

**DEPARTMENT OF THE INTERIOR****Fish and Wildlife Service****50 CFR Part 17**

[Docket No. FWS-R1-ES-2016-0057; 4500030113]

RIN 1018-BB54

**Endangered and Threatened Wildlife and Plants; Threatened Species Status for the Iiwi (*Drepanis coccinea*)****AGENCY:** Fish and Wildlife Service, Interior.**ACTION:** Final rule.

**SUMMARY:** We, the U.S. Fish and Wildlife Service (Service), determine threatened status under the Endangered Species Act of 1973, as amended (Act), for the Iiwi (*Drepanis coccinea*), a bird species from the Hawaiian Islands. The effect of this regulation is to add this species to the Federal List of Endangered and Threatened Wildlife.

**DATES:** This rule becomes effective October 20, 2017.

**ADDRESSES:** This final rule is available on the internet at <http://www.regulations.gov> and <http://www.fws.gov/pacificislands>. Comments and materials we received, as well as supporting documentation we used in preparing this rule, such as the species status report, are available for public inspection at <http://www.regulations.gov>. Comments, materials, and documentation that we considered in this rulemaking will be available by appointment, during normal business hours at: U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, 300 Ala Moana Boulevard, Room 3-122, Honolulu, HI 96850; by telephone at 808-792-9400; or by facsimile at 808-792-9581.

**FOR FURTHER INFORMATION CONTACT:** Mary Abrams, Field Supervisor, Pacific Islands Fish and Wildlife Office, 300 Ala Moana Boulevard, Room 3-122, Honolulu, HI 96850; by telephone (808-792-9400); or by facsimile (808-792-9581). Persons who use a telecommunications device for the deaf (TDD) may call the Federal Relay Service (FIRS) at 800-877-8339.

**SUPPLEMENTARY INFORMATION:****Executive Summary**

*Why we need to publish a rule.* Under the Endangered Species Act, 16 U.S.C. 1531 *et seq.*, a species or subspecies may warrant protection through listing if it is endangered or threatened throughout all or a significant portion of its range. Critical habitat shall be designated, to the maximum extent

prudent and determinable, for any species determined to be an endangered or threatened species under the Act.

This rule finalizes the listing of the Iiwi (*Drepanis coccinea*) as threatened under the Act because of current and future threats, and listing can only be done by issuing a rule. The Iiwi no longer occurs across much of its historical range, and faces a variety of threats in the form of diseases and impacts to its remaining habitat.

Delineation of critical habitat requires, within the geographical area occupied by the species, identification of the physical or biological features essential to the species' conservation. A careful assessment of the biological needs of the species and the areas that may have the physical or biological features essential for the conservation of the species and that may require special management considerations or protections, and thus qualify for designation as critical habitat, is particularly complicated in this case by the ongoing and projected effects of climate change and will require a thorough assessment. We require additional time to analyze the best available scientific data in order to identify specific areas appropriate for critical habitat designation and to analyze the impacts of designating such areas as critical habitat. Accordingly, we find designation of critical habitat for the Iiwi to be "not determinable" at this time.

*What this document does.* This document lists the Iiwi as a threatened species. We previously published a 90-day finding and a 12-month finding and proposed listing rule for the Iiwi. Those documents assessed all available information regarding status of and threats to the Iiwi.

*The basis for our action.* Under the Act, we can determine that a species is an endangered or threatened species based on any of five factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) Overutilization for commercial, recreational, scientific, or educational purposes; (C) Disease or predation; (D) The inadequacy of existing regulatory mechanisms; or (E) Other natural or manmade factors affecting its continued existence. We have determined that the primary threats to the Iiwi are its susceptibility to avian malaria (Factor C) and the expected reduction in disease-free habitat as a result of increased temperatures caused by climate change (Factor E). Although not identified as primary threat factors, rapid ohia death, a fungal disease that kills the tree species required by Iiwi for nesting and

foraging, and impacts from nonnative invasive plants and feral ungulates, contribute to the degradation and curtailment of the Iiwi's remaining, disease-free native ohia forest habitat, exacerbating threats to the species' viability.

*Peer review and public comment.* We sought comments on our proposal from eight independent specialists to ensure that our designation is based on scientifically sound data, assumptions, and analyses. We also considered all comments and information received during the public comment period.

A species status report for the Iiwi was prepared by a team of Service biologists, with the assistance of scientists from the U.S. Geological Survey's (USGS) Pacific Islands Ecosystems Research Center and the Service's Pacific Islands Climate Change Cooperative. We also obtained review and input from experts familiar with avian malaria and avian genetics. The species status report represents a compilation of the best scientific and commercial data available concerning the status of the species, including the past, present, and future threats to the Iiwi. The final species status report, revised in response to peer reviewer comments, and other materials relating to this proposal can be found at <http://www.regulations.gov>, at Docket No. FWS-R1-ES-2016-0057, or by contacting the Pacific Islands Fish and Wildlife Office (see **FOR FURTHER INFORMATION CONTACT**).

**Background***Previous Federal Actions*

Please refer to the proposed listing rule, published in the **Federal Register** on September 20, 2016 (81 FR 64414), for previous Federal actions for this species prior to that date. The publication of the proposed listing rule opened a 60-day public comment period that closed on November 21, 2016. We published a public notice of the proposed rule on September 19, 2016. This notice was picked up and published by several local media outlets including the State's largest newspaper, the Honolulu Star Advertiser, as well as the Garden Island Newspaper, Honolulu Civil Beat, and Hawaii News Now.

*Summary of Comments and Recommendations*

We solicited comments during the 60-day public comment period from September 20, to November 21, 2016 (81 FR 64414). We contacted appropriate Federal and State agencies, scientific experts and organizations, and other interested parties and invited them to

comment on the proposal. Notices inviting public comment also were published in four major news outlets in the State. During the comment period, we received a total of nine letters from members of the public. We did not receive any requests for a public hearing. In this final rule, we address only those comments directly relevant to the listing of the iiwi. All nine letters were from individual members of the public. We did not receive any comments from the State of Hawaii.

#### Public Comments

Of the nine comment letters we received from members of the public, eight expressed general support for our listing the iiwi under the Act, and one commented on a topic unrelated to our proposed rule. None of these letters provided new, substantive information or comments requiring specific response here.

#### Peer Review

In accordance with our peer review policy published on July 1, 1994 (59 FR 34270), we solicited expert opinions from eight individuals with scientific expertise on the iiwi and its habitat, biological needs, and threats, including familiarity with the geographic region where the iiwi occurs, and principles of conservation biology. We received responses from all eight of these individuals.

In general, all of the peer reviewers agreed that the draft Species Status Report and proposed rule provided an accurate synthesis of the life history of the iiwi and robust analysis of the stressors affecting the species. They further agreed that our conclusions regarding the status of the species were reasonable and scientifically sound. We reviewed all comments received from the peer reviewers for substantive issues and new information regarding the listing of iiwi. Where appropriate, we have incorporated corrections, editorial suggestions, and new literature and other information they provided into both the final species report and final rule. Any substantive comments are discussed below (see also Summary of Changes from Proposed Rule). All of the peer reviews were constructive and thorough; we thank the peer reviewers for their thoughtful assistance.

*Comment (1):* Two of the peer reviews suggested that we had not sufficiently emphasized the potential importance of avian pox as a threat to the iiwi. Specifically, the reviewers noted that the literature on mosquito-borne diseases affecting native Hawaiian forest birds tends to be focused more on avian malaria due, in part, to the knowledge

gaps about the impacts of avian pox and the lack of an accurate, noninvasive diagnostic test for identifying acute active infections and birds that have recovered from infection. The reviewers point out that the two diseases may be acting both individually and synergistically when infections are simultaneous. Although avian malaria has been more thoroughly studied, the peer reviewers felt that the available evidence suggests avian pox may also be a significant source of mortality and pose a greater threat to the iiwi than would be suggested by our analysis.

*Our Response:* Although our draft Species Status Report pointed to the difficulty in untangling the relationship between the two diseases because of their frequent occurrence together, we agree with the reviewers that we placed more emphasis on the threat posed by avian malaria, in part simply due to the greater amount of scientific information available that clearly links high levels of mortality in iiwi directly to infection with malaria. In our final Species Status Report and this final rule, we have increased emphasis on the possibility that avian pox, both alone and in combination with avian malaria, may have negative, population-level impacts on iiwi.

*Comment (2):* One reviewer suggested that the “estimate” of 50 birds on Oahu reported in the draft Species Status Report is unrealistically high and not based on scientific data; the reviewer stated that based on observations of occasional single birds over the past 15 years, the population is probably much less than 50, perhaps 10 at the most. Likewise for Molokai, the reviewer pointed out that the estimated number of birds from the 1980s is no longer accurate, and there are many fewer than 80 birds on that island.

*Our Response:* We thank the reviewer for his comments, and have made the corrections as needed in the final Species Status Report. Because the proposed rule did not refer to specific numbers of birds, no associated changes were required in this final rule.

*Comment (3):* Two peer reviewers provided updated information regarding the impacts and extent of various diseases affecting ohia trees, especially rapid ohia death (also known as ohia wilt, caused by fungi in the genus *Ceratocystis*).

*Our Response:* We have incorporated these changes into the final Species Status Report and final rule, as appropriate. In particular, we have updated the estimated area infected with rapid ohia death on Hawaii Island to more than 50,000 acres (20,235 hectares) (Hughes 2016, pers. comm.).

*Comment (4):* One peer reviewer pointed out that, although Paxton *et al.* (2013) stated that the iiwi population on the leeward (Kona) side of Hawaii Island is strongly increasing, they couched those specific results as the inference from a limited dataset. The reviewer suggested that it was important for us to provide a similar caveat with regard to this reported trend in our final Species Status Report and final rule.

*Our Response:* We agree that this point provides important context for the interpretation of this reported trend, and have provided additional language in the final Species Status Report and in this final rule to more accurately mirror the reported results of Paxton *et al.* 2013.

