms. Existing State and Federal regulatory mechanisms are not preventing the introduction of nonnative species into Hawaiʻi or effectively controlling the spread of nonnative species between islands and watersheds (Howarth and Medeiros 1989, entire; Staples and Cowie 2001, entire).

Factor E (Other natural or manmade factors affecting its continued existence)

Anomalous increases in sea surface temperatures, such as El Niño-Southern Oscillation (ENSO), have increased in frequency as a consequence of warming of ocean temperatures, contributing to increased tropical cyclone activity around Hawaiʻi (Chu and Wang 1997, p. 2683; Smith and Reynolds 2004, p. 2,466; Murakami et al. 2013, p. 749). Severe storms can result in defoliation and death of

ʻōhiʻa and other native trees over broad areas (Harrington et al. 1997, pp. 539–540). Temporary loss of nectar resources as the result of strong winds from hurricanes has been shown to have negative population effects on nectarivorous island birds (Waide 1991, p. 475; Wiley and Wunderle, Jr. 1993, p. 319). Prolonged periods of rain or high winds have resulted in nest failure and reduction in daily survival rate for nests of Hawaiian forest birds (USFWS 2016, p. 77; Cummins et al. 2014, p. 17).

Competition between introduced insects, birds, and small mammals is possible, but not well-documented historically (Lindsey et al. 2009, pp. 286– 287). Introduced bird and insect species potentially could compete with ʻiʻiwi for nectar from ʻōhiʻa flowers (the ʻiʻiwi's primary food source), or by consuming insects that ʻiʻiwi use as a secondary food source (USFWS 2016, p. 59). Researchers first began suggesting in the 1980s that ʻiʻiwi may face competition from the nonnative warbling white-eye (*Zosterops japonicus*) (Mountainspring and Scott 1985, p. 219), a malaria-resistant nonnative bird species, whose numbers have dramatically increased throughout the Hawaiian Islands, particularly since the 1970s (Foster et al. 2004, p. 716). Negative correlations between ʻiʻiwi and warbling white-eye densities may correlate with competition between the species for limited nectar resources (Fancy and Ralph 1998, p. 7). Niche overlap between ʻiʻiwi and the warbling white-eye, in combination with parasitism by chewing lice (Phthiraptera (Insecta)), have been proposed as causes for reduced fitness in ʻiʻiwi at Hakalau Forest NWR (Freed et al. 2008, pp. 1009-1018; Freed and Cann 2014, p. 1).

Pertaining to competition for insect food resources, the most likely competitor in some ʻiʻiwi populations is the introduced yellowjacket wasp (*Vespula pensylvanica*). This insect is widely recognized for its indirect impacts to native forests including predation upon a variety of native insects including many pollinator species (Foote et al. 2011, pp. 6–7; Hanna et al. 2012, p. 1). The wasps shift to become voracious feeders of nectar following seasonal changes in colony nutritional needs, and the species is even documented to impact ʻōhiʻa fruit set due to its effective disruption of ʻōhiʻa pollination ecology (Hanna et al. 2014, p. 1622).

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:
The ʻiʻwi is an Hawaiian forest bird in the endemic honeycreeper subfamily of the Fringillidae (finch family). It is found primarily in closed canopy, tall stature montane wet or montane mesic forests, dominated by native ʻōhiʻa trees or both ʻōhiʻa and koa (*Acacia koa*) trees. ʻIʻiwi are nectarivorus and feed primarily on flowering ʻōhiʻa; ʻōhiʻa trees are also used for nesting. ʻIʻiwi however are found to use forests of ʻōhiʻa and introduced flowering trees, such as in Kula, east Maui. The species is also found in high elevation māmane (*Sophora chrysophylla*)/naio

(*Myoporum sandwicense*) forests on the island of Hawai‘i. Annual survival is approximately 55 percent for adults and 9 percent for juveniles, but because of low detection probability, longevity in the wild is unknown (Fancy and Ralph 1998, p. 9). ‘I‘iwi move several miles seasonally in search of large forest patches of asynchronous flowering trees or shrubs on windward Hawai‘i Island (Guillaumet et al. 2017, p. 1). These movements are between higher elevation areas and lower elevation, and when ‘i‘iwi are at lower elevations foraging for food they are at greater risk of exposure to avian diseases.

