DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[Docket No. FWS–R1–ES–2015–0125; 4500030113]

RIN 1018–BB07

Endangered and Threatened Wildlife and Plants; Endangered Status for 49 Species From the Hawaiian Islands

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Final rule.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), determine endangered status under the Endangered Species Act of 1973 (Act), as amended, for 10 animal species, including the Hawaii DPS of the band-rumped storm-petrel (*Oceanodroma castro*), the orangeblack Hawaiian damselfly (*Megalagrion xanthomelas*), the anchialine pool shrimp (*Procaris hawaiana*), and seven yellow-faced bees (*Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris, H. kuakea, H. longiceps,* and *H. mana*), and for 39 plant species from the Hawaiian Islands. This rule adds these species to the Federal Lists of Endangered and Threatened Wildlife and Plants.

DATES: This rule is effective October 31, 2016.

ADDRESSES: This final rule is available on the Internet at *http://www.regulations.gov* and at *http://www.fws.gov/pacificislands.* 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,* or, by appointment, during normal business hours at: U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, 300 Ala Moana Boulevard, Honolulu, HI 96850; telephone 808–792–9400; or facsimile 808–792–9581.

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SUPPLEMENTARY INFORMATION:

Executive Summary

Why we need to publish a rule. Under the Endangered Species Act (Act), a species may warrant protection through listing if it is endangered or threatened throughout all or a significant portion of its range. Listing a species as an endangered or threatened species can only be completed by issuing a rule. Critical habitat is to 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 makes final the listing of 10 animal species (the Hawaii DPS of the band-rumped storm-petrel (*Oceanodroma castro*), the orangeblack Hawaiian damselfly (*Megalagrion xanthomelas*), the anchialine pool shrimp (*Procaris hawaiana*), and seven yellow-faced bees (*Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris, H. kuakea, H. longiceps,* and *H. mana*)), and 39 plant species (*Asplenium diellaciniatum* (no common name, NCN), *Calamagrostis expansa* (Maui reedgrass), *Cyanea kauaulaensis* (NCN), *Cyclosorus boydiae* (kupukupu makalii), *Cyperus neokunthianus* (NCN), *Cyrtandra hematos* (haiwale), *Deparia kaalaana* (NCN), *Dryopteris glabra* var. *pusilla* (hohiu), *Exocarpos menziesii* (heau), *Festuca hawaiiensis* (NCN), *Gardenia remyi* (nanu), *Huperzia stemmermanniae* (NCN), *Hypolepis hawaiiensis* var. *mauiensis* (olua), *Joinvillea ascendens* ssp. *ascendens* (ohe), *Kadua fluviatilis* (kamapuaa), *Kadua haupuensis* (NCN), *Labordia lorenciana* (NCN), *Lepidium orbiculare* (anaunau), *Microlepia strigosa* var. *mauiensis* (NCN), *Myrsine fosbergii* (kolea), *Nothocestrum latifolium* (aiea), *Ochrosia haleakalae* (holei), *Phyllostegia brevidens* (NCN), *Phyllostegia helleri* (NCN), *Phyllostegia stachyoides* (NCN), *Portulaca villosa* (ihi), *Pritchardia bakeri* (Baker's loulu), *Pseudognaphalium sandwicensium* var. *molokaiense* (enaena), *Ranunculus hawaiensis* (makou), *Ranunculus mauiensis* (makou), *Sanicula sandwicensis* (NCN), *Santalum involutum* (iliahi), *Schiedea diffusa* ssp. *diffusa* (NCN), *Schiedea pubescens* (maolioli), *Sicyos lanceoloideus* (anunu), *Sicyos macrophyllus* (anunu), *Solanum nelsonii* (popolo), *Stenogyne kaalae* ssp. *sherffii* (NCN), and *Wikstroemia skottsbergiana* (akia), as endangered species.

Delineation of critical habitat requires 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 required. 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 to be ''not determinable'' at this time.

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 these 49 species are experiencing population-level impacts as the result of the following current and ongoing threats:

- Habitat loss and degradation due to urbanization; nonnative feral ungulates (hoofed mammals, *e.g.,* pigs, goats, axis deer, black-tailed deer, mouflon, and cattle); nonnative plants; wildfire; and water extraction.
- Predation or herbivory by nonnative feral ungulates, rats, slugs, bullfrogs, Jackson's chameleons, ants, and wasps.
- Stochastic events such as landslides, flooding, drought, tsunami, and hurricanes.
- Human activities such as recreational use of anchialine pools, dumping of nonnative fish and trash into anchialine pools, and manmade structures and artificial lighting.
- Vulnerability to extinction due to small numbers of individuals and occurrences and lack of regeneration.
- Competition with nonnative plants and nonnative invertebrates.

Existing regulatory mechanisms and conservation efforts are not adequate to ameliorate the impacts of these threats on any of the 49 species such that listing is not warranted. Environmental effects from climate change are likely to exacerbate the impacts of these threats.

Peer review and public comment. We sought comments from independent specialists to ensure that our designation is based on scientifically sound data, assumptions, and analyses. We invited these peer reviewers to comment on our listing proposal. We also considered all comments and information we received during two comment periods, including at one public hearing.

Previous Federal Actions

Please refer to the proposed listing rule for the 49 species from the Hawaiian Islands (80 FR 58820; September 30, 2015) for a detailed description of previous Federal actions concerning these species.

Summary of Comments and Recommendations

On September 30, 2015, we published a proposed rule to list 49 species (39 plants and 9 animals) from the Hawaiian Islands as endangered throughout their ranges and the Hawaii population (distinct population segment (DPS)) of the band-rumped storm-petrel as endangered (80 FR 58820). The comment period for the proposed rule lasted 60 days, ending November 30, 2015 We published a public notice of the proposed rule in the local Honolulu Star Advertiser, West Hawaii Today, Hawaii Tribune-Herald, Molokai Dispatch, The Maui News, and The Garden Island newspapers at the beginning of the comment period. We received two requests for a public hearing. On January 22, 2016 (81 FR 3767), we reopened the comment period for an additional 30 days, ending on February 22, 2016, and we announced a public meeting and public hearing for the proposed rule. We again published a public notice in local newspapers and provided the public notice to local media. For both comment periods, we requested that all interested parties submit comments or information concerning the proposed listing of the 49 species. We contacted all appropriate State and Federal agencies, county governments, elected officials, scientific organizations, and other interested parties and invited them to comment. The public meeting and hearing were held in Hilo, Hawaii, on February 9, 2016.

During the comment periods, we received a total of 41 unique public comment letters (including comments received at the public hearing) on the proposed listing of the 49 species. Of the 41 commenters, 21 were peer reviewers, 3 were Federal agencies (Hawaii Volcanoes National Park, Haleakala National Park, and Kaloko-Honokohau and Puuhonua o Honaunau National Historical Parks (NHPs)), 4 were State of Hawaii agencies (Hawaii Department of Health, Hawaii Department of Land and Natural Resources Division of Aquatic Resources, Hawaii Division of Forestry and Wildlife, and Hawaii Department of Hawaiian Home Lands), and 13 were nongovernmental organizations or individuals (including those who provided comments or testimony at the public hearing). The National Park Service (NPS) provided new information about the numbers and range of species in this rule that occur on NPS lands, and about graduate research on the orangeblack Hawaiian damselfly. We appreciate the time and effort taken by all commenters to submit their views and information, and we have incorporated all substantive new information, *e.g.,* from the National Park Service, into this final rule. However, we received some comments from the public on the possible future designation of critical habitat and on a variety of other topics. To the extent that comments do not pertain to the proposed listing rule, we do not address them in this final rule. In this final rule, we address only those comments relevant to the listing of the 49 species from the Hawaiian Islands.