*Comment (5):* One peer reviewer suggested that, although it is true that the effects of predation have not been well documented or quantified for the iiwi, there is substantial evidence that predation by nonnative rats, particularly the black rat (*Rattus rattus*), is a serious threat to other Hawaiian forest birds. Although the reviewer acknowledges that predation is difficult to detect and document, particularly in species like the iiwi that nest high in the forest canopy, he believes the available evidence suggests predation by rats is likely also a contributing factor in the decline of the iiwi.

*Our Response:* We have incorporated additional discussion of the potential impacts of rat predation on the iiwi in this final rule.

*Comment (6):* Two peer reviewers suggested that we consider the findings of Paxton *et al.* (2016) in a paper published subsequent to the writing of our draft Species Status Report.

*Our Response:* We have incorporated the results of Paxton *et al.* 2016 into our final Species Status Report and this final rule. This research documents the rapid collapse of the native avian community on the island of Kauai since 2000 as a result of the impacts of mosquito-borne diseases exacerbated by increased ambient temperature. In particular, the projections of Paxton *et al.* (2016) point to the likely extirpation of the iiwi from the island of Kauai by the year 2050 as a consequence of the loss of disease-free habitat on Kauai and consequent exposure to avian malaria and pox. We also updated the reported numbers and range of iiwi on Kauai with the more recent estimates from Paxton *et al.* (2016).

#### Summary of Changes From Proposed Rule

After consideration of the comments we received during the public comment period and new information published

or obtained since the proposed rule was published, we have made some changes to the final rule. None of these changes affect the determination. We made many small, nonsubstantive changes and corrections (e.g., updating the Background section in response to comments, minor clarifications, and editorial changes) throughout the document. In addition, we made some substantive changes to the information in this final rule in response to peer review, which are summarized here:

(1) We have elevated the identification of avian pox as a potentially important factor contributing to the decline of iiwi in response to mosquito-borne diseases, in addition to the effects of avian malaria;

(2) We have made a more definitive statement about the likely negative effects of rat predation on iiwi (VanderWerf 2016, pers. comm.);

(3) We updated the amount of area on Hawaii Island that is now estimated to be affected by rapid ohia death, which has now increased to more than 50,000 acres (20,235 hectares) (Hughes 2016, pers. comm.);

(4) We have updated our discussion of both the documented and projected declines of native forest birds on the island of Kauai to reflect the recently published work of Paxton *et al.* (2016), which projects the potential extirpation of iiwi from that island by the year 2050 as a consequence of warming temperatures and associated exposure to mosquito-borne diseases.

#### Status Assessment for the Iiwi

A thorough review of the taxonomy, life history, and ecology of the iiwi (*Drepanis coccinea*) is presented in the Iiwi (*Drepanis coccinea*) Species Status Report, available online at <http://www.regulations.gov> under Docket No. FWS-R1-ES-2016-0057. The species status report documents the results of our comprehensive biological status review for the iiwi, including an assessment of the potential stressors to the species. The species status report does not represent a decision by the Service on whether the iiwi should be listed as a threatened or endangered species under the Act; that decision involves the application of standards within the Act and its implementing regulations and policies. The species report does, however, provide the scientific basis that informs our regulatory decision. We have revised the report in response to comments from peer reviewers, who provided new information, additional references, and minor corrections. None of these changes substantively altered the conclusions we drew from the available

information or changed the outcome of our assessment. The following is a summary of the key results and conclusions from the species status report.

#### Summary of Biological Status

A medium-sized forest bird notable for its iconic bright red feathers, black wings and tail, and a long, curved bill (Fancy and Ralph 1998, p. 2), the iiwi belongs to the family Fringillidae and the endemic Hawaiian honeycreeper subfamily, Drepanidinae (Pratt *et al.* 2009, pp. 114, 122). Iiwi songs are complex with variable creaks (often described as sounding like a “rusty hinge”), whistles, or gurgling sounds, and they sometimes mimic other birds (Fancy and Ralph 1998, p. 5; Hawaii Audubon Society 2011, p. 97). The species is found primarily in closed canopy, montane wet or montane mesic forests composed of tall stature ohia (*Metrosideros polymorpha*) trees or ohia and koa (*Acacia koa*) tree mixed forest. The iiwi’s diet consists primarily of nectar from the flowers of ohia and mamane (*Sophora chrysophylla*), various plants in the lobelia (*Campanulaceae*) family (Pratt *et al.* 2009, p. 193), and occasionally, insects and spiders (Fancy and Ralph 1998, pp. 4–5; Pratt *et al.* 2009, p. 193).

Although iiwi may breed anytime between October and August (Fancy and Ralph 1998, p. 7–8), the main breeding season occurs between February and June, which coincides with peak flowering of ohia (Fancy and Ralph 1997, p. 2). Iiwi create cup-shaped nests typically within the upper canopy of ohia (Fancy and Ralph 1998, p. 7–8), and breeding pairs defend a small area around the nest and disperse after the breeding season (Fancy and Ralph 1997, p. 2). An iiwi clutch typically consists of two eggs, with a breeding pair raising one to two broods per year (Fancy and Ralph 1998, p. 7–8).

Well known for their seasonal movements in response to the availability of flowering ohia and mamane, iiwi are strong fliers that move long distances following their breeding season to locate nectar sources (Fancy and Ralph 1998, p. 3; Kuntz 2008, p. 1; Guillaumet *et al.* 2016, p. 192). The iiwi’s seasonal movement to lower elevation areas in search of nectar sources is an important factor in the exposure of the species to avian diseases, particularly malaria (discussed below).

Although historical abundance estimates are not available, the iiwi was considered one of the most common of the native forest birds in Hawaii by early naturalists, described as “ubiquitous” and found from sea level

to the tree line across all the major islands (Banko 1981, pp. 1–2). Today the iiwi is no longer found on Lanai, and only a few individuals may be found on Oahu, Molokai, and west Maui. Remaining populations of iiwi are largely restricted to forests above approximately 3,937 feet (ft) (1,200 meters (m)) in elevation on Hawaii Island (Big Island), east Maui, and Kauai. As described below, the present distribution of iiwi corresponds with areas that are above the elevation at which the transmission of avian malaria readily occurs (“disease-free” habitats). The current abundance of iiwi rangewide is estimated at a mean of 605,418 individuals (range 550,972 to 659,864). Ninety percent of all iiwi now occur on Hawaii Island, followed by east Maui (about 10 percent), and Kauai (less than 1 percent) (Paxton *et al.* 2013, p. 10; Paxton *et al.* 2016, p. 2).

Iiwi population trends and abundance vary across the islands. The population on Kauai appears to be in steep decline, with a modeled rate of decrease equivalent to a 92 percent reduction in population over a 25-year period (Paxton *et al.* 2013, p. 10); the total population on Kauai is estimated at a mean of 2,603 birds (range 1,789 to 3,520) (Paxton *et al.* 2016, p. 2). Trends on Maui are mixed, but populations there generally appear to be in decline; East Maui supports an estimated population of 59,859 individuals (range 54,569 to 65,148) (Paxton *et al.* 2013, p. 10). On Hawaii Island, which supports the largest remaining numbers of iiwi at an estimated average of 543,009 individuals (range 516,312 to 569,706), evidence exists for stable or declining populations on the windward side of the island. Strong trends of increase are inferred on the leeward (Kona) side of the island, but these trends should be interpreted with caution because they are based on a limited number of surveys (Paxton *et al.* 2013, pp. 25–26; Camp 2016, pers. comm.). As noted above, iiwi have been extirpated from Lanai, and only a few individual birds have been sporadically detected on the islands of Oahu, Molokai, and on west Maui in recent decades. Of the nine iiwi population regions for which sufficient information is available for quantitative inference, five of those show strong or very strong evidence of declining populations; one, a stable to declining population; one, a stable to increasing population; and two, strong evidence for increasing populations. Four of the nine regions show evidence of range contraction. Overall, based on the most recent surveys (up to 2012), approximately 90 percent of remaining

iiwi are restricted to forest within a narrow band between 4,265 and 6,234 ft (1,300 and 1,900 m) in elevation (Paxton *et al.* 2013, pp. 1, 10–11, and Figure 1) (See the Population Status section of the species status report for details).

#### Summary of Factors Affecting the Species

The Act directs us to determine whether any species is an endangered species or a threatened species because of any of five various factors affecting its continued existence. Our species status report evaluated many potential stressors to iiwi, particularly direct impacts on the species from introduced diseases, as well as predation by introduced mammals, competition with nonnative birds, climate change, ectoparasites, and the effects of small population size. We also assessed stressors that may affect the extent or quality of the iiwi's required ohia forest habitat, including ohia dieback (a natural phenomenon), ohia rust (a nonnative pathogen), drought, fires, volcanic eruptions, climate change, and particularly rapid ohia death (ROD, also known as ohia wilt; a nonnative pathogen) and habitat alteration by nonnative plants and feral ungulates.

All species experience stressors; we consider a stressor to rise to the level of a threat to the species if the magnitude of the stressor is such that it places the current or future viability of the species at risk. In considering what stressors or factors might constitute threats to a species, we must look beyond the exposure of the species to a particular stressor to evaluate whether the species may respond to that stressor in a way that causes impacts to the species now or is likely to cause impacts in the future. If there is exposure to a stressor and the species responds negatively, the stressor may be a threat. We consider the stressor to be a threat if it drives, or contributes to, the risk of extinction of the species such that the species warrants listing as endangered or threatened as those terms are defined in the Act. However, the identification of stressors that could affect a species negatively may not be sufficient to compel a finding that the species warrants listing. The information must include evidence sufficient to suggest that these stressors are operative threats that act on the species to the point that the species may meet the definition of endangered or threatened under the Act.

Our species status report examines all of the potential stressors to iiwi in detail. Here we describe those stressors that we conclude rise to the level of a threat to the long-term viability of iiwi.