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:
Although historical abundance estimates are not available, the ‘i‘iwi was considered one of the most common of the native forest birds in Hawai‘i by early naturalists, described as “ubiquitous” and found from sea level to the tree line across all the major islands. In the late 1800s, ‘i‘iwi began to disappear from low elevation forests, and by the mid-1900s, the species was largely absent from sea level to mid-elevation forests. ‘I‘iwi have declined to extremely low numbers in recent decades on Moloka‘i and O‘ahu and have experienced a population reduction of 92 percent over 25 years on Kaua‘i (Paxton et al. 2013, p. 1; Paxton et al. 2016, pp. 2, 10; Paxton et al. 2020, p. 6). Trends on Maui are mixed, but populations generally appear to be in decline. East Maui supports an estimated population of 50,252 individuals in 2 populations (Judge et al. 2019, p. 34), while west Maui supports only a few hundred individuals (Paxton et al. 2013, p. 18). The island of Hawai‘i supports the largest remaining number of ‘i‘iwi at an estimated average of 543,009 individuals (range 516,312 to 569,706). Of the nine ‘i‘iwi population regions described in Paxton et al. 2013 (p. 10) for Kaua‘i, Maui and Hawai‘i islands, which sufficient information available for quantitative inference, five regions showed strong or very strong evidence of declining populations; one a stable to declining population; one stable to increasing population; and two strong evidence for increasing populations. However, trends for increasing regional populations on Hawa‘i Island are based on a limited number of population surveys. Four of the nine regions on Kaua‘i, Maui, and Hawai‘i show evidence of range contraction (Paxton et al. 2013, pp. 1, 10–11). Recent information for Kohala region on Hawa‘i Island (not evaluated in Paxton et al. 2013), shows a remarkable increase in ‘i‘iwi population, from 690 to 4928 birds, or 714 percent increase, from 1979-2017 (Burnett et al. 2021, p. 382), though the area over which the species occurred shrank.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):
Little information is available. The continued persistence of a small population of ‘i‘iwi on west Maui and the rapid increase of the ‘i‘iwi population in the Kohala region of Hawai‘i Island, both regions with highest elevation of under 5,800 feet, suggest there may be development of disease resistance in these populations (USFWS 2016, p. 62). Alternatively, persistence of ‘i‘iwi in the west Maui mountains and population increase in the Kohala mountains may be related to

environmental conditions or management actions that limit numbers of mosquitoes in these areas.

2.3.1.4 Taxonomic classification or changes in nomenclature: N/A

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.):
ʻIʻiwi population trends vary across the islands. The population on Kauaʻi is in steep decline (Paxton et al. 2013, p. 1; Paxton et al. 2016, pp. 2, 10; Paxton et al. 2020, p. 6). Trends on Maui are mixed but generally appear to be in decline (Paxton et al. 2013). On the island of Hawaiʻi, there is evidence for stable or declining populations on the windward side of the island. Apparent trends of increase have been documented on the leeward (Kona) side of Hawaiʻi Island however these trends were inferred from a limited data set. Overall, based on the most recent surveys (up to 2012), approximately 90 percent of remaining ʻiʻiwi are restricted to a narrow band of habitat between elevations of roughly 4,265 and 6,234 feet (ft) (1,300 and 1,900 meters (m)) (Paxton et al. 2013).

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):
The estimated loss of ʻiʻiwi habitat, defined as native ʻōhiʻa forest, from time of first human occupation of the Hawaiian Islands, ranges from 52 percent on the island of Hawaiʻi to 85 percent on Oʻahu (Mountainspring 1986, p. 98). Remaining high elevation habitat is in various condition. Habitat in conservation management areas that are protected from feral ungulates by exclusion fencing and ungulates are dominated by overstory of ʻōhiʻa and koa and understory of native shrubs and ferns. However, these areas are impacted by ROD, with many trees dead in some areas.