All substantive information related to the listing action provided during the comment periods has either been incorporated directly into this final rule, or is addressed below. For readers' convenience, we have combined similar comments into a single comment and response.

Peer Review

In accordance with our peer review policy published in the **Federal Register** on July 1, 1994 (59 FR 34270), we solicited expert opinions from 29 knowledgeable individuals with scientific expertise on one or more of the 49 Hawaiian Islands species, which include 39 plants, a seabird, a damselfly, an anchialine pool shrimp, and seven yellow-faced bees, and their habitats. This expertise also included familiarity with the geographic region in which these species occur and conservation biology principles. We received responses from 21 of these individuals. We reviewed all comments we received from the peer reviewers for substantive issues and new information regarding the 49 species. Of these 21 peer reviewers, 18 provided comments or new information on one or more of the 49 species. Ten peer reviewers stated support for the proposed listing, and 11 were neutral regarding the proposed listing. These peer reviewers generally supported our methodology and conclusions. Peer reviewer comments are either addressed below or are incorporated into this final rule as appropriate.

(1) *Comment:* One peer reviewer stated that sea-level rise and coastal inundation collectively are also potential future threats to the welfare of *Procaris hawaiana,* because they may cause further loss of anchialine pool habitat.

Our Response: We have added sea-level rise and coastal inundation as threats to *P. hawaiana* and its habitat under the discussion in this rule titled ''Climate Change'' (*Factor E. Other Natural or Manmade Factors Affecting Their Continued Existence*).

(2) *Comment:* One peer reviewer stated that because sea-level rise could increase surface connectivity between currently isolated anchialine pools, invasion by nonnative fish would be exacerbated.

Our Response: In this rule, we have added surface connectivity to our summary description of the status and stressors to *P. hawaiana* as a factor likely to exacerbate the threat posed by nonnative fish to this species and its anchialine pool habitat (see *Anchialine pool shrimp* (Procaris hawaiana), under *Summary of Biological Status of the 49 Hawaiian Islands Species*).

(3) *Comment:* One peer reviewer recommended that the island of Lanai, and coastal habitat, be included as habitat for the band-rumped storm-petrel, as birds were observed during the breeding season transiting this habitat, which is conducive to nesting where crevices and ledges are numerous and can provide some protection from feral cats (*Felis catus*), goats (*Capra hircus*), and mouflon (*Ovis gmelini musimon*).

Our Response: We have added coastal habitat on Lanai in our description of habitat for the band-rumped storm-petrel in this final listing rule.

(4) *Comment:* One peer reviewer recommended that coastal habitat on leeward east Maui be included for the band-rumped storm-petrel, as remains of a chick were found there in 1999.

Our Response: We understand that coastal habitat on east Maui may be part of the species' historical range, but we have not added coastal areas on leeward east Maui as currently occupied habitat for the band-rumped storm-petrel in this final rule. Unlike coastal Lanai, in coastal areas on leeward east Maui, no indication of the species' presence or use of this habitat has been observed for 17 years.

(5) *Comment:* One peer reviewer stated that predation by bullfrogs (*Lithobates catesbeianus*) should be included as a threat to the orangeblack Hawaiian damselfly, and that impacts of backswimmers (Notonectidae family) and caddisflies (Trichoptera order) on the damselfly are speculative.

Our Response: We have included in this final rule that bullfrogs are a threat to the orangeblack Hawaiian damselfly, and clarified that the effects of predation by backswimmers and caddisflies are not well understood.

Comments From State Agencies

(6) *Comment:* The Hawaii Department of Land and Natural Resources' Division of Forestry and Wildlife did not comment in support of, or in opposition to, the proposed listing of the 49 species from the Hawaiian Islands. District botanists from Kauai, Oahu, Maui, and Hawaii Island provided plant species occurrence updates by island.

Our Response: We appreciate the information provided regarding the 49 plant species from the Hawaiian Islands, and have incorporated it into the Summary of Biological Status of the 49 Hawaiian Islands Species for the appropriate species in this final rule.

(7) *Comment:* The Hawaii Department of Health acknowledged that protecting wildlife and plants can often be important for human and environmental health. They further commented that managing and controlling wild ungulates is necessary for 95 percent of these proposed plant species, the orangeblack Hawaiian damselfly (*Megalagrion xanthomelas*), and the yellow-faced bees (*Hylaeus* spp.), but that it is also essential to preventing erosion, and, therefore, protecting water quality. Fire is a natural process that is now unnaturally frequent, intense, and destructive to the Hawaiian Islands, in part due to invasive grasses. Mitigating wildfires is essential to caring for 38 percent of the plant species, the damselfly, and yellow-faced bees, but it also limits the release of air pollutants that are known to be harmful to human health. Protection of coastal and wetland habitat such as that populated by the anchialine pool shrimp (*Procaris hawaiana*) limits further human pressures on our sensitive coastlines and aquatic environments.

Our Response: We agree that managing and controlling ungulates would provide significant conservation benefits to listed plant and animal species, and would also prevent erosion and protect water quality of the islands and near shore reefs. We also acknowledge that nonnative grasses contribute to the increase in numbers and intensity of wildfires in Hawaii. Protection of coastal habitat (through nonnative plant and ungulate control, and prevention of wildfires) would provide a conservation benefit to the anchialine pool shrimp, and to other species that depend on coastal habitat.

(8) *Comment:* The Hawaii Department of Land and Natural Resources Division of Aquatic Resources concurred that the information in the proposed rule for the anchialine pool shrimp, *Procaris hawaiana,* is the most accurate and up-to-date information available, and supported listing the species as endangered under the Act (16 U.S.C. 1531 *et seq.*).

Our Response: We appreciate this support for the proposed listing of the anchialine pool shrimp, *Procaris hawaiana.*

(9) *Comment:* The Department of Hawaiian Home Lands (DHHL) asked that the Secretary of the Interior consider the effects of designation of endangered species that may potentially have critical habitat on Hawaiian Home Lands in a similar manner to the effects such designation has on tribal lands, including the impact on tribal sovereignty. DHHL is aware that Secretarial Order 3206, issued in June 1997, establishes guidelines for the Service when dealing with Indian tribes relating to endangered species. Secretarial Order 3206 recognizes that, in order to respect the cultural and social aspects of Indian tribes, some environmental restrictions on Indian tribal lands are not appropriate, and it calls on the Service to preserve endangered species while respecting tribal authority over their own lands. While native Hawaiians are not an ''Indian tribe'' under the Order, DHHL's mission, to place native Hawaiians on its lands for residential, agricultural, and pastoral homesteading purposes, is analogous to the circumstances of Indian tribes. The Department also recommends that the Secretaries of the Interior and Commerce, in determining endangered species and critical habitat designations, consult directly with the Hawaiian Homes Commission, DHHL, Office of Native Hawaiian Relations, and beneficiaries of the Hawaiian Homes Commission Act to include native intelligence and knowledge on species, habitat, and place-based management and protection.