Based on our comprehensive assessment of the status of the iiwi, we conclude that the best scientific data available consistently identifies avian malaria as the primary driver of declines in abundance and distribution of iiwi observed since the turn of the 20th century. This conclusion is supported by the extremely high mortality rate of iiwi (approximately 95 percent) in response to avian malaria, and the disappearance of iiwi from low-elevation ohia forest where it was formerly common and where malaria is prevalent today. Both the life cycle of the mosquito vector and the development and transmission of the malaria parasite are temperature-limited; thus, iiwi are now found primarily in high-elevation forests above 3,937 ft (1,200 m) where malaria prevalence and transmission is only brief and episodic, or nonexistent, under current conditions. The honeycreepers amakihi and apapane appear to be developing some resistance or tolerance to avian malaria (*e.g.*, Woodworth *et al.* 2005, p. 1,531; Atkinson *et al.* 2014, p. 366; Samuel *et al.* 2015, pp. 12–13). In contrast, iiwi have not demonstrated any substantial sign of developing resistance to avian malaria to date and do not appear to be genetically predisposed to evolve resistance (Jarvi *et al.* 2004, pp. 2,164–2,166). As the prevalence of avian malaria increases in association with warmer temperatures (*e.g.*, LaPointe *et al.* 2012, p. 217), the extent and impact of avian diseases upon iiwi are projected to become greatly exacerbated by climate change during this century.

Additionally, on Hawaii Island, where 90 percent of the iiwi currently occur, the recently discovered tree disease, ohia wilt, commonly known in Hawaii as rapid ohia death (ROD), was identified as an emergent source of habitat loss and degradation that has the potential to exacerbate other stressors to ohia forest habitat, as well as reduce the amount of habitat remaining for iiwi in an already limited, disease-free zone contained within a narrow elevation band. Rapid ohia death leads to significant mortality of the ohia that iiwi depend upon for nesting and foraging. This disease is spreading rapidly and has become a matter of urgent concern. If ROD continues to spread across the native ohia forests, it will directly threaten iiwi by eliminating the limited, malaria-free native forest areas that remain for the species.

Based on the analysis in our species status report, invasive, nonnative plants and feral ungulates have major, adverse impacts on ohia forest habitat. Although we did not find that the historical and

ongoing habitat alteration by nonnative species is the primary cause of the significant observed decline in iiwi's abundance and distribution, the cumulative impacts to iiwi's habitat, and in particular the activities of feral ungulates, are not insignificant and likely exacerbate the effects of avian malaria. Feral ungulates, particularly pigs (*Sus scrofa*), goats (*Capra hircus*), and axis deer (*Axis axis*), degrade ohia forest habitat by spreading nonnative plant seeds and grazing on and trampling native vegetation, and contributing to erosion (Mountainspring 1986, p. 95; Camp *et al.* 2010, p. 198). Invasive nonnative plants, such as strawberry guava (*Psidium cattleianum*) and albizia trees (*Falcataria moluccana*), prevent or retard regeneration of ohia forest used by iiwi for foraging and nesting. The combined effects of drought and nonnative, invasive grasses have resulted in increased fire frequency and the conversion of mesic ohia woodland to exotic grassland in many areas of Hawaii (D'Antonio and Vitousek 1992, p. 67; Smith and Tunison 1992, pp. 395–397; Vitousek *et al.* 1997, pp. 7–8; D'Antonio *et al.* 2011, p. 1,617). Beyond alteration of ohia forest, feral pig activities that create mosquito habitat in ohia forest where there would otherwise be very little to none is identified as an important compounding stressor that acts synergistically with the prevalence of malaria and results in iiwi mortality. Although habitat loss and degradation is not, by itself, considered to be a primary driver of iiwi declines, the habitat impacts described above contribute cumulatively to the vulnerability of the species to the threat of avian malaria by degrading the quality and quantity of the remaining disease-free habitat upon which the iiwi depends. In this regard, ROD, discussed above, is a matter of urgent concern as it can further exacerbate and compound effects from the suite of stressors that impact iiwi (see below).

#### Avian Diseases

The introduction of avian diseases transmitted by the introduced southern house mosquito (*Culex quinquefasciatus*), including avian malaria (caused by the protozoan *Plasmodium relictum*) and avian pox (*Avipoxvirus* sp.), has been a key driving force in both extinctions and extensive declines over the last century in the abundance, diversity, and distribution of many Hawaiian forest bird species, including declines of the iiwi and other endemic honeycreepers (*e.g.*, Warner 1968, entire; Van Riper *et al.* 1986, entire; Benning *et al.* 2002, p.

14,246; Atkinson and LaPointe 2009a, p. 243; Atkinson and LaPointe 2009b, pp. 55–56; Samuel *et al.* 2011, p. 2,970; LaPointe *et al.* 2012, p. 214; Samuel *et al.* 2015, pp. 13–15). Nonnative to Hawaii, the first species of mosquitoes were accidentally introduced to the Hawaiian Islands in 1826, and spread quickly to the lowlands of all the major islands (Warner 1968, p. 104; Van Riper *et al.* 1986, p. 340). Early observations of birds with characteristic lesions suggest that avian pox virus was established in Hawaii by the late 1800s (Warner 1968, p. 106; Atkinson and LaPointe 2009a, p. 55), and later genetic analyses indicate pox was present in the Hawaiian Islands by at least 1900 (Jarvi *et al.* 2008, p. 339). Avian malaria had arrived in Hawaii in the early 20th century (Warner 1968, p. 107; Van Riper *et al.* 1986, pp. 340–341; Atkinson and LaPointe 2009, p. 55; Banko and Banko 2009, p. 52), likely in association with imported cage birds (Yorinks and Atkinson 2000, p. 731), or through the deliberate introduction of nonnative birds to replace the native birds that had by then disappeared from the lowlands (Atkinson and LaPointe 2009a, p. 55).

#### Avian Malaria

As noted above, avian malaria is a disease caused by the protozoan parasite *Plasmodium relictum*; the parasite is transmitted by the mosquito *Culex quinquefasciatus*, and invades the red blood cells of birds. Birds suffering from malaria infection undergo an acute phase of the disease during which parasitemia, a quantitative measure of the number of *Plasmodium* parasites in the circulating red blood cells, increases steadily. Because the parasite destroys the red blood cells, anemia and decline of physical condition can quickly result. In native Hawaiian forest birds, death may result either directly from the effects of anemia, or indirectly when anemia-weakened birds become vulnerable to predation, starvation, or a combination of other stressors (LaPointe *et al.* 2012, p. 213). Native Hawaiian birds that survive avian malaria remain chronically infected, thus becoming lifetime reservoirs of the disease (Samuel *et al.* 2011, p. 2,960; LaPointe *et al.* 2012, p. 216) and remaining capable of further disease transmission to other native birds. In contrast, nonnative birds in Hawaii are little affected by avian malaria and later become incapable of disease transmission (LaPointe *et al.* 2012, p. 216).

Wild iiwi infected with malaria are rarely captured, apparently because the onset of infection leads to rapid mortality, precluding their capture

(Samuel *et al.* 2011, p. 2,967; LaPointe *et al.* 2016, p. 11). However, controlled experiments with captive birds have demonstrated the susceptibility of native Hawaiian honeycreepers to avian malaria; mortality is extremely high in some species, including iiwi, experimentally infected with the disease. As early as the 1960s, experiments with Laysan finches (*Telespiza cantans*) and several other species of native Hawaiian honeycreepers demonstrated 100 percent mortality from malaria in a very short period of time (Warner 1968, pp. 109–112, 118; Fig. 426).

In a study specific to iiwi, Atkinson *et al.* (1995, entire) demonstrated that the species suffers approximately 95 percent mortality when infected with malaria (Atkinson *et al.* 1995, p. S65). All of the exposed iiwi developed infections within 4 days, with only a single male iiwi surviving. Following re-exposure with the same *Plasmodium* isolate after initial infection, no subsequent increase in parasitemia was detected, suggesting a possible development of some immunity (Atkinson *et al.* 1995, p. S66). The authors suggested that iiwi may lack sufficient diversity in the major histocompatibility complex or genetically based immunity traits capable of recognizing and responding to malarial antigens, an important factor in iiwi's susceptibility to introduced disease (Atkinson *et al.* 1995, pp. S65–S66).

Despite extremely high mortality of iiwi from avian malaria in general, the aforementioned study as well as two other studies have demonstrated that a few individuals have survived infection (Van Riper *et al.* 1986, p. 334; Atkinson *et al.* 1995, p. S63; Freed *et al.* 2005, p. 759). If a genetic correlation were identified, it is possible that surviving individuals could serve as a potential source for the evolution of genetic resistance to malaria, although evidence of this is scant to date. Eggert *et al.* (2008, p. 8) reported a slight but detectable level of genetic differentiation between iiwi populations located at mid and high elevation, potentially the first sign of selection acting on these populations in response to disease. Additionally, the infrequent but occasional sighting of iiwi on Oahu indicates a possible developed resistance or tolerance to avian malaria. Moreover, other more common honeycreepers, such as the amakihi and apapane, show signs of developing resistance or tolerance to the disease, as evidenced by molecular studies (*e.g.*, Woodworth *et al.* 2005, p. 1,531; Atkinson *et al.* 2014, p. 366) and their

continued distribution at mid and low elevations where mosquitoes and malaria transmission persist year-round (*e.g.*, Foster *et al.* 2004, entire; Eggert *et al.* 2008, pp. 7–8).