Areas that are unfenced or recovering forest after history of cattle grazing provide habitat for ʻiʻiwi, including ohia for foraging and nesting, however, lack abundance of nectar because fewer ʻōhiʻa trees and vulnerable to degradation by introduced invasive plants.

2.3.1.7 Other:
The primary stressor for ʻiʻiwi and driver of the species threatened status, continuing population decline, and range contraction is avian disease. Avian disease is discussed below under **2.3.2.3 Disease or predation**.

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:

‘I‘iwi depend on areas of intact native ‘ōhi‘a forest for foraging and nesting, and are typically found at high elevations in native ‘ōhi‘a and mixed ‘ōhi‘a /koa forests. ‘I‘iwi, however, use some areas of native forest with introduced trees, as in Kula, east Maui, and high elevation māmane/naio forest. The invasion of low- and middle-elevation Hawaiian forests throughout the main Hawaiian islands by introduced strawberry guava and albizia trees in the last century has converted large areas of low- and mid-elevation ‘ōhi‘a forests to forests dominated by nonnative species, that do not provide abundance of nectar resources. With climate change strawberry guava continues to invade higher elevation ‘ōhi‘a forest. ‘Ōhi‘a trees are affected by several diseases (e.g., ‘ōhi‘a rust and Rapid ‘Ōhi‘a Death, ROD) as well as ‘ōhi‘a dieback. These impacts, together with wildfire, drought, invasive species, and climate change, likely have synergistic negative effects on ‘ōhi‘a forests as ‘i‘iwi habitat. Localized drought impacts ‘ōhi‘a trees, particularly those growing in less than optimal soil or at the margins of their precipitation tolerance (USFWS 2016, p. 34).

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

Overutilization is not known to be a threat to ‘i‘iwi.

2.3.2.3 Disease or predation:

Disease

As described in the ‘I‘iwi Status Report (USFWS 2016), the best scientific data available consistently identifies introduced mosquito-borne avian diseases, including avian malaria and avian pox, as the primary stressors driving the declines in abundance and distribution of ‘i‘iwi observed since the turn of the 20th century. Avian malaria is a disease caused by a blood parasite and avian pox is caused by a virus; both are transmitted by the bite of the nonnative mosquito *Culex quinquefasciatus,* and both have serious impacts on native forest birds, including ‘i‘iwi. The two diseases often co-occur, and although avian malaria has received greater study, avian pox is likely also an important factor in ‘i‘iwi declines based on field observations and limited experimental studies in other native forest birds. ‘I‘iwi exhibit an extremely high mortality rate in response to avian malaria (95 percent) and are absent at low elevations where malaria is prevalent, despite the availability of otherwise suitable habitat. Both the life cycle of the mosquito vector and the development and transmission of the malaria parasite are temperature-limited; neither can be completed at cool temperatures, which prevail at high elevations. ‘I‘iwi are now found primarily in high elevation forests above 4,000 ft (1,219 m) that provide areas with fewer mosquitoes and malaria prevalence and transmission is only brief and episodic. ‘I‘iwi has not demonstrated any sign of developing resistance to avian malaria to date. Although there has been less research on the effects of avian pox virus, the limited results to date suggest it may also be a source of significant mortality (USFWS 2016, p 37). The fact that avian malaria and avian pox often infect the same individual simultaneously complicates the ability to discern the effects of each disease, as the two diseases may be acting both individually and synergistically.

Predation
There are three species of nonnative rats that occur in Hawai‘i. The black rat is the most common in wet and mesic forests, and because of its arboreal habits is considered the most significant predator on forest birds, including ‘i‘iwi. Feral cats are a known predator of many Hawaiian bird species but are not known to prey on ‘i‘iwi, although they occur and prey on other forest birds in areas where ‘i‘iwi occur, so it is possible. ‘I‘iwi nests, typically placed high in the terminal branches of ‘ōhi‘a trees, are not likely to be accessible to cats. ‘I‘iwi may be depredated by Hawaiian hawk or ‘io. Of 264 prey items from direct observations of adult ‘io delivering prey at nests, diet included 13 species of birds, including other species of Hawaiian honeycreepers, however, no ‘i‘iwi were identified as prey item (Griffin 1985, p. 142).