Our Response: In accordance with the President's memorandum of April 29, 1994 (Government-to-Government Relations With Native American Tribal Governments; 59 FR 22951), Executive Order 13175 (Consultation and Coordination With Indian Tribal Governments), and the Department of the Interior's manual at 512 DM 2, we readily acknowledge our responsibility to communicate meaningfully with recognized Federal Tribes on a government-to-government basis. In accordance with Secretarial Order 3206 of June 5, 1997 (American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act), we readily acknowledge our responsibilities to work directly with tribes in developing programs for healthy ecosystems; to incorporate native intelligence and knowledge of species, habitat, and place-based management and protection; to acknowledge that tribal lands are not subject to the same controls as Federal public lands; to remain sensitive to Indian culture; and to make information available to tribes. In addition, a 2004 consolidated appropriations bill (Pub. L. 108–199, see section 148) established the Office of Native Hawaiian Relations within the Secretary of the Interior's Office, and its duties include effectuating and implementing the special legal relationship between the Native Hawaiian people and the United States, and fully integrating the principle and practice of meaningful, regular, and appropriate consultation with the Native Hawaiian people by assuring timely notification of and prior consultation with the Native Hawaiian people before any Federal agency takes any actions that may have the potential to significantly affect Native Hawaiian resources, rights, or lands. A 2011 memorandum of understanding (MOU) signed by the Department of the Interior states that ''Federal agencies are required to consult with Native Hawaiian organizations before taking any action that may have the potential to significantly affect Native Hawaiian resources, rights, or lands.'' Although native Hawaiians are not technically a ''recognized Federal tribe'' as referenced in the above Executive and Secretarial Orders, we endeavor to fully engage and work directly with native Hawaiians as much as possible. At the time we published our proposed rule (80 FR 58820; September 30, 2015), we notified several Hawaiian organizations including the DHHL, Kamehameha Schools, the Office of Hawaiian Affairs, the Kahoolawe Island Reserve Commission (KIRC), and Kahea-The Hawaiian-Environmental Alliance. We contacted the Department of the Interior's Office of Native Hawaiian Relations on September 28, 2015, to inform them of our proposed listing action. We also conducted in-person meetings with staff of the Department of Hawaiian Home Lands, Kamehameha Schools, and KIRC. We considered all comments and recommendations provided by these organizations in developing this final listing rule. At the time we prepare a proposed critical habitat rule for these species, we will notify these groups and organizations, and carefully consider any comments and new information they provide regarding habitat for these species.

Public Comments

Seven public commenters supported listing of all 49 Hawaiian Islands species. Seven public commenters opposed the listing of the 49 Hawaiian Islands species, and one of these commenters supported the intent of listing but opposed designation of critical habitat on their lands.

(10) *Comment:* One commenter supported this rule because of the facts and analysis stated in the proposed rule. Two commenters stated that humans need to be a voice for plants and animals, and that this listing will positively impact the conservation of many animals and positively lead other conversations in the right direction.

Our Response: We appreciate the comments and believe that listing status will help provide conservation benefits to the species and their habitats.

(11) *Comment:* One commenter stated that the 49 species also play a pivotal role in promoting tourism and building the economy of Hawaii and that they deserve to be put onto the Lists of Endangered and Threatened Wildlife and Plants. Two commenters stated that listing these species will attract wildlife enthusiasts and nature lovers from all around the world, and their spending and tourism helps to build and maintain sources of revenue in Hawaii; most markets within the islands depend on the tourism dollars that wildlife attracts.

Our Response: We do not consider economic consequences in our decisions to list or not list species as endangered or threatened under the Act. Section 4(b)(1)(a) of the Act specifies that listing determinations be made ''solely on the basis of the best scientific and commercial data available.''

(12) *Comment:* One commenter stated that the potential negative impacts of listing to landowners is very small, as the vast majority of the habitat for these rare species occurs on State and Federal lands, or in private lands devoted to conservation.

Our Response: We agree that many of the 49 species occur or were known from State and Federal lands, or in undeveloped areas already dedicated to conservation. However, listing a species as endangered or threatened is based on the species' biological status; the development of a proposed rule for critical habitat for these species will be completed in a separate rule, and the effects of critical habitat on landowners will be analyzed upon preparation of that proposed rule.

(13) *Comment:* One commenter stated that island residents have entirely lost historical and cultural opportunities and rights as a result of species protection enforcement and that those in the field of endangered species protection have a single focus, with little or no concern for cultural and historical values. Another commenter stated that this listing would cause a further loss for the public of cultural, historical, and economic resources. A third commenter stated that native Hawaiian society believes they should be able to manage their people, land, and resources autonomously.

Our Response: Listing a species as endangered or threatened does not cause loss of historical and cultural opportunities; in fact, it highlights the need to protect the characteristics that are unique to the Hawaiian Islands. We acknowledge that some economic impacts are a possible consequence of listing a species under the Act; for example, there may be costs to the landowner associated with the development of a habitat conservation plan (HCP). In other cases, if the landowner does not acquire a permit for incidental take (for animals), the landowner may choose to forego certain activities on their property to avoid violating the Act, resulting in potential lost income. However, the Act does not provide for the consideration of such impacts when making a listing decision. Section 4(b)(1)(a) of the Act specifies that listing determinations be made ''solely on the basis of the best scientific and commercial data available.'' The language provided by Congress in the Act thus precludes such costs from consideration in association with a listing determination. We work collaboratively with private landowners, and strongly encourage those with listed species on their property to work with us to develop incentive-based measures such as strategic habitat areas (SHAs) and HCPs, which have the potential to provide conservation measures that effect positive results for the species and their habitat while providing regulatory relief for landowners. The conservation and recovery of endangered and threatened species, especially of those in Hawaii that occur nowhere else in the world, and the ecosystems upon which they depend, is the ultimate objective of the Act, and the Service recognizes the vital importance of voluntary, nonregulatory conservation measures that provide incentives for landowners in achieving that objective. In regards to land management by native Hawaiians, see our response to *Comment* (9), above. The Act does provide for the consideration of potential economic impacts in the course of designating critical habitat (limited to activities that are funded, authorized, or carried out by a Federal agency), and that analysis will be conducted as we prepare a rule proposing critical habitat for the multi-island species.

(14) *Comment:* Four commenters were concerned that listing a species would entail removal of nonnative species with cultural significance, or removal of those used for food and sport hunting, and that control of nonnative ungulates would not be conducted humanely.

Our Response: Habitat destruction and modification by ungulates is a threat to 37 of the 39 plants, and to 9 of the 10 animals proposed for listing. Herbivory by ungulates is a threat to 27 of the 39 plants proposed for listing. Hawaii was inhabited as early as the 2nd century; therefore, hunting of game mammals is a relatively recent activity (Tomich 1986, p. 1). The first Polynesian settlers brought domestic pigs of southeast Asia (*Sus scrofa* or a species derived from *Sus scrofa vittatus*) with them that were small in size, domesticated, and allowed to run freely around habitations (Tomich 1986, p. 120). Cook brought English pigs on his first voyage to Hawaii and landed a boar and sow on Niihau in 1778 (Tomich 1986, p. 121). Goats and European boars were introduced and released (on Niihau in 1778) by ship captains with the intent of establishing feral populations of these animals to be an available food source in future visits to the islands. Cattle (*Bos taurus*) and domestic sheep (*Ovis aries*) were released in 1794, by Vancouver. Deer were released later; first, axis deer in 1867, and then mule deer (black-tailed deer) in 1961 (Tomich 1986, pp. 127, 133, 141, 150, 158). These ungulates multiplied rapidly, with immense negative impacts to native vegetation (Loope 1988, pp. 274–276). The need for control of feral cattle was recognized as early as 1918, by C.S. Judd (Tomich 1986, p. 146). The commenter may be referring to the Federal court order mandating the removal of sheep and goats for protection of the palila (*Loxioides bailleui*), an endangered bird endemic to Hawaii. Aerial hunting is an efficient control method and was chosen by the State to comply with this order. Carcasses taken during hunts (in both 2014 and 2015) were available to the permitted public for salvage (DLNR 2014, in litt.; DLNR 2015, in litt.). Aerial hunting is not conducted by the Service in Hawaii.