Despite these observations, there is no indication as of yet that iiwi have developed significant resistance to malaria such that individuals can survive in areas where the disease is strongly prevalent, including all potential low-elevation forest habitat and most mid-elevation forest habitat (Foster *et al.* 2007, p. 4,743; Eggert *et al.* 2008, p. 2). In one study, for example, 4 years of mist-netting effort across extensive areas of Hawaii Island resulted in the capture of a substantial number of iiwi, yet no iiwi were captured in low-elevation forests and only a few were captured in mid-elevation forests (Samuel *et al.* 2015, p. 11). In addition, several studies indicate that iiwi have low genetic variability, and even genetic impediments to a possible evolved resistance to malaria in the future (Jarvi *et al.* 2001, p. 255; Jarvi *et al.* 2004, Table 4, p. 2,164; Foster *et al.* 2007, p. 4,744; Samuel *et al.* 2015, pp. 12–13). For example, Eggert *et al.* (2008, p. 9) noted that gene variations that may confer resistance appear to be rare in iiwi.

Three factors—the homogeneity of a portion of the iiwi genome, the high mortality rate of iiwi in response to avian malaria, and high levels of gene flow resulting from the wide-ranging nature of the species—suggest that iiwi would likely require a significant amount of time for development of genetic resistance to avian malaria, assuming the species retains a sufficiently large reservoir of genetic diversity for a response to natural selection. Genetic studies of iiwi have also noted a dichotomy between the lack of variation in mitochondrial DNA (Tarr and Fleischer 1993, 1995; Fleischer *et al.* 1998; Foster *et al.* 2007, p. 4,743), and maintenance of variation in nuclear DNA (Jarvi *et al.* 2004, p. 2,166; Foster *et al.* 2007, p. 4,744); both attributes suggest that iiwi may have historically experienced a drastic reduction in population size that led to a genetic bottleneck. Studies have also found low diversity in the antigen-binding sites of the iiwi's major histocompatibility complex (that part of an organism's immune system that helps to recognize foreign or incompatible proteins (antigens) and trigger an immune response).

The relationship between temperature and avian malaria is of extreme importance to the current persistence of iiwi and the viability of the species in the future. The development of the

*Plasmodium* parasite that carries malaria responds positively to increased temperature, such that malaria transmission is greatest in warm, low-elevation forests with an average temperature of 72 °F (22 °C), and is largely absent in high-elevation forests above 4,921 ft (1,500 m) with cooler mean annual temperatures around 57 °F (14 °C) (Ahumada *et al.* 2004, p. 1,167; LaPointe *et al.* 2010, p. 318; Liao *et al.* 2015, p. 4,343). High-elevation forests thus currently serve as disease-free habitat zones for Hawaiian forest birds, including iiwi. Once one of the most common birds in forests throughout the Hawaiian islands, iiwi are now rarely found at lower elevations, and are increasingly restricted to high-elevation mesic and wet forests where cooler temperatures limit both the development of the malarial parasite and mosquito densities (Scott *et al.* 1986, pp. 367–368; Ahumada *et al.* 2004, p. 1,167; LaPointe *et al.* 2010, p. 318; Samuel *et al.* 2011, p. 2,960; Liao *et al.* 2015, p. 4,346; Samuel *et al.* 2015, p. 14).

Temperature also affects the life cycle of the malaria mosquito vector, *Culex quinquefasciatus*. Lower temperatures slow the development of larval stages and can affect the survival of adults (Ahumada *et al.* 2005, pp. 1,165–1,168; LaPointe *et al.* 2012, p. 217). Although closely tied to altitude and a corresponding decrease in temperature, the actual range of mosquitoes varies with season. Generally, as temperature decreases with increasing elevation, mosquito abundance drops significantly at higher altitudes. In the Hawaiian Islands, the mosquito boundary occurs between 4,921 and 5,577 ft (1,500 and 1,700 m) (VanRiper *et al.* 1986, p. 338; LaPointe *et al.* 2012, p. 218). Areas above this elevation are at least seasonally relatively free of mosquitoes; thus, malaria transmission is unlikely at these high elevations under current conditions.

Early on, Ralph and Fancy (1995, p. 741) and Atkinson *et al.* (1995, p. S66) suggested that the seasonal movements of iiwi to lower elevation areas where ohia is flowering may result in increased contact with malaria-infected mosquitoes, which, combined with the iiwi's high susceptibility to the disease, may explain their observed low annual survivorship relative to other native Hawaiian birds. Compounding the issue, other bird species that overlap with iiwi in habitat, including Apapane (*Himatione sanguinea*), are relatively resistant to the diseases and carry both *Plasmodium* and avian pox virus. As reservoirs, they carry these diseases up slope where mosquitoes are less

abundant but still occur in numbers sufficient to facilitate and continue transmission to iiwi (Ralph and Fancy 1995, p. 741).

Subsequent studies have confirmed the correlation between risk of malaria infection and iiwi altitudinal migrations, and suggest upper elevation forest reserves in Hawaii may not adequately protect mobile nectarivores such as iiwi. Kuntz (2008, p. 3) found iiwi populations at upper elevation study sites (6,300 ft (1,920 m)) declined during the non-breeding season when birds departed for lower elevations in search of flowering ohia, traveling up to 12 mi (19.4 km) over contiguous mosquito-infested wet forest. Guillamet *et al.* (2016, p. 192) used empirical measures of seasonal movement patterns in iiwi to model how movement across elevations increases the risk of disease exposure, even affecting breeding populations in disease-free areas. LaPointe *et al.* (unpublished data 2015) found that, based on malaria prevalence in all Hawaiian forest birds, species migrating between upper elevations to lower elevations increased their risk of exposure to avian malaria by as much as 27 times. The greater risk was shown to be due to a much higher abundance of mosquitoes at lower elevations, which in turn was attributable at least in part to the higher abundance of pigs and their activities in lower elevation forests (discussed further below).

#### Avian Pox

Avian pox (or bird pox) is an infection caused by the virus *Avipoxvirus*, which produces large, granular, and eventually dead tissue lesions or tumors on exposed skin or infected lesions on the mouth, trachea, and esophagus of infected birds. Avian pox can be transmitted through cuts or wounds upon physical contact or through the mouth parts of blood-sucking insects such as the mosquito *Culex quinquefasciatus*, the common vector for both the pox virus and avian malaria (LaPointe *et al.* 2012, p. 221). Tumors or lesions caused by avian pox can be crippling for birds, and may result in death. Although not extensively studied, existing data suggest that mortality from avian pox may range from 4 to 10 percent observed in Oahu Elepaio (*Chasiempis ibidis*) (for birds with active lesions) (VanderWerf 2009, p. 743) to 100 percent in Laysan finches (Warner 1968, p. 108). VanderWerf (2009, p. 743) has also suggested that mortality levels from pox may correlate with higher rainfall years, and at least in the case of the Elepaio, observed

mortality may decrease over time with a reduction in susceptible birds.

As early as 1902, native birds suffering from avian pox were observed in the Hawaiian Islands, and Warner (1968, p. 106) described reports that epizootics of avian pox “were so numerous and extreme that large numbers of diseased and badly debilitated birds could be observed in the field.” As the initial wave of post-European extinctions of native Hawaiian birds was largely observed in the late 1800s, prior to the introduction of avian malaria (Van Riper *et al.* 1986, p. 342), it is possible that avian pox played a significant role, although there is no direct evidence (Warner 1968, p. 106). Molecular work has revealed two genetically distinct variants of the pox virus affecting forest birds in Hawaii that differ in virulence (Jarvi *et al.* 2008, p. 347): One tends to produce fatal lesions, and the other appears to be less severe, based on the observation of recurring pox infections in birds with healed lesions (Atkinson *et al.* 2009, p. 56).

The largest study of avian pox in scope and scale took place between 1977 and 1980, during which approximately 15,000 native and nonnative forest birds were captured and examined for pox virus lesions on Hawaii Island (Van Riper *et al.* 2002, pp. 929–942). The study made several important determinations, including that native forest birds were indeed more susceptible than introduced species, that all species were more likely to be infected during the wet season, and that pox prevalence was greatest at mid-elevation sites approximately 3,937 ft (1,200 m) in elevation, coinciding with the greatest overlap between birds and the mosquito vector. Of the 107 iiwi captured and examined during the study, 17 percent showed signs of either active or inactive pox lesions (Van Riper *et al.* 2002, p. 932). Many studies of avian pox have documented that native birds are frequently infected with both avian pox and avian malaria (Van Riper *et al.* 1986, p. 331; Atkinson *et al.* 2005, p. 537; Jarvi *et al.* 2008, p. 347). This may be due to mosquito transmission of both pathogens simultaneously, because documented immune system suppression by the pox virus renders chronically infected birds more vulnerable to infection by, or a relapse of, malaria (Jarvi *et al.* 2008, p. 347), or due to other unknown factors. The relative frequency with which the two diseases co-occur makes it challenging to disentangle the independent impact of either stressor acting alone (LaPointe *et al.* 2012, p. 221). Although we lack

direct evidence of the degree to which pox may be a specific threat to iiwi or contributing to its decline, both field observations of and limited experimental studies on closely related species of honeycreepers suggests that it may be a significant factor (Warner 1968, pp. 106, 108–109; VanRiper *et al.* 2002, pp. 936–939).

*Compounded Impacts—Feral Ungulates Create Habitat for Culex Quinquefasciatus Mosquitoes and Exacerbate Impacts of Disease*

It has been widely established that damage to native tree ferns (*Cibotium* spp.) and rooting and wallowing activity by feral pigs create mosquito larval breeding sites in Hawaiian forests where they would not otherwise occur. The porous geology and relative absence of puddles, ponds, and slow-moving streams in most Hawaiian landscapes precludes an abundance of water-holding habitat sites for mosquito larvae; however, *Culex quinquefasciatus* mosquitoes, the sole vector for avian malaria in Hawaii, now occur in great density in many wet forests where their larvae primarily rely on habitats created by pig activity (LaPointe 2006, pp. 1–3; Ahumada *et al.* 2009, p. 354; Atkinson and LaPointe 2009, p. 60; Samuel *et al.* 2011, p. 2,971). Pigs compact volcanic soils and create wallows and water containers within downed, hollowed-out tree ferns, knocked over and consumed for their starchy pith (Scott *et al.* 1986, pp. 365–368; Atkinson *et al.* 1995, p. S68). The abundance of *C. quinquefasciatus* mosquitoes is also much greater in suburban and agricultural areas than in undisturbed native forest, and the mosquito is capable of dispersing up to 1 mile (1.6 kilometers) within closed-canopy native forest, including habitat occupied by the iiwi (LaPointe 2006, p. 3; LaPointe *et al.* 2009, p. 409).