2.3.2.4 Inadequacy of existing regulatory mechanisms:
Loss of habitat and introduction of harmful nonnative species is an ongoing threat due to inadequacy of existing regulatory mechanisms. Existing State and Federal regulatory mechanisms are not preventing the introduction of nonnative species into Hawai‘i or effectively controlling the spread of nonnative species between islands and watersheds (Howarth and Medeiros 1989; Staples and Cowie 2001).

2.3.2.5 Other natural or manmade factors affecting its continued existence:
Climate change may also exacerbate other stressors to ‘i‘iwi. Changes in the amount and distribution of rainfall in Hawai‘i likely will affect the quality and extent of mesic and wet forests on which ‘i‘iwi depend. However, changes in the trade wind inversion (which strongly influences rainfall) and other aspects of precipitation with climate change are difficult to model with confidence. In addition, potential increases in storm frequency and intensity in Hawai‘i as a result of climate change may lead to an increase in direct mortality of individual ‘i‘iwi and a decline in the species’ reproductive success. Currently, no well-developed projections exist of these possible synergistic effects. Based on several climate change models projecting future increased temperatures, research indicates that risk to ‘i‘iwi from avian diseases will increase as increasing temperatures allow *Culex* mosquitoes to persist at ever higher elevations. This risk is particularly immediate on Kaua‘i, a lower-elevation island where ‘i‘iwi populations are in steep decline (Paxton et al. 2013, p. 13; Paxton et al. 2016, p. 2; Paxton et al. 2020, p. 8) and mosquitoes are now present at all elevations (Glad and Crampton 2015, entire).

2.4 Synthesis

The species, although still numerous on the island of Hawai‘i and east Maui, is in steep decline on Kaua‘i, is declining on east Maui, and some regional populations on the island of Hawai‘i also are declining. The species still occurs in a minimum of four viable populations on Kaua‘i, Maui, and Hawai‘i with at least two populations occurring on the island of Hawai‘i. Threats to the species have been identified, however, population surveys indicate the species is not stable and is declining in 5 of 10 regional populations. The primary threat, avian disease, is not sufficiently managed to prevent continuing population decline, and avian disease

threatens all regional populations on all islands. Therefore, ‘i‘iwi meets the definition of threatened as it remains in danger of becoming endangered throughout its range.

Table 1. Status of ‘i‘iwi from listing through current 5-year review.

Date	Estimated Number	Delisting Criteria identified in Recovery Plan	Downlisting Criteria Completed?
2017 (listing)	Unknown	None	N/A
2023 (5-year review)	543,009 on Hawai‘i (Paxton et al. 2013); 50,252 on East Maui (Judge et al. 2019); ~300 West Maui (Paxton et al. 2013); 1,855 on Kaua‘i (Paxton et al. 2020). Unknown O‘ahu and Moloka‘i.	The species occurs in a minimum of four viable populations on three or more islands with at least two occurring on the island of Hawai‘i, one on the windward side and one on the leeward side.	Yes, though population declines in some populations may lead to populations becoming non-viable.
		Either (a) surveys conducted at appropriate intervals indicate that the number of individuals in each population in Delisting criterion 1 is stable or increasing over a period of 25 years, or (b) demographic monitoring shows that each population exhibits intrinisc growth rate of no less than 1.0 over a period of 25 years.	No. Surveys are conducted in portions of the range of the species, but stability and time period criteria have not been met.
		Sufficient habitat is protected and managed for long-term persistence to achieve Delisting criteria 1 and 2.	Partially. Many areas are protected and partially managed, but threats remain in many areas including ungulates, ROD, and mosquitoes.

		Threats to the species have been identified and managed; monitoring of populations and threats is ongoing.	No. The most severe threats are currently unmanaged.