(15) *Comment:* One commenter stated that once species are listed for protection under the Act, there is no public recourse.

Our Response: There is public recourse after a rulemaking is published in the **Federal Register**. Under the Act, an interested person may petition to add a species to, or to remove a species from, either of the Lists of Endangered and Threatened Wildlife and Plants. Within 12 months of the petition, the Secretary will make a finding as to whether the petition presents substantial scientific or commercial information indicating that the petitioned action may be warranted. Persons may also petition to designate or revise a critical habitat designation. Our petition regulations are set forth at 50 CFR 424.14.

(16) *Comment:* Two commenters expressed concern that the magnitude of the proposed listing rule and the subsequent designation of critical habitat will have negative effects on Hawaii's economy, property values, and land use.

Our Response: We understand there is confusion and concern about the effects of listing the 49 multi-island species. Listing provides certain protections to the species under the Act. Section 7 of the Act states that each Federal agency (through consultation) shall insure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any endangered or threatened species. For endangered species of fish or wildlife, section 9 of the Act prohibits any person subject to the jurisdiction of the United States to import or export; ''take'' (defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt any of these actions) within the United States or the territorial sea of the United States; take upon the high seas; deliver, receive, carry, transport, or ship in interstate or foreign commerce in the course of a commercial activity; or sell or offer for sale in interstate or foreign commerce. For endangered plants, section 9 of the Act prohibits any person subject to the jurisdiction of the United States to import or export; deliver, receive, carry, transport, or ship in interstate or foreign commerce in the course of a commercial activity; sell or offer for sale in interstate or foreign commerce; remove and reduce the species to possession from areas under Federal jurisdiction; maliciously damage or destroy any such species on areas under Federal jurisdiction; or remove, cut, dig up, or damage or destroy any species species in knowing violation of any State law or regulations or in the course of any violation of a State criminal trespass law. Section 10 of the Act provides for permitting of actions that may enhance the propagation or survival of the species, or that may ''take'' a species. We acknowledge that some economic impacts are a possible consequence of listing a species under the Act; for example, there may be costs to the landowner associated with the development of an HCP. In other cases, if the landowner does not acquire a permit for incidental take, the landowner may choose to forego certain activities on their property to avoid violating the Act, resulting in potential lost income. However, the statute does not provide for the consideration of such impacts when making a listing decision. Listing determinations are made ''solely on the basis of the best scientific and commercial data available.'' This rule only lists the 49 species from the Hawaiian Islands; it does not designate critical habitat.

(17) *Comment:* Two commenters stated that listing species and designating critical habitat on private property in Hawaii will alienate ranchers, a group that can help with species and habitat conservation. The commenters state that conservation can best be achieved by cooperation and coordination with private landowners.

Our Response: This rule only addresses the listing of 49 species from the Hawaiian Islands and does not designate critical habitat. We agree that partnerships can provide benefits for listed species and their habitat through development of conservation plans and implementation of management actions.

(18) *Comment:* One commenter stated that the Service should include the public now, not after designating critical habitat, with outreach, public forums, presentations, and meetings on every island for community groups, industry and business groups, the Soil and Water Conservation Districts, the Farm Bureau, Hawaii Cattlemen's Council, and schools.

Our Response: As described above, the publication of the proposed listing rule did not include a critical habitat proposal. We opened a 60-day comment period on the proposed listing rule, obtained extensive peer review, published notices in numerous local newspapers, reopened the comment period, and held a public hearing and information meeting. We considered all comments we received in preparing this final listing rule, and this rule incorporates new, substantive information provided to us by commenters.

Summary of Changes From the Proposed Rule

In preparing this final rule, we reviewed and fully considered comments from the public and peer reviewers on the proposed rule, and incorporated the following substantive changes into this final rule. None of the new information we received changed our evaluation of the threats to these species or our determinations in this final rule that they are endangered.

(1) We made revisions to the demographic status or distribution of 31 species of plants, based on comments from peer reviewers, by correcting current locations or numbers of individuals for: *Asplenium diellaciniatum, Calamagrostis expansa, Cyanea kauaulaensis, Cyclosorus boydiae, Cyrtandra hematos, Dryopteris glabra* var. *pusilla, Exocarpos menziesii, Gardenia remyi, Huperzia stemmermanniae, Joinvillea ascendens* ssp. *ascendens, Kadua fluviatilis, Microlepia strigosa* var. *mauiensis, Myrsine fosbergii, Nothocestrum latifolium, Ochrosia haleakalae, Phyllostegia brevidens, P. helleri, P. stachyoides, Portulaca villosa, Pritchardia bakeri, Pseudognaphalium sandwicensium* var. *molokaiense, Ranunculus hawaiensis, R. mauiensis, Sanicula sandwicensis, Santalum involutum, Schiedea diffusa* ssp. *diffusa, S. pubescens, Sicyos lanceoloideus, S. macrophyllus, Stenogyne kaalae* ssp. *sherffii,* and *Wikstroemia skottsbergiana.*

(2) We made revisions to specific threats to 31 plant species, based on comments from peer reviewers, including: *Asplenium diellaciniatum, Calamagrostis expansa, Cyanea kauaulaensis, Cyclosorus boydiae, Cyperus neokunthianus, Cyrtandra hematos, Deparia kaalaana, Dryopteris glabra* var. *pusilla, Exocarpos menziesii, Huperzia stemmermanniae, Hypolepis hawaiiensis* var. *mauiensis, Joinvillea ascendens* ssp. *ascendens, Kadua fluviatilis, K. haupuensis, Labordia lorenciana, Lepidium orbiculare, Microlepia strigosa* var. *mauiensis, Myrsine fosbergii, Nothocestrum latifolium, Ochrosia haleakalae, Phyllostegia brevidens, P. helleri, P. stachyoides, Portulaca villosa, Sanicula sandwicensis, Santalum involutum, Schiedea diffusa* ssp. *diffusa, S. pubescens, Sicyos lanceoloideus, Solanum nelsonii,* and *Wikstroemia skottsbergiana.*

(3) We corrected the taxonomy for the nonnative plant, California grass, from *Brachiaria mutica* to *Urochloa mutica.*

(4) We added further references concerning genetic research that supports differences in populations of the band-rumped storm-petrel breeding in different oceans and archipelagos.

(5) We added additional information on current nesting sites of the band-rumped storm-petrel on Lehua Island, Kauai, Molokai (coastal), Lanai (coastal), Hawaii Island (Hawaii Volcanoes National Park), and subalpine habitat

(Hawaii Island), based on comments regarding audio detections.

(6) We added information regarding additional populations of the orangeblack Hawaiian damselfly on Hawaii Island.