In studies of native forest plots where feral ungulates (including pigs) were removed by trapping and other methods, researchers have demonstrated a correlation in the abundance of *Culex* spp. mosquitoes when comparing pig-free, fenced areas to adjacent sites where feral pig activity is unmanaged. Aruch *et al.* 2007 (p. 574), LaPointe 2006 (pp. 1–3) and LaPointe *et al.* (2009, p. 409; 2012, pp. 215, 219) assert that management of feral pigs may be strategic to managing avian malaria and pox, particularly in remote Hawaiian rain forests where studies have documented that habitats created by pigs are the most abundant and productive habitat for larval mosquitoes. Reduction in mosquito habitat must involve pig management across large

landscapes due to the tremendous dispersal ability of *C. quinquefasciatus* and the possibility of the species invading from adjacent areas lacking management (LaPointe 2006, pp. 3–4). The consequences of feral pig activities thus further exacerbate the impacts to iiwi from avian malaria and avian pox, by creating and enhancing larval habitats for the mosquito vector, thereby increasing exposure to these diseases.

*Avian Diseases—Summary*

The relatively recent introduction of avian pox and avian malaria, in concert with the introduction of the mosquito disease vector, is widely viewed as one of the key factors underlying the loss and decline of native forest birds throughout the Hawaiian Islands. Evolving in the absence of mosquitoes and their vectored pathogens, native Hawaiian forest birds, particularly honeycreepers such as iiwi, lack natural immunity or genetic resistance, and thus are more susceptible to these diseases than are nonnative bird species (van Riper *et al.* 1986, pp. 327–328; Yorinks and Atkinson 2000, p. 737). Researchers consider iiwi one of the most vulnerable species, with an average of 95 percent mortality in response to infection with avian malaria (Atkinson *et al.* 1995, p. S63; Samuel *et al.* 2015, p. 2).

Many native forest birds, including iiwi, are now absent from warm, low-elevation areas that support large populations of disease-carrying mosquitoes, and these birds persist only in relatively disease-free zones in high-elevation forests, above roughly 4,921 to 5,577 ft (1,500 to 1,700 m), where both the development of the malarial parasite and the density of mosquito populations are held in check by cooler temperatures (Scott *et al.* 1986, pp. 85, 100, 365–368; Woodworth *et al.* 2009, p. 1,531; Liao *et al.* 2015, pp. 4,342–4,343; Samuel *et al.* 2015, pp. 11–12). Even at these elevations, however, disease transmission may occur when iiwi move downslope to forage on ephemeral patches of flowering ohia in the nonbreeding season, encountering disease-carrying mosquitoes in the process (Ralph and Fancy 1995, p. 741; Fancy and Ralph 1998, p. 3; Guillaumet *et al.* 2015, p. EV–8; LaPointe *et al.* 2015, p. 1). Iiwi have not demonstrably developed resistance to avian malaria, unlike related honeycreepers including Amakihi (*Hemignathus* spp.) and Apapane. Due to the extreme mortality rate of iiwi when exposed to avian malaria, we consider avian malaria in particular to pose a threat to iiwi. Having already experienced local extinctions and widespread population

declines, it is possible that the species may not possess sufficient genetic diversity to adapt to these diseases (Atkinson *et al.* 2009, p. 58).

**Climate Change**

Based on the assessment of the best scientific data available, we conclude that climate change exacerbates the impacts to iiwi from mosquito-borne disease, and this effect is likely to continue and worsen in the future. Air temperature in Hawaii has increased in the past century and particularly since the 1970s, with the greatest increases at higher elevations, and several conservative climate change models project continued warming in Hawaii into the future. As a result, the temperature barrier to the development and transmission of avian malaria will continue to move up in elevation in response to warmer conditions, leading to the curtailment or loss of disease-free habitats for iiwi. We briefly discuss below three climate studies that conservatively predict the iiwi will lose between 60 and 90 percent of its current (and already limited) disease-free range by the end of this century, with significant effects occurring by mid-century.

*Climate Change Effects on Iiwi*

Climate change is a stressor that is likely to significantly exacerbate the effects of avian malaria on iiwi both directly through increased prevalence and mortality, and indirectly through the loss of disease-free habitat. Air temperature in Hawaii has increased in the past century and particularly since the 1970s, with greater increases at high elevation (Giambelluca *et al.* 2008, pp. 2–4; Wang *et al.* 2014, pp. 95, 97). Documented impacts of increased temperature include the prevalence of avian malaria in forest birds at increasing elevation, including high-elevation sites where iiwi are already declining, for example, on Kauai (Paxton *et al.* 2013, p. 13; Paxton *et al.* 2016, entire). Several projections for future climate in Hawaii describe a continued warming trend, especially at high elevations. In our species status report, we analyzed in particular three climate studies (summarized below) that address the future of native forest birds, including iiwi, in the face of the interactions between climate change and avian malaria.

Benning *et al.* (2002) concluded that under optimistic assumptions (*i.e.*, 3.6 °F (2 °C) increase in temperature by the year 2100), malaria-susceptible Hawaiian forest birds, including iiwi, will lose most of their disease-free habitat in the three sites they considered

in their projection of climate change impacts. For example, current disease-free habitat at high elevation within the Hakalau Forest National Wildlife Refuge (NWR) on the island of Hawaii (where the environment is still too cold for development of the malarial parasite) would be reduced by 96 percent by the end of the century.

Fortini *et al.* (2015) conducted a vulnerability assessment for 20 species of Hawaiian forest birds based on a projected increase of 6.1 °F (3.4 °C) under the A1B emissions scenario at higher elevations by 2100. Even under this relatively optimistic scenario, in which emissions decline after mid-century (IPCC 2007, p. 44), all species were projected to suffer range loss as the result of increased transmission of avian malaria at higher elevations with increasing temperature. Iiwi was predicted to lose 60 percent of its current range by the year 2100, and climate conditions suitable for the species will shift up in elevation, including into areas that are not currently forested, such as lava flows and high-elevation grasslands. Most of the remaining habitat for iiwi would be restricted to a single island, Hawaii Island.

Liao *et al.* (2015) generated temperature and precipitation projections under three alternative emissions scenarios and projected future malaria risk for Hawaiian forest birds. Irrespective of the scenario modeled, by mid-century (roughly 2040), malaria transmission rates and impacts to bird populations began increasing at high elevations. By 2100, the increased annual malaria transmission rate for iiwi was projected to result in population declines of 70 to 90 percent for the species, depending on the emissions scenario.

All three of these studies consistently predict a significant loss of disease-free habitat for iiwi with consequent severe reductions in population size and distribution by the year 2100, with significant changes likely to be observed as early as 2040. As the iiwi's numbers and distribution continue to decline, the remaining small, isolated populations become increasingly vulnerable to loss of ohia forest habitat from other stressors such as ROD, as well as other environmental catastrophes and demographic stochasticity, particularly should all remaining iiwi become restricted to a single island (Hawaii Island), as some scenarios suggest.

Climate change will likely exacerbate other stressors to iiwi in addition to disease. Projected increases in temperature and humidity are likely to increase the spatial extent of areas on

Hawaii Island vulnerable to ROD (Keith 2016, pers. comm.). Changes in the amount and distribution of rainfall in Hawaii likely will affect the quality and extent of mesic and wet forests on which iiwi depend. Hawaii has experienced an overall drying trend since the 1920s, with an average annual decline in precipitation of 1.78 percent (Frazier and Giambelluca 2016, p. 4), but some future projections suggest that areas that currently are wet (windward sides of islands) will experience greater rainfall and more extreme rainfall events, while currently dry areas (leeward sides and high elevations) will become drier (Zhang *et al.* 2016, pp. 8,350–8,351). Changes in the trade wind inversion (which strongly influences rainfall) and other aspects of precipitation with climate change are difficult to model with confidence, complicating projections of future precipitation in Hawaii on various spatial scales (Chu and Chen 2005, pp. 4,801–4,802; Cao *et al.* 2007, pp. 1,158–1,159; Timm *et al.* 2015, p. 107; Fortini *et al.* 2015, p. 5; Liao *et al.* 2015, p. 4,345). In addition, potential increases in storm frequency and intensity in Hawaii as a result of climate change may lead to an increase in direct mortality of individual iiwi and a decline in the species' reproductive success. Currently, no well-developed projections exist for these possible cumulative effects.

#### *Climate Change—Summary*

The natural susceptibility of native forest birds to introduced diseases, in combination with the observed restriction of Hawaiian honeycreepers to high-elevation forests, led Atkinson *et al.* (1995, p. S68) to predict two decades ago that a shift in the current mosquito distribution to higher elevations could be “disastrous for those species with already reduced populations.” Thus, climate change has significant implications for the future of Hawaiian forest birds, as predictions suggest increased temperatures may largely eliminate the high-elevation forest currently inhospitable to the transmission of mosquito-borne diseases (Benning *et al.* 2002, pp. 14,247–14,249; LaPointe *et al.* 2012, p. 219; Fortini *et al.* 2015, p. 9). Samuel *et al.* (2015, p. 15) predict further reductions and extinctions of native Hawaiian birds as a consequence, noting that the iiwi is particularly vulnerable due to its high susceptibility to malaria. Finally, Paxton *et al.* (2016, entire) report a steepening decline in iiwi and other honeycreepers on Kauai since 2000.