Table 2. Status of threats to ʻiʻiwi from listing through current 5-year review.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Small mammal predation	C	Ongoing	Partially. Some rodent control occurs within the range of ʻiʻiwi on Kauaʻi, Maui, and Hawaiʻi islands.
Avian malaria and avian pox	C, E	Ongoing	Yes – ongoing research, planned broad-scale mosquito control using the Incompatible Insect Technique (IIT)
Habitat loss from ungulates	A	Completed and Ongoing	Many upper elevation forests are fenced and protected, but habitat is still threatened, particularly on Kauaʻi and portions of leeward Hawaiʻi island.
Habitat loss from invasive plant species	A	Ongoing	Little landscape-control of strawberry guava occurs currently. Some invasive plant control occurs, but mostly below the current range of ʻiʻiwi.
Rapid ʻŌhiʻa Death	A, C	Ongoing	ROD threatens habitat on the island of Hawaiʻi in particular, but may also threaten habitat on other islands if it spreads further.
Climate change	A, E	Increasing	Mosquito control – planned broad -scale mosquito control using IIT. Habitat management – highest elevation forest areas protected from ungulates and still relatively free of avian disease
Competition	E	Unknown	Little information is available on the competition threat from introduced birds and invertebrates currently. No management is ongoing.

3.0 RESULTS

3.1 Recommended Classification: *Given your responses to previous sections, particularly section 2.4. Synthesis, make a recommendation with regard to the listing classification of the species*

____ Downlist to Threatened

____ **Uplist to Endangered**
____ **Delist** (Indicate reasons for delisting per 50 CFR 424.11):
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X__ **No change is needed**

3.2 New Recovery Priority Number *(indicate if no change; see Appendix E):* N/A
Brief Rationale:

3.3 Listing and Reclassification Priority Number*, if reclassification is recommended (see Appendix E)*
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

ʻIʻiwi populations on Oʻahu and Molokaʻi are very small (if they exist at all), and the threat of avian disease is so pervasive on these islands that restoration or recovery of ʻiʻiwi populations on Oʻahu and Molokaʻi is unlikely in the near future. However, ʻiʻiwi on the islands of Kauaʻi, Maui, and Hawaiʻi are sufficiently numerous and the area of suitable habitat is widely enough distributed to recover the species on Kauaʻi, Maui, and Hawaiʻi.

Avian Disease:
Avian disease is the primary cause for the disappearance of ʻiʻiwi from lowland ʻōhiʻa forests that otherwise provide suitable habitat and the primary reason for the species' range contraction to higher elevations. Research on methods to control mosquito vectors, and control of avian disease over wide areas is crucial for the species' recovery, particularly because of the expected continued upslope movement of mosquitoes that transmit avian disease due to climate change.

Mosquito breeding source control. To address the threat of avian disease, it is important to continue management of forest bird habitat to limit mosquito breeding sources (pools of standing water) created by feral ungulates. Feral ungulates root the soil and knock down and eat hāpuʻu (*Cibotium* spp.) tree ferns, creating ground pools and cavities in hapuʻu stems where water collects. Large portions of ʻiʻiwi habitat are already protected by ungulate fencing, however, construction of additional ungulate-proof fencing is needed, and maintenance in perpetuity of existing fencing will be necessary, throughout all areas ʻiʻiwi currently inhabit. Mosquitoes have been observed to disperse up to 2 miles in rainforest in Hawaiʻi (LaPointe et al. 2009, p. 409). Thus, ungulate exclusion should be implemented at elevations below the lower elevation limit of the ʻiʻiwi's current range to reduce standing sources of water where mosquitoes breed and from which mosquitoes are transported by wind into upper elevations. Mosquitoes also breed in natural pools along stream sides. On Kauaʻi, because of climate change, it has been found that less frequent

storms, that scour streams less often, is providing enough time for mosquito larvae to develop in stream side pools, contributing to increased incidence of avian disease on Kauaʻi (USFWS 2016, p. 68). An experimental larval mosquito control program was conducted in Kawaikōī Stream of the Hono O Nā Pali NAR in 2016 and 2017, by the Kauaʻi Forest Bird Recovery Program (KFBRP) using *Bacillus thuringensis israelenis* (*Bti*), a bacterial larvicide, and was shown to be effective albeit with small sample sizes (LaPointe et al. 2021) at limiting mosquito reproduction in different water sources. In fall 2023, KFBRP plans to pilot aerial applications of *Bti* to expand the scope of this control. Treatment of mosquito larval habitat by hand with *Bti*, and aerial application of *Bti* over large areas are important methods to control mosquito reproduction wherever feasible.