(7) We added information on predation of the orangeblack Hawaiian damselfly by Jackson's chameleons, backswimmers, and bullfrogs as a threat, and predation by the black twig borer as a threat to *Labordia lorenciana* and *Nothocestrum latifolium.*

(8) We added competition with caddisflies for resources, prey, and space as a potential threat to the orangeblack Hawaiian damselfly.

(9) We made revisions to the demographic status or distribution of the yellow-faced bees *Hylaeus anthracinus, H. facilis,* and *H. longiceps.*

(10) We added tsunami as a threat to the yellow-faced bees that occur in coastal areas (*Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris,* and *H. longiceps*), and to *Solanum nelsonii,* also in coastal areas.

(11) We changed ''Australian colletid'' to ''alien *Hylaeus''* bees, and included competition with sweat bees (*Lasioglossum* spp.) as a threat to the yellow-faced bees.

(12) We noted that transmission of diseases carried by nonnative insects through shared food sources could be a threat to the yellow-faced bees, but we have no specific evidence of this type of disease transmission.

(13) We added drought as a potential threat to all seven yellow-faced bees.

(14) We added infiltration of waste water, fertilizers, or pesticides resulting from development activities as a potential threat to the anchialine pool shrimp.

(15) We added sea-level rise and coastal inundation as a potential threat to *Solanum nelsonii,* as occurrences in low-lying coastal areas are at risk, and to the anchialine pool shrimp, as these events could increase connectivity of anchialine pools leading to further incursion by nonnative fish from one pool to another.

Background

Please refer to the proposed listing rule for the 49 species from the Hawaiian Islands (80 FR 58820; September 30, 2015), available at *http://www.regulations.gov* (see **ADDRESSES**), for the following information:

- For background information on the Hawaii Islands, see ''The Hawaiian Islands'' under **Background**;
- For ecosystem descriptions, see An Ecosystem-Based Approach To Assessing the Conservation Status of the 49 Species in the Hawaiian Islands;
- For detailed descriptions of the species and their taxonomy, see Description of the 49 Hawaiian Islands Species.

Hawaiian Islands Species Addressed in This Final Rule

Table 1A (plants) and Table 1B (animals), below, provide the common name, scientific name, and range (by Hawaiian Island) for the 49 species addressed in this final rule.

TABLE 1A—PLANT SPECIES LISTED AS ENDANGERED

Scientific name	Common name	Hawaiian Island
Plants		
Asplenium diellaciniatum	No common name (NCN)	Kauai.
Calamagrostis expansa	Maui reedgrass	Hawaii, Maui.
Cyanea kauaulaensis	NCN	Maui.
Cyclosorus boydiae	kupukupu makalii	Hawaii (H), Maui, Oahu.
Cyperus neokunthianus	NCN	Maui (H).
Cyrtandra hematos	haiwale	Molokai.
Deparia kaalaana	NCN	Hawaii (H), Maui, Kauai (H).
Dryopteris glabra var. *pusilla*	hohiu	Kauai.
Exocarpos menziesii	heau	Hawaii, Lanai (H).
Festuca hawaiiensis	NCN	Hawaii, Maui (H).
Gardenia remyi	nanu	Hawaii, Maui, Molokai, Kauai.
Huperzia stemmermanniae	NCN	Hawaii, Maui (H).
Hypolepis hawaiiensis var. *mauiensis*	olua	Maui.
Joinvillea ascendens ssp. *ascendens*	ohe	Hawaii, Maui, Molokai, Oahu, Kauai.
Kadua fluviatilis	kamapuaa	Oahu, Kauai.
Kadua haupuensis	NCN	Kauai (H).
Labordia lorenciana	NCN	Kauai.
Lepidium orbiculare	anaunau	Kauai.
Microlepia strigosa var. *mauiensis*	NCN	Hawaii, Maui, Oahu.
Myrsine fosbergii	kolea	Oahu, Kauai.
Nothocestrum latifolium	aiea	Maui, Lanai (H), Molokai, Oahu, Kauai (H).
Ochrosia haleakalae	holei	Hawaii, Maui.
Phyllostegia brevidens	NCN	Hawaii, Maui.
Phyllostegia helleri	NCN	Kauai.
Phyllostegia stachyoides	NCN	Hawaii (H), Maui, Molokai.
Portulaca villosa	ihi	Hawaii, Maui, Kahoolawe, Lanai (H), Molokai, Oahu (H), Kaula (H), Lehua (H), Nihoa (H).
Pritchardia bakeri	Baker's loulu	Oahu.
Pseudognaphalium sandwicensium var. *molokaiense*	enaena	Maui, Lanai (H), Molokai, Oahu (H).
Ranunculus hawaiensis	makou	Hawaii, Maui (H).
Ranunculus mauiensis	makou	Hawaii (H), Maui, Molokai (H), Oahu (H), Kauai.
Sanicula sandwicensis	NCN	Hawaii, Maui.
Santalum involutum	iliahi	Kauai.
Schiedea diffusa ssp. *diffusa*	NCN	Maui, Molokai (H).
Schiedea pubescens	maolioli	Maui, Lanai (H), Molokai.
Sicyos lanceoloideus	anunu	Oahu, Kauai.
Sicyos macrophyllus	anunu	Hawaii, Maui (H).
Solanum nelsonii	popolo	Hawaii, Maui (H), Molokai, Niihau (H), Pearl & Hermes, Kure, Midway, Laysan, Nihoa.
Stenogyne kaalae ssp. *sherffii*	NCN	Oahu (H).

TABLE 1A—PLANT SPECIES LISTED AS ENDANGERED—Continued

Scientific name	Common name	Hawaiian Island
Wikstroemia skottsbergiana	akia	Kauai.

(H) = historically known from island, but not observed in the past 20 years.

TABLE 1B—ANIMAL SPECIES LISTED AS ENDANGERED

Common name	Scientific name	Hawaiian Island
Animals		
Band-rumped storm-petrel	*Oceanodroma castro*	Hawaii, Maui, Kahoolawe, Lanai, Molokai (H), Oahu (H), Kauai, Lehua.
Yellow-faced bee	*Hylaeus anthracinus*	Hawaii, Maui, Kahoolawe, Lanai (H), Molokai, Oahu.
Yellow-faced bee	*Hylaeus assimulans*	Maui, Kahoolawe, Lanai, Oahu (H).
Yellow-faced bee	*Hylaeus facilis*	Maui (H), Lanai (H), Molokai, Oahu.
Yellow-faced bee	*Hylaeus hilaris*	Maui (H), Lanai (H), Molokai.
Yellow-faced bee	*Hylaeus kuakea*	Oahu.
Yellow-faced bee	*Hylaeus longiceps*	Maui, Lanai, Molokai, Oahu.
Yellow-faced bee	*Hylaeus mana*	Oahu.
Orangeblack Hawaiian damselfly	*Megalagrion xanthomelas*	Hawaii, Maui, Lanai, Molokai, Oahu, Kauai (H).
Anchialine pool shrimp	*Procaris hawaiana*	Hawaii, Maui.

(H) = Historically known from the island, but not observed in the last 20 years.

Summary of Biological Status of the 49 Hawaiian Islands Species

The Act directs us to determine whether any species is an endangered species or a threatened species because of any one of the factors listed in section 4(a)(1). We summarize, below, the biological condition of, and factors affecting, each of the 49 species and determine whether each species is endangered or threatened. The summaries below include only brief lists of factors affecting each species. Each of these factors is fully considered, in detail, in the subsequent section, Summary of Factors Affecting the 49 Species From the Hawaiian Islands.