Iiwi is projected to be extirpated from Kauai by 2050 as a result of the island

having now passed a “tipping point” where increasing temperature exposes birds to mosquito-borne disease throughout their remaining range on the island; if the current trends of decline in distribution and abundance continue in a linear fashion in the future, iiwi could be extirpated from Kauai much sooner (Paxton *et al.* 2016, pp. 3, 5). The maximum elevation of forest habitat on Kauai (about 4,900 ft (1,500 m)) is less than that on either Maui or Hawaii Island, where similar trends of increase in temperature and the elevation of disease transmission are well documented, as discussed above. Iiwi, and other disease-susceptible honeycreepers, only persist in abundance on these higher islands in high-elevation, disease-free habitat that is shrinking with increasing temperature. In sum, several independent studies project consistently significant negative impacts to the iiwi as a result of climate change and the increased exposure to avian malaria as disease-free habitats shrink. As iiwi are known to exhibit 95 percent mortality on average as a result of avian malaria, the current numbers of iiwi are of little consequence should all or most of the remaining individuals become exposed to the disease in the future.

#### **Rapid Ohia Death**

Rapid ohia death, a new disease that kills ohia trees, is a factor with the potential to exacerbate the threats currently affecting iiwi and reduce the amount of disease-free habitat remaining by destroying high-elevation ohia forest. Unexplained, widespread mortality of ohia trees was first detected in 2012 in lowland forests of the Puna Region of Hawaii Island (Keith *et al.* 2015, entire). Pathogenicity tests conducted by the USDA Agriculture Research Service determined that the vascular wilt disease, now commonly known in Hawaii as rapid ohia death (ROD), is caused by the fungus *Ceratocystis fimbriata* (Keith *et al.* 2015, pp. 1–2). A second, new species of *Ceratocystis* also kills ohia; this new species is being described as of this writing (Hughes 2016, pers. comm.; Keith 2016, pers. comm.).

Ohia stands experience rapid and extensive mortality from ROD. In 2014, approximately 15,000 ac (6,000 ha) of ohia forest from Kalapana to Hilo on Hawaii Island experienced greater than 50 percent mortality, with 100 percent mortality in some stands over a two to three year period (Friday *et al.* 2015, p. 1). Between 2014 and 2015, annual mortality rates measured in monitoring plots averaged from 24 percent (measured as ohia stems) to 28 percent



(measured as ohia basal area) (Mortenson *et al.* 2016, p. 89). When these plots were established in the ROD-infected area in January and February of 2014, all had already experienced an average of approximately 39 percent ohia mortality (Mortenson *et al.* 2016, p. 89).

At present, the disease remains restricted to Hawaii Island, where it is spreading rapidly. In 2016, the amount of forest area affected on Hawaii Island was estimated to be more than 50,000 ac (20,235 ha), and this estimate includes a new outbreak in Laupahoehoe Forest Reserve on the Hamakua Coast (Hughes 2016, pers. comm.). The largest affected area is within the Puna District, where infected trees have been observed within approximately 4,000 discontinuous acres (1,619 ha) (Hughes 2016, pers. comm.). In some areas, dead and dying trees affected by the fungus have been observed within the range of iiwi (Hughes 2016, pers. comm.; Keith 2016, pers. comm.). Affected trees are found at elevations ranging from sea level up to approximately 5,000 ft (1,524 m), including at Wailuku Forest near Hakalau Forest NWR (Hughes 2016, pers. comm.), which contains a stable to increasing iiwi population (Paxton *et al.* 2013, p. 12). Hawaii Island is home to 90 percent of the current iiwi population, and this island will remain particularly important for the species: iiwi are predicted to be largely if not entirely restricted to that island under some future climate change projections (Fortini *et al.* 2015, p. 9, Supplement 6).

#### Evaluation of Existing Regulatory Mechanisms and Conservation Measures

Our species status report evaluated several regulatory and other measures in place today that might address or are otherwise intended to ameliorate the stressors to iiwi. Our analysis concluded that forest habitat protection, conservation, and restoration has the potential to benefit iiwi by protecting and enhancing breeding and foraging areas for the species while simultaneously reducing the abundance of mosquito breeding sites, despite the disease vector's (*Culex quinquefasciatus*) 1-mi (1.6-km) dispersal ability (LaPointe *et al.* 2009, pp. 408; 411–412; LaPointe *et al.* 2012, p. 215).

Because of the iiwi's extreme susceptibility to avian malaria, habitat to sustain the species must be disease-free. Efforts to restore and manage large, contiguous tracts of native forests have been shown to benefit iiwi, especially when combined with fencing and ungulate removal (LaPointe *et al.* 2009,

p. 412; LaPointe *et al.* 2012, p. 219). While forest restoration and ungulate management at the Hakalau Forest NWR on Hawaii Island are excellent examples of what is needed to increase iiwi abundance, many similar large-scale projects would be necessary rangewide to simply reduce mosquito abundance and protect the species from current habitat threats alone. However, even wide-scale landscape habitat management would be unable to fully address the present scope of the threat of disease, and sufficient high-elevation forest is not available to provide disease-free habitat for iiwi in the face of future climate change. Even if disease-free habitat within managed areas could be restored and protected now, much of this habitat will lose its disease-free status as avian malaria moves upward in elevation in response to warming temperatures, as is occurring already within the Alakai Wilderness on the island of Kauai.

New opportunities are emerging, such as large-scale vector control using new tools that have the potential to assist Hawaiian forest birds (LaPointe *et al.* 2009, pp. 416–417; Reeves *et al.* 2014, p. e97557; Gantz *et al.* 2015, pp. E6736–E6743; Fischer in press, pp. 1–2). The most promising of these new tools forego chemicals as a means of lethal control and directly manipulate the viability (or fitness) of the mosquitoes and can be grouped into two broad categories: the Sterile Insect Technique (SIT) and the Population Replacement Technique (PRT) (Fischer in press, pp. 1–2). These tools have positive attributes that set them apart from traditional mosquito control options. These new approaches have the potential to achieve landscape-scale control, are species specific, and are more effective against dispersed, cryptic, and hard-to-reach targets such as the *Culex* mosquitoes that carry avian malaria in Hawaiian forests (Alphey *et al.* 2010, pp. 297–299). Although these new developments are encouraging, these new technologies for achieving large-scale control or eradication of mosquitoes in Hawaii are still in the research and planning stage and have yet to be implemented or proven effective.

We also evaluated several regulations and agreements pertaining to climate change. Although the United States and some other countries have passed some regulations specifically intended to reduce the emission of greenhouse gases that contribute to climate change, the scope and effect of such regulations are limited. Indeed, during the United Nations Framework Convention on Climate Change (UNFCCC) meeting in

December 2015, the UNFCCC indicated that, even if all the member countries' intended contributions to greenhouse gas reductions were fully implemented and targets met, the goal of limiting the increase in global average temperature to 2 °C (3.6 °F) by the year 2100 would not be achieved.

Many of the efforts to tackle the primary stressors to iiwi are still in the research and development stage, or are implemented only on a small or limited scale. Because the primary stressor, avian malaria, continues to have negative impacts, and these impacts are exacerbated by climate change, we conclude that the existing regulatory mechanisms do not offset these impacts to the species.

#### Summary of Biological Status and Threats

We have reviewed the best scientific and commercial data available regarding iiwi populations and the stressors that affect the species. This information includes, notably, a recent comprehensive analysis of iiwi abundance, distribution, and population trends (Paxton *et al.* 2013); numerous studies that provide information on the particularly high mortality of iiwi in response to avian malaria; and recent models examining the current relationship between climate and malaria, as well as the likely future consequences of climate change for iiwi and other Hawaiian forest birds (including Benning *et al.* 2002, Fortini *et al.* 2013, and Liao *et al.* 2015). Our review also reflects the expert opinion of the species' status report team members, and input provided by specialists familiar with avian malaria and iiwi genetics. We direct the reader to the iiwi species status report for our detailed evaluation of the biological status of the iiwi and the influences that may affect its continued existence.

Once one of the most common of the native Hawaiian forest birds, the iiwi has declined across large portions of its range and has been extirpated or nearly so from some islands, and many of the few remaining populations are declining. The iiwi's range is contracting upslope in most areas, and population declines and range contraction are concurrent with increasing prevalence of avian malaria. The iiwi is highly susceptible to avian malaria, and that the prevalence of this disease is moving upslope in Hawaiian forests correlated with temperature increases associated with climate change. This disease and its trend of increasing prevalence at increasing elevation are the chief drivers of observed iiwi population declines and

range contraction. Although habitat management to reduce breeding habitat for mosquitoes may have slowed the decline of iiwi and other forest birds to some degree in a few locations, no landscape-scale plans or strategies exist for eradicating mosquitoes or otherwise reducing the risk posed by avian malaria to iiwi and other susceptible Hawaiian bird species.

The documented trend of temperature increase, which is greatest at high elevation, is projected to continue at least through the 21st century. The transmission of avian malaria is currently limited or absent at higher elevations, where temperatures are too cool for the development of the malaria parasite. However, multiple independent modeling efforts consistently project that the prevalence of avian malaria will continue to increase upslope with increasing temperature, eventually eliminating most or all remaining disease-free habitat in the islands. These models, which incorporate data on the distribution of forest birds and on disease transmission, project moderate to high avian malaria transmission at the highest elevations of the iiwi's current range by the end of this century, with some significant effects predicted within the next few decades. As a consequence, significant declines in iiwi populations are projected, on the order of 70 to 90 percent by 2100, depending on the future climate scenario.

The impacts of other stressors to iiwi, such as loss or degradation of native forest by nonnative species (disturbance or destruction by feral ungulates; invasion by nonnative plants; impacts from nonnative pathogens such as ROD), predation by mongooses and feral cats, and small-population stressors such as demographic stochasticity and loss of genetic diversity, have not been well documented or quantified (predation by rats, notably *Rattus rattus*, is suspected to contribute to decline in iiwi) (VanderWerf 2016, pers. comm.). However, any stressors that result in further degradation or fragmentation of the forests on which the iiwi relies for foraging and nesting, or result in increased mortality or reduced reproductive success, are likely to exacerbate the impacts of disease on the species. The effects of climate change are likely to exacerbate these other stressors to iiwi as well.