Land-scape scale mosquito control. It is critical to support the development of landscape-scale tools for mosquito control. Substantial recent progress has been made in utilizing the bacterium *Wolbachia* in an Incompatible Insect Technique (IIT) for land-scape scale mosquito control, and long-term planning for additional mosquito control tool development is needed. IIT is a technique whereby an incompatible strain of endo-bacteria is injected into male mosquitoes rendering the mosquitoes sterile. Male mosquitoes with the incompatible *Wolbachia* strain are released on the landscape and breed with female mosquitoes, but eggs laid by female mosquitoes do not hatch. One significant limitation is that the technique is not self-sustaining. Sterile male mosquitoes need to be released regularly to breed with female mosquitoes. Although the tool has known limitations, *Wolbachia* IIT is very promising at addressing disease by reducing numbers of mosquitoes on the landscape and aiding in the expansion of local avian disease management efforts. Landscape-level mosquito control over approximately 60,000 acres using *Wolbachia* treated mosquitoes is planned for 2024 on Kauaʻi (HDLNR/USFWS 2023). A similar effort is being planned on east Maui (HALE 2022). If implemented and successful, mosquito control on Kauaʻi and east Maui will likely greatly benefit ʻiʻiwi and other Hawaiian forest birds on these islands in areas where *Wolbachia* treated mosquitoes are released.

Habitat management:
Control or eradication of significant habitat-modifying invasive plants (e.g., strawberry guava) is necessary to protect or restore the species' habitat. Research and development of new control tools should be considered for this and other ecosystem-modifying invasive plants. Impacts to forests from ROD and other diseases should be minimized by preventing disease spread, or restoring affected forests with alternative nectar resources for ʻiʻiwi. Ungulate exclusion and removal will also likely help limit the spread of ROD, as it is thought ʻōhiʻa trees damaged by feral ungulate rubbing may be more likely to become infected with the disease (Friday and Mokiao-Lee 2022). Management actions will be needed to reduce the likelihood of fire and the need for fire management plans should be assessed for habitats affected by drought and the drying effects of climate change. Habitat management actions should include control or eradication of significant habitat-modifying invasive plants, ungulate removal and construction of exclusion fencing to protect habitat areas ʻiʻiwi depend upon, reduction of the spread of rapid ʻōhiʻa death and other plant pathogens, and habitat restoration to encourage multiple types of

native flowering plants. These management actions will result in the enhancement of ‘i‘iwi breeding and foraging areas.

Stochastic events:
To minimize the effects of stochastic events such as hurricanes, floods, and landslides on regional and island-wide ‘i‘iwi populations, ‘i‘iwi need to be represented by resilient populations distributed throughout their range. These island-wide and regional populations should include all remaining species’ genetic diversity.

Genetic studies:
The continued persistence of a small population of ‘i‘iwi on west Maui and the rapid increase of the ‘i‘iwi population in the Kohala region of Hawai‘i Island, both regions with highest elevation of under 5,800 feet, suggest development of disease resistance in ‘i‘iwi may be occurring for these regional populations (USFWS 2016, p. 62). Genetic studies of regional ‘i‘iwi populations are needed to determine if ‘i‘iwi are developing disease resistance.

Conservation breeding:
Should wild populations continue to decline, recovery of ‘i‘iwi may require captive propagation to provide a source of birds for reintroduction once the disease threat that is driving population declines has been addressed.

Predator control:
Predator control for rats and/or other potential predators may be necessary in some areas.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of ʻIʻiwi
(Drepanis coccinea)

Current Classification: Threatened

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X__ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By:
Jay Nelson, Fish and Wildlife Biologist, PIFWO
John Vetter, Animal Recovery Coordinator, PIFWO
Lauren Weisenberger, Acting Recovery Program Manager

for **FIELD OFFICE APPROVAL**:
LAUREN WEISENBERGER Digitally signed by LAUREN WEISENBERGER Date: 2023.08.24 09:44:41 -10'00' Date _____
Lead Field Supervisor, Fish and Wildlife Service