Climate Change Vulnerability Assessment for the Hawaiian Plants

Twenty-seven of the plant species described below were evaluated for their vulnerability to climate change as part of a comprehensive vulnerability analysis of native Hawaiian plants, as indicated in Table 2 (Fortini *et al.* 2013, 134 pp.). This analysis used ''climate envelopes'' (geographic ranges encompassing suitable climate for each species, as defined by temperature and moisture (Fortini *et al.* 2013, p. 17)) developed from field records by Price *et al.* (2012) to project each species' potential range in the year 2100. The location and spatial extent of these future ranges, and their overlap with current ranges, allows calculation of a vulnerability score. Estimates of vulnerability based on climate-envelope modeling are conservative in that they do not take into account potential changes in interspecific interactions such as predation, disease, pollination, or competition. This study provides a landscape- or island-scale picture of potential climate-change vulnerability of Hawaiian plants; the results are less clear at finer spatial scales (Fortini *et al.* 2013, p. 42). However, all 27 of these plant species scored moderately or extremely vulnerable in the analysis because of their relative inability to exhibit the possible responses necessary for persistence under projected climate change (Fortini *et al.* 2013, 134 pp.). These responses include the migration response (dispersal and establishment in new areas beyond their current distribution), the microrefugia response (persistence in topographically complex areas that are less exposed), evolutionary adaptation response (morphological changes in response to the changing environment), and toleration response (adaptation to environmental changes through phenotypic plasticity). In the study, response probabilities ranged from 0 (not vulnerable at all) to 1.0 (extremely vulnerable; species likely to disappear or ''wink out'' by the year 2100) (Fortini *et al.* 2013, pp. 6–7). Many species found to be moderately vulnerable in this study, with scores of 0.5 or greater, already are listed as endangered; some already are extinct (Fortini *et al.* 2013, pp. 24, 93). Therefore, because the species in this rule were found by the Fortini *et al.* (2013) study to be moderately (0.5) to extremely (1.0) vulnerable, we deem the likelihood of their persistence to be low with the impacts of climate change in addition to other threats these species face. The environmental changes associated with climate change are likely to exacerbate these ongoing threats and further reduce the likelihood that these species will persist in the future.

Plants

Asplenium diellaciniatum (no common name, NCN), a terrestrial or epipetric (growing on rocks) fern in the spleenwort family (Aspleniaceae), is endemic to Kauai (Palmer 2003, p. 117). Little is known of the historical distribution of this species. It was described from a collection from ''Halemanu,'' the Knudsen homestead area on western Kauai. Currently, this fern is found in montane mesic forest at Kawaiiki and Kaluahaulu Ridge (Palmer 2003, p. 117; HBMP 2010; Lorence *et al.* 2013, p. 167) in 3 occurrences, totaling approximately 100 individuals, 30 of which are in an ungulate exclosure (TNCH 2007; HBMP 2010; Lorence *et al.* 2013, p. 167; Wood 2013, in litt.; Plant Extinction Prevention Program (PEPP) 2014, pp. 33, 59; Kishida 2015, in litt.; Williams 2015, in litt.).

Feral pigs (*Sus scrofa*), goats (*Capra hircus*), and black-tailed deer (*Odocoileus hemionus columbianus)* modify and destroy the habitat of *Asplenium diellaciniatum* on Kauai, with evidence of the activities of these animals reported in the areas where *A. diellaciniatum* occurs (Service 1999, p. 72; HBMP 2010). Feral pigs, goats, and black-tailed deer also forage on *A. diellaciniatum.* Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt; Hawaii Administrative

Rule-Hawaii Department of Land and Natural Resources (HAR–DLNR) 2010, in litt.). Nonnative plants, such as *Adiantum hispidulum* (rough maidenhair fern), *Blechnum appendiculatum* (no common name), *Erigeron karvinskianus* (daisy fleabane), and *Rubus argutus* (prickly Florida blackberry), compete with *A. diellaciniatum,* modify and destroy native habitat, and displace native plant species by competing for water, nutrients, light, and space; they may also produce chemicals that inhibit growth of other plants (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74; Williams 2015, in litt.). Additionally, the small number of individuals of *A. diellaciniatum* limits this species' ability to adapt to environmental change.

The remaining occurrences of *Asplenium diellaciniatum* are at risk; *A. diellaciniatum* numbers are decreasing on Kauai, and both the species and its habitat continue to be negatively affected by destruction and modification by ungulates and by direct competition by nonnative plants, combined with herbivory by nonnative ungulates. Because of the threats described above, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Calamagrostis expansa (Maui reedgrass), a perennial in the grass family (Poaceae), is known from the islands of Maui and Hawaii (O'Connor 1999, p. 1509; Wagner and Herbst 2003, p. 59). Historically, *C. expansa* was known from wet forest, open bogs, and bog margins on Maui at 17 locations on east Maui, and in a large occurrence covering nearly the entire summit on west Maui, and was discovered in 7 occurrences totaling approximately 750 individuals on the island of Hawaii in 1995 (O'Connor 1999, p. 1509; HBMP 2010; Smithsonian National Museum of Natural History (NMNH) Botany Collections 2014, in litt.; Vetter 2015, in litt.). Currently, this species is known from 13 to 33 occurrences totaling fewer than 750 individuals. This species is rhizomatous (growing from underground stems), making it difficult to determine exact numbers of distinct individuals and populations, and botanists' estimations vary. On the island of Maui, there are 2 occurrences in the west Maui Mountains (approximately 100 individuals) and from 7 to as many as 40 occurrences in the east Maui Mountains (totaling at least 200 individuals), often along ridges above 6,000 feet (ft) (1,830 meters (m)), or on raised hummocks in wet forest and bogs, in the montane wet ecosystem (Wood 2005a, in litt.; TNCH 2007; Welton 2008 and 2010, in litt.; Fay 2010, in litt.; HBMP 2010; Oppenheimer 2010, in litt.; Agorastos 2011, in litt.; Vetter 2015, in litt.). Most of the east Maui occurrences are in exclosures (Duvall 2015, in litt.). On the island of Hawaii, there are 3 occurrences in the Kohala Mountains (totaling several hundred individuals) and 1 occurrence of 6 individuals last observed in 2004 in Upper Waiakea Forest Reserve, in the montane wet ecosystem (Perry 2006, in litt; TNCH 2007; HBMP 2010; Perry 2015, in litt.).

Feral pigs modify and destroy the habitat of *Calamagrostis expansa* on Maui and Hawaii, with evidence of the activities of feral pigs reported in the areas where *C. expansa* occurs on east Maui, and on Hawaii Island in the Kohala Mountains and in the Waiakea Forest Reserve (Hobdy 1996, in litt.; Perlman 1996, in litt.; Wood 1996, in litt.; Perry 2006, in litt.; HBMP 2010). Some occurrences on east and west Maui are currently fenced; however, ungulate and weed control activities must be maintained to provide continued protection (Duvall 2015, in litt.). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Rats have been noted by biologists as a threat to *C. expansa* at Laupahoehoe Natural Area Reserve (NAR) on Hawaii Island, by consuming seeds (HBMP 2010). Nonnative plants compete with this species and modify and destroy native habitat, negatively affecting *C. expansa* on east and west Maui and Hawaii Island. Additionally, the small number of individuals limits this species' ability to adapt to environmental change. Fortini *et al.* (2013, p. 68) found that, as environmental conditions are altered by climate change, *C. expansa* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *C. expansa* described above (see ''Climate Change'' under *Factor E. Other Natural or Manmade Factors Affecting Their Continued Existence,* below).

The remaining occurrences of *Calamagrostis expansa* are at risk; *C. expansa* populations are decreasing on Maui and Hawaii Island, and this species continues to be negatively affected by habitat modification and destruction by feral pigs, and by direct competition from nonnative plants, combined with herbivory by feral pigs and rats. This species is vulnerable to the effects of climate change, and the likelihood of its persistence with the impacts of climate change, exacerbated by the ongoing threats, is low. We find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Cyanea kauaulaensis (NCN), a shrub in the bellflower family (Campanulaceae), is endemic to Maui (Oppenheimer and Lorence 2012, p. 15). *Cyanea kauaulaensis* occurs on leeward west Maui, on talus or basalt boulder-strewn slopes along perennial streams from 2,400 to 3,000 ft (730 to 900 m), in the lowland wet ecosystem (TNCH 2007; HBMP 2010; Oppenheimer and Lorence 2012, pp. 17–18). This species was first collected during a botanical survey in 1989. Further surveys (in 2008, 2009, and 2011) revealed more individuals, and study of the collections indicated that it was a new species of *Cyanea.* Currently, *C. kauaulaensis* is known from Kauaula Valley (approximately 100 individuals) (Oppenheimer and Lorence 2012, pp. 15–16, 20; Duvall 2015, in litt.; Oppenheimer 2015, in litt.).

The greatest threats to this species currently are the low numbers of occurrences and individuals, its limited range, poor seedling recruitment, and loss of pollinators and dispersal agents (Oppenheimer and Lorence 2012, pp. 20–21; Duvall 2015, in litt.). Rats and slugs are noted as a threat to *Cyanea kauaulaensis* because of their herbivory and seed predation. Additionally, nonnative plants modify and destroy native habitat and outcompete native species, negatively affecting *C. kauaulaensis* and its habitat. Although feral ungulates are present on west Maui, the known occurrences of *C. kauaulaensis* may be less at risk from this particular threat because of their location in extremely steep and rugged terrain; however, erosion, landslides, flooding, and drying due to climate change affect this species because of the terrain where it occurs (Oppenheimer and Lorence 2012, pp. 20–21; Duvall 2015, in litt.). The remaining occurrence of *Cyanea kauaulaensis* is at risk. Because of the threats described above, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Cyclosorus boydiae (previously *Christella boydiae*) (kupukupu makalii) is a small to medium-sized member of the thelypteroid fern family (Thelypteridaceae) (Pukui and Elbert 1986, p. 186; Palmer 2003, pp. 87–88). Typical habitat for *C. boydiae* is exposed, rocky, or moss-covered banks of stream courses in dense-wet *Metrosideros-Acacia* (ohia-koa) forest, from 2,300 to 4,400 ft (700 to 1,350 m), with other native ferns, grasses, and dwarfed woody species, in the lowland wet and montane wet ecosystems (Hillebrand 1888, p. 572; Medeiros *et al.* 1993, p. 87; Wagner (W.H.) *et al.* 1999, p. 156; TNCH 2007; HBMP 2010; Gates 2015, in litt.). Historically, this fern was known from near sea level to 4,400 ft (1,350 m) on Oahu, Maui, and Hawaii Island (Hillebrand 1888, p. 572; Medeiros *et al.* 1993, pp. 86–87; Palmer 2003, pp. 87–88). Currently, *C. boydiae* is found on Oahu and east Maui, in 13 occurrences totaling approximately 400 individuals (Palmer 2003, pp. 87–88; Oppenheimer 2008, in litt.; Fay 2010, in litt.; HBMP 2010; Welton 2010, in litt.). On east Maui, there are at least 11 occurrences (over 1,000 individuals) in the lowland wet and montane wet ecosystems, and on Oahu there are 2 occurrences in the Koolau Mountains in the montane wet ecosystem, totaling 40 individuals, and one historic occurrence in Kaluanui Drainage, but the status of the species at this location is currently unknown (Palmer 2003, pp. 87–88; Wood 2007a, in litt.; Kam 2008, in litt.; Oppenheimer 2008 and 2010, in litt.; HBMP 2010; Welton 2010, in litt.; Ching 2011, in litt.; Ching Harbin 2015, in litt.; Oppenheimer 2015, in litt.). The historical occurrence of *C. boydiae* on the island of Hawaii was found in the lowland wet ecosystem (HBMP 2010).

Feral pigs modify and destroy the habitat of *Cyclosorus boydiae* on Maui and Oahu, with evidence of their activities reported at three occurrences of *C. boydiae* on east Maui and at two occurrences on Oahu. However, on east Maui, two of the five occurrences are provided protection in Haleakala National Park (Wood 2007a, in litt.; HBMP 2010; Kawelo 2011, in litt.). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Historical occurrences of *C. boydiae* on Oahu have dramatically declined in numbers or disappeared as a result of habitat modification and destruction, landslides and flooding, invasion of lower elevation stream courses by nonnative plants, and manmade stream diversions (Medeiros *et al.* 1993, p. 88; Palmer 2003, p. 88). Nonnative plants, such as *Tibouchina herbacea* (glorybush), modify and destroy native habitat of. *C. boydiae* and outcompete this and other native species for water, nutrients, light, and space (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74). Herbivory by feral pigs negatively impacts this species (HBMP 2010). This species occurs on stream banks at or just above water level, and flash floods or drought can damage and destroy it (Ching Harbin 2015, in litt.). Fortini *et al.* (2013, p. 72) found that, as environmental conditions are altered by climate change, *C. boydiae* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *C. boydiae* described above.

The remaining occurrences of *Cyclosorus boydiae* are at risk; *C. boydiae* populations are decreasing on Oahu and Maui, and the species continues to be negatively affected by habitat loss and destruction by ungulates, direct competition with nonnative plants, and herbivory by ungulates. Flash floods and drought can damage and destroy this species. The effects of climate change are likely to further exacerbate these threats. Because of the threats describe above, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Cyperus neokunthianus (NCN) is a perennial plant in the sedge family (Cyperaceae) (Koyama 1999, p. 1420). *Cyperus neokunthianus* occurs in riparian areas of the lowland wet ecosystem on west Maui (Koyama 1999, p. 1420; TNCH 2007; HBMP 2010). Historically, this species was known from Honokohau Falls and Waihee Valley (HBMP 2010; Global Biodiversity Information Facility (GBIF) database 2014, in litt.). This species was last observed in 1996. Currently, there are no known individuals in the wild; however, Waihee Valley and Maui County lands have been suggested as potential habitat for further surveys (PEPP 2013, p. 32; PEPP 2014, p. 59; Duvall 2015, in litt.).

Feral pigs modify and destroy the habitat of *Cyperus neokunthianus* on west Maui, with evidence of the activities of feral pigs reported in the area where this species was last observed (HBMP 2010). Habitat modifications resulting from activities of feral pigs that affect *C. neokunthianus* include direct destruction of this species and other native plants, disruption of topsoil leading to erosion, and establishment and spread of nonnative plants. Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Additionally, nonnative plants modify and destroy native habitat and outcompete native species, also negatively affecting habitat of *C. neokunthianus* on west Maui. Currently, there are no known extant individuals, and low numbers makes this species more vulnerable to extinction because of the higher risks from genetic bottlenecks, random demographic fluctuations, and localized catastrophes.

Cyperus neokunthianus is at risk and continues to be negatively affected by modification and destruction by nonnative animals and plants (Duvall 2015, in litt.). Because of the threats described above, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Cyrtandra hematos (haiwale), a shrub in the African violet family (Gesneriaceae), is endemic to Molokai (Wagner *et al.* 1999, pp. 760, 762). *Cyrtandra hematos* occurs in wet forest from 3,400 to 3,800 ft (1,030 to 1,150 m) on eastern Molokai, in the montane wet ecosystem (Wagner *et al.* 1999, pp. 760, 762; HBMP 2010; TNCH 2007). Historically, this species was known from four locations on Molokai (Wagner *et al.* 1999, pp. 760, 762). Currently, there are fewer than 100 individuals at two locations on Molokai (Duvall 2015, in litt.; Oppenheimer 2015, in litt.).

Feral pigs and goats modify and destroy the habitat of *Cyrtandra hematos* on Molokai, with evidence of the activities of these animals reported in the areas where this species occurs (Service 2015, in litt.). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Additionally, nonnative plants modify and destroy native habitat and outcompete this and other native species for water, nutrients, light, and space, or a nonnative plant may produce chemicals that inhibit growth of other plants (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 in Cuddihy and Stone 1990, p. 74; Service 2015, in litt.). This species experiences reduced reproductive vigor due to low numbers and lack of regeneration, leading to diminished capacity to adapt to environmental changes, and thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). This species hybridizes with *C. grayana* (Oppenheimer 2015, in litt.). Fortini *et al.* (2013, p. 72) found that, as environmental conditions are altered by climate change, *C. hematos* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *C. hematos* described above.

The remaining occurrences of *Cyrtandra hematos* are at risk. The known individuals are restricted to a small area on Molokai and continue to be negatively affected by habitat modification and destruction by ungulates and nonnative plants, and by direct competition with nonnative plants. The low number of remaining individuals limits this species' ability to adapt to environmental changes. Hybridization results in a reduction of the numbers of *C. hematos.* The effects of climate change are likely to further exacerbate these threats. We find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Deparia kaalaana (NCN), a small, terrestrial fern in the ladyfern family (Athyriaceae), is recognized as a distinct taxon by Palmer (2003, pp. 109–111) and Christenhusz *et al.* (2012, p. 16). This fern is historically known from the islands of Kauai, Maui, and Hawaii, on rocky stream banks and in wet forest, in the lowland mesic and lowland wet ecosystems (Palmer 2003, pp. 109–111; TNCH 2007; HBMP 2010; Oppenheimer and Bustamente 2014, p. 103; PEPP 2014, p. 95). *Deparia kaalaana* was presumed extinct on all three islands where it previously occurred until one individual was discovered on east Maui, growing along a perennial stream on the western side of a small pool with other native ferns and herbaceous plants (Oppenheimer and Bustamente 2014, pp. 103–107; PEPP 2014, p. 95).

Feral pigs modify and destroy habitat of *Deparia kaalaana* by facilitating the spread of nonnative plants, which converts vegetation communities from native to nonnative (Cuddihy and Stone 1990, p. 63; Oppenheimer and Bustamente 2014, p. 106). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt; HAR–DLNR 2010, in litt.). Nonnative plants, such as *Blechnum appendiculatum* (NCN), *Clidemia hirta* (Koster's curse), *Hedychium gardnerianum* (kahili ginger), *Prunella vulgaris* (selfheal), and *Rubus argutus,* are capable of displacing all of the riparian habitat elements, including native plants, in the area where *D. kaalaana* occurs. Nonnative slugs such as *Derocerus laeve* and *Limax maximus* are common in the area and can consume young plants (Joe and Daehler 2008, pp. 252–253). Flash floods and drought can damage and destroy this species at its only known location. A single catastrophic event may result in extirpation of the remaining individual.

The remaining occurrence of *Deparia kaalaana* is at risk, and both the species and its habitat on Hawaii, Maui, and Kauai continues to be negatively affected by modification and destruction by nonnative ungulates, and by direct competition with nonnative plants, combined with herbivory by nonnative ungulates and slugs. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *D. kaalaana* described above. We find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Dryopteris glabra var. *pusilla* (hohiu) is a small, terrestrial fern in the wood fern family (Dryopteridaceae) (Palmer 2003, p. 144). Habitat for *D. glabra* var. *pusilla* is deep shade on rocky, mossy streambanks in wet forest at about 4,000 ft (1,200 m), in the montane wet ecosystem on Kauai (Palmer 2003, p. 144; TNCH 2007; HBMP 2010). Historically, *D. glabra* var. *pusilla* was known from the Kawaikoi stream area (HBMP 2010). Currently, this variety is known from fewer than 250 individuals in the Alakai Wilderness Preserve on Kauai (National Tropical Botanical Garden (NTBG) Herbarium Database 1995, in litt.; HBMP 2010; Wood 2015, in litt.).

Dryopteris glabra var. *pusilla* is at risk from habitat modification and destruction by nonnative plants, feral pigs, and black-tailed deer (Wood 2015, in litt.). Most individuals occur in the Alakai Wilderness Preserve; however, only portions of the Preserve are fenced to prevent ungulate incursion. Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants modify and destroy native habitat and outcompete this and other native species for water, nutrients, light, and space, or a nonnative plant may produce chemicals that inhibit growth of other plants, also negatively affecting habitat of *D. glabra* var. *pusilla* (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74). Herbivory by rats and slugs is a threat to *D. glabra* var. *pusilla* (Wood 2015, in litt.). In addition, the limited number of occurrences and few individuals lead to a diminished capacity to adapt to environmental changes, thereby lessening the probability of long-term persistence, and a single catastrophic event may result in extirpation of remaining occurrences. Landslides along streambanks have been known to destroy populations of this fern (Wood 2015, in litt.).

Fortini *et al.* (2013, p. 74) found that, as environmental conditions are altered by climate change, *D. glabra* var. *pusilla* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *D. glabra* var. *pusilla* described above. Because of these threats, we find that this variety is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Exocarpos menziesii (heau) is a shrub in the sandalwood family (Santalaceae) (Wagner *et al.* 1999, p. 1218). This species occurs in *Metrosideros* shrubland or drier forest areas, and on lava flows with sparse vegetation, from 4,600 to 6,900 ft (1,400 to 2,100 m), in the montane dry ecosystem on the island of Hawaii (Wagner *et al.* 1999, p.

1218; TNCH 2007), and historically occurred in the lowland mesic (Lanai and Hawaii Island) and montane mesic ecosystems (Hawaii Island) (TNCH 2007; Bishop Museum 2014). *Exocarpos menziesii* is historically known from the island of Lanai and was wide-spread on the island of Hawaii (Wagner *et al.* 1999, p. 1218; TNCH 2007; Bishop Museum 2014). Currently, there are seven scattered occurrences on Hawaii Island, six of which consist of only a few individuals, the seventh totals an estimated 1,800 individuals (PEPP 2013, pp. 10, 33; Thomas 2014, in litt.; Evans 2015a, in litt.; Orlando 2015, in litt.; Perry 2015, in litt.). There are no currently known occurrences of this species on Lanai.

Feral goats, mouflon, and sheep