As the number and distribution of iiwi continue to decline, the remaining small, isolated populations become increasingly vulnerable to environmental catastrophes and demographic stochasticity; this will

particularly be the case should all remaining iiwi become restricted to Hawaii Island, as some modeling scenarios suggest. Ninety percent of the rangewide iiwi population is already restricted to Hawaii Island, where ROD has recently emerged as a fast-moving threat to the already limited ohia forest habitat required by iiwi.

In consideration of all of this information, we conclude that avian malaria and possibly avian pox, as exacerbated by the ongoing effects of climate change, pose a threat to iiwi, and the action of these stressors places the species as a whole at an elevated risk of extinction. Because the vast majority of the remaining iiwi population is restricted to the island of Hawaii, we consider ROD to pose a threat to the future viability of iiwi as well, as it may result in major loss of forest within the iiwi's remaining range on that island.

#### Determination

Section 4 of the Act (16 U.S.C. 1533), and its implementing regulations in title 50 of the Code of Federal Regulations at 50 CFR part 424, set forth the procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, we may list a species based on (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) Overutilization for commercial, recreational, scientific, or educational purposes; (C) Disease or predation; (D) The inadequacy of existing regulatory mechanisms; or (E) Other natural or manmade factors affecting its continued existence. Listing actions may be warranted based on any of the above threat factors, singly or in combination.

We have carefully assessed the best scientific and commercial information available regarding the past, present, and future threats to the iiwi. As described in the species status report, in considering the five listing factors, we evaluated many potential stressors to iiwi, including but not limited to: Stressors that may affect the extent or quality of the bird's ohia forest habitat (ROD and ohia rust (both nonnative pathogens), ohia dieback (a natural phenomenon), drought, fires, volcanic eruptions, nonnative plants, and feral ungulates), introduced diseases, predation by introduced mammals, competition with nonnative birds, ectoparasites, climate change, and the effects of small population size. Based on our assessment, disease—particularly avian malaria—is the primary driver in the ongoing declines in abundance and range of iiwi, and climate change

substantially exacerbates the impact of disease on the species and will continue to do so into the future.

The greatest current threat to iiwi comes from exposure to introduced diseases carried by nonnative mosquitoes (Factor C). Avian malaria in particular has been clearly demonstrated to result in extremely high mortality of iiwi; avian pox may have significant effects on iiwi as well, although the evidence is not as clear or measurable. These diseases have resulted in significant losses of the once ubiquitous iiwi, which remains highly susceptible and, as of present, shows no clear indication of having developed substantial resistance or tolerance. Exposure to these diseases is ongoing, and is expected to increase as a consequence of the effects of climate change (Factor E).

Several climate model projections predict that continued increases in temperature due to climate change will greatly exacerbate the impacts of avian diseases upon iiwi due to loss of disease-free habitat. Several iiwi populations, including those on Molokai, Kauai, West Maui, and possibly Oahu—all lower in elevation than East Maui and Hawaii Island—are already extremely small in size or are represented by only a few occasional individuals, probably owing to the loss of disease-free habitat. Iiwi may face extirpation in these places due to the inability to overcome the effects of malaria. The species is expected to first become restricted to Hawaii Island, perhaps by the year 2040. By the end of the century, the existence of iiwi is uncertain due to the ongoing loss of disease-free habitat; the potential impacts to ohia forests from ROD and other stressors could increase the risk to iiwi as well. These threats to iiwi are ongoing, most are rangewide, are expected to increase in the future, and are significant because they will likely result in increased mortality of iiwi and loss of remaining populations, as well as further decreases in the availability and amount of disease-free habitat at high elevation. As discussed above, the existing regulatory mechanisms are not sufficient to address these threats (Factor D).

Some of the other stressors contributed to past declines in iiwi, or negatively affect the species or its habitat today; however, of the additional stressors considered, we found no information to suggest that any is currently a key factor in the ongoing declines in abundance and range of iiwi, although they may be contributing or exacerbating factors. Habitat loss and alteration (Factor A) caused by

nonnative plants and ungulates is occurring rangewide, has resulted in degraded ohia forest habitat, and is not likely to be reduced in the future. While ohia forests still comprise the majority of native forest cover on most of the main Hawaiian Islands, climate change and its likely effects, such as increased drought frequency, are expected to further affect ohia forest habitat and compound other impacts, including the spread of invasive plants and perhaps the severity and frequency of ohia diseases. In particular, ROD, the rapidly spreading and highly lethal tree disease, poses an increasing risk to the native forest habitat of iiwi on Hawaii Island, where 90 percent of remaining iiwi occur. This emerging factor has the potential to exacerbate avian disease and other stressors in the future by accelerating the loss and degradation of iiwi's habitat. If this disease becomes widespread, it could further increase the vulnerability of the iiwi by eliminating the native forest it requires for foraging and nesting.

We do not have any information that overutilization for commercial, recreational, scientific, or educational purposes (Factor B) poses a threat to iiwi.

The Act defines an endangered species as any species that is "in danger of extinction throughout all or a significant portion of its range" and a threatened species as any species "which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." We considered whether the iiwi meets either of these definitions, and find that the iiwi meets the definition of a threatened species for the reasons described below.

We considered whether the iiwi is currently in danger of extinction and determined that endangered status is not appropriate. Although the species has experienced significant reductions in both abundance and range, at the present time the species is still found on multiple islands, and the species as a whole still occurs in relatively high numbers. Additionally, disease-free habitat currently remains available for iiwi in high-elevation ohia forests with temperatures sufficiently cool to prevent the development of the malarial parasite. For these reasons, we do not consider the iiwi to be in imminent danger of extinction, although this formerly common species has experienced threats of such severity and magnitude that it has now become highly vulnerable to continued decline and local extirpation, such that the species is likely to become endangered

within the foreseeable future, as explained below.

Based on our review of the best scientific and commercial data available, we expect that additional iiwi population declines will be observed range-wide within the next few decades, and indications are that declines are already taking place on Kauai and in some Maui and Hawaii Island populations as a result of increasing temperatures and consequent exposure to avian malaria at some elevations where the disease is uncommon or absent today. Iiwi has a very high observed mortality rate when exposed to avian malaria, and the warming effects of climate change will result in increased exposure of the remaining iiwi populations to this disease, especially at high elevation. Peer-reviewed results of modeling experiments project that malaria transmission rates and effects on iiwi populations will begin increasing at high elevations by mid-century, and result in population declines of 70 to 90 percent by the year 2100. We thus conclude that the iiwi is likely to become in danger of extinction throughout all of its range within the foreseeable future. Because the iiwi is not in imminent danger of extinction, but is likely to become in danger of extinction within the foreseeable future, it meets the definition of a threatened species. Therefore, on the basis of the best available scientific and commercial information, we are listing the iiwi as a threatened species in accordance with sections 3(20) and 4(a)(1) of the Act.

Under the Act and our implementing regulations, a species may warrant listing if it is endangered or threatened throughout all or a significant portion of its range. Because we have determined that the iiwi is threatened throughout all of its range, under the Final Policy on Interpretation of the Phrase "Significant Portion of Its Range" in the Endangered Species Act's Definitions of "Endangered Species and "Threatened Species" (79 FR 37577 (July 1, 2014)) (SPR Policy), if a species warrants listing throughout all of its range, no portion of the species' range can be a "significant" portion of its range. While it is the Service's position under the SPR Policy that undertaking no further analysis of "significant portion of its range" in this circumstance is consistent with the language of the Act, we recognize that the Policy is currently under judicial review, so we also took the additional step of considering whether there could be any significant portions of the species' range where the species is in danger of extinction. We evaluated whether there is substantial

information indicating that there are any portions of the species' range: (1) That may be "significant," and (2) where the species may be in danger of extinction. In practice, a key part of identifying portions appropriate for further analysis is whether the threats are geographically concentrated. For the iiwi, the primary driver of its status is avian malaria. The prevalence of this disease is moving upslope in Hawaiian forests correlated with temperature increases associated with climate change. These threats are affecting the species throughout its entire range; therefore, there is not a meaningful geographical concentration of threats. As a result, even if we were to undertake a detailed SPR analysis, there would not be any portions of the species' range where the threats are harming the species to a greater degree such that it is in danger of extinction in that portion.

#### *Available Conservation Measures*

Conservation measures provided to species listed as endangered or threatened species under the Act include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition from listing will result in public awareness and conservation by Federal, State, Tribal, and local agencies, private organizations, and individuals. The Act encourages cooperation with the States and other countries and calls for recovery actions to be carried out for listed species. The protection required by Federal agencies and the prohibitions against certain activities are discussed, in part, below.

The primary purpose of the Act is the conservation of endangered and threatened species and the ecosystems upon which they depend. The ultimate goal of such conservation efforts is the recovery of these listed species, so that they no longer need the protective measures of the Act. Subsection 4(f) of the Act calls for the Service to develop and implement recovery plans for the conservation of endangered and threatened species. The recovery planning process involves the identification of actions that are necessary to halt or reverse the species' decline by addressing the threats to its survival and recovery. The goal of this process is to restore listed species to a point where they are secure, self-sustaining, and functioning components of their ecosystems.

Recovery planning includes the development of a recovery outline shortly after a species is listed and preparation of a draft and final recovery plan. The recovery outline guides the immediate implementation of urgent

recovery actions and describes the process to be used to develop a recovery plan. Revisions of the plan may be done to address continuing or new threats to the species, as new substantive information becomes available. The recovery plan also identifies recovery criteria for review of when a species may be ready for downlisting or delisting, and methods for monitoring recovery progress. Recovery plans also establish a framework for agencies to coordinate their recovery efforts and provide estimates of the cost of implementing recovery tasks. Recovery teams (composed of species experts, Federal and State agencies, nongovernmental organizations, and other qualified persons) are often established to develop recovery plans. When completed, the recovery outline, draft recovery plan, and the final recovery plan for iiwi will be available on our Web site (<http://www.fws.gov/ endangered>), or from our Pacific Islands Fish and Wildlife Office (see **FOR FURTHER INFORMATION CONTACT**). The public will have an opportunity to comment on the draft recovery plan, and the Service will consider all information presented during the public comment period prior to approval of the plan.

Implementation of recovery actions generally requires the participation of a broad range of partners, including other Federal agencies, States, Tribes, nongovernmental organizations, businesses, and private landowners. Examples of recovery actions include habitat restoration (e.g., restoration of native vegetation), research, captive propagation and reintroduction, and outreach and education. The recovery of many listed species cannot be accomplished solely on Federal lands because their range may occur primarily or solely on non-Federal lands. To achieve recovery of these species requires cooperative conservation efforts on private, State, and Tribal lands. If this species is listed, funding for recovery actions will be available from a variety of sources, including Federal budgets, State programs, and cost-share grants for non-Federal landowners, the academic community, and nongovernmental organizations. In addition, pursuant to section 6 of the Act, the State of Hawaii would be eligible for Federal funds to implement management actions that promote the protection or recovery of the iiwi. Information on our grant programs that are available to aid species recovery can be found at: <http://www.fws.gov/grants>.

Please let us know if you are interested in participating in recovery efforts for this species. Additionally, we

invite you to submit any new information on this species whenever it becomes available and any information you may have for recovery planning purposes (see **FOR FURTHER INFORMATION CONTACT**).

Section 7(a) of the Act requires Federal agencies to evaluate their actions with respect to any species that is listed as an endangered or threatened species and with respect to its critical habitat, if any is designated. Regulations implementing this interagency cooperation provision of the Act are codified at 50 CFR part 402. Section 7(a)(2) of the Act requires Federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of the species or destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into consultation with the Service.

Federal agency actions within the iiwi's habitat that may require a conference or consultation or both as described in the preceding paragraph, include but are not limited to, management and any other landscape-altering activities on Federal lands administered by the U.S. Fish and Wildlife Service, U.S. Forest Service, and National Park Service; actions within the jurisdiction of the Natural Resources Conservation Service, the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, and branches of the Department of Defense (DOD); and activities funded or authorized under the Federal Highway Administration, Partners for Fish and Wildlife Program, and DOD construction activities related to training or other military missions.

Under section 4(d) of the Act, the Service has discretion to issue regulations that we find necessary and advisable to provide for the conservation of threatened species. We are not proposing to issue a special rule pursuant to section 4(d) for this species. Therefore, the provisions of 50 CFR 17.31(a) and (b) would apply. These regulatory provisions apply the prohibitions of section 9(a)(1) of the Act to threatened wildlife and make it illegal for any person subject to the jurisdiction of the United States to take (which includes harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or to attempt any of these) threatened wildlife within the United States or on the high seas. In addition, it is unlawful to import, export, deliver, receive, carry, transport, or ship in interstate or foreign commerce in the course of commercial activity; or sell or

offer for sale in interstate or foreign commerce any listed species. It is also illegal to possess, sell, deliver, carry, transport, or ship any such wildlife that has been taken illegally. Certain exceptions apply to employees of the Service, the National Marine Fisheries Service, other Federal land management agencies, and State conservation agencies.

We may issue permits to carry out otherwise prohibited activities involving threatened wildlife under certain circumstances. Regulations governing permits are codified at 50 CFR 17.32. With regard to threatened wildlife, a permit may be issued for the following purposes: For scientific purposes, to enhance the propagation or survival of the species, or for incidental take in connection with otherwise lawful activities. There are also certain statutory exemptions from the prohibitions, which are found in sections 9 and 10 of the Act.

It is our policy, as published in the **Federal Register** on July 1, 1994 (59 FR 34272), to identify to the maximum extent practicable at the time a species is listed, those activities that would or would not constitute a violation of section 9 of the Act. The intent of this policy is to increase public awareness of the effect of a final listing on proposed and ongoing activities within the range of a listed species. Based on the best available information, actions that may result in a violation of section 9 include but are not limited to:

(1) Development of land or the conversion of native ohia forest, including the construction of any infrastructure (e.g., roads, bridges, railroads, pipelines, utilities) in occupied iiwi habitat;

(2) Unauthorized collecting, handling, possessing, selling, delivering, carrying, or transporting of the species, including import or export across State lines and international boundaries, except for properly documented antique specimens of this species at least 100 years old, as defined by section 10(h)(1) of the Act;

(3) Introduction of nonnative species that compete with or prey upon the iiwi, such as the new introduction of nonnative predators or competing birds to the State of Hawaii; and

(4) Certain research activities: Collection and handling of iiwi for research that may result in displacement or death of individuals.

Questions regarding whether specific activities would constitute a violation of section 9 of the Act should be directed to the Pacific Islands Fish and Wildlife Office, Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**).

**Required Determinations**

*National Environmental Policy Act (42 U.S.C. 4321 et seq.)*

We have determined that environmental assessments and environmental impact statements, as defined under the authority of the National Environmental Policy Act (NEPA; 42 U.S.C. 4321 et seq.), need not be prepared in connection with listing a species as an endangered or threatened species under the Endangered Species Act. We published a notice outlining our reasons for this determination in the **Federal Register** on October 25, 1983 (48 FR 49244).

**References Cited**

A complete list of references cited in this rulemaking is available on the

Internet at <http://www.regulations.gov> at Docket No. FWS-R1-ES-2016-0057 and upon request from the Pacific Islands Fish and Wildlife Office (see **FOR FURTHER INFORMATION CONTACT**).

**Authors**

The primary authors of this final rule are the staff members of the Pacific Islands Fish and Wildlife Office.

**List of Subjects in 50 CFR Part 17**

Endangered and threatened species, Exports, Imports, Reporting and recordkeeping requirements, Transportation.

**Regulation Promulgation**

Accordingly, we amend part 17, subchapter B of chapter I, title 50 of the

Code of Federal Regulations, as set forth below:

**PART 17—ENDANGERED AND THREATENED WILDLIFE AND PLANTS**

■ 1. The authority citation for part 17 continues to read as follows:

**Authority:** 16 U.S.C. 1361–1407; 1531–1544; 4201–4245; unless otherwise noted.

■ 2. In § 17.11(h), add an entry for “Iiwi (honeycreeper)” to the List of Endangered and Threatened Wildlife in alphabetical order under BIRDS to read as set forth below:

**§ 17.11 Endangered and threatened wildlife.**

\* \* \* \* \*  
(h) \* \* \*

Common name	Scientific name	Where listed	Status	Listing citations and applicable rules
* BIRDS	*	*	*	*
liwi (honeycreeper) .....	<i>Drepanis coccinea</i> .....	Wherever found .....	T	82 FR [Insert <b>Federal Register</b> page where the document begins], 9/20/2017.
*	*	*	*	*

Dated: August 23, 2017.

**James W. Kurth**

*Acting Director, U.S. Fish and Wildlife Service.*

[FR Doc. 2017–20074 Filed 9–19–17; 8:45 am]

**BILLING CODE 4333–15–P**

**DEPARTMENT OF THE INTERIOR**

**Fish and Wildlife Service**

**50 CFR Part 17**

[Docket No. FWS–R4–ES–2016–0037; 4500030113]

**RIN 1018–BB55**

**Endangered and Threatened Wildlife and Plants; Threatened Species Status for Pearl Darter**

**AGENCY:** Fish and Wildlife Service, Interior.

**ACTION:** Final rule.

**SUMMARY:** We, the U.S. Fish and Wildlife Service (Service), determine threatened species status under the Endangered Species Act of 1973 (Act), as amended, for the pearl darter (*Percina aurora*), a fish whose historical range includes Mississippi and Louisiana. The effect of this regulation will be to add

this species to the List of Endangered and Threatened Wildlife.

**DATES:** This rule becomes effective October 20, 2017.

**ADDRESSES:** This final rule is available on the internet at <http://www.regulations.gov> in Docket No. FWS–R4–ES–2016–0037 and on the Mississippi Field Office Web site at <https://www.fws.gov/mississippiES/>. Comments and materials we received, as well as supporting documentation we used in preparing this rule, are available for public inspection at <http://www.regulations.gov> and by appointment, during normal business hours at: U.S. Fish and Wildlife Service, Mississippi Ecological Services Field Office, 6578 Dogwood View Parkway, Jackson, Mississippi 39213, by telephone 601–321–1122 or by facsimile 601–965–4340.

**FOR FURTHER INFORMATION CONTACT:** Stephen Ricks, Field Supervisor, U.S. Fish and Wildlife Service, Mississippi Ecological Services Field Office, 601–321–1122. Persons who use a telecommunications device for the deaf (TDD) may call the Federal Relay Service at 800–877–8339.

**SUPPLEMENTARY INFORMATION:**

**Executive Summary**

*Why we need to publish a rule.* Under the Endangered Species Act of 1973, as amended (Act, 16 U.S.C. 1531 et seq.), if we determine that a species is an endangered or threatened species throughout all or a significant portion of its range, we are required to promptly publish a proposal in the **Federal Register** and make a determination on our proposal within 1 year. Listing a species as an endangered or threatened species can only be completed by issuing a rule. We published a proposed rule to add the pearl darter (*Percina aurora*) to the List of Endangered and Threatened Wildlife in title 50 of the Code of Federal Regulations (50 CFR 17.11(h)) as threatened on September 21, 2016 (81 FR 64857).

*What this document does.* This rule will finalize the listing of the pearl darter as a threatened species.

*The basis for our action.* Under the Act, we may determine that a species is an endangered or threatened species based on any of five factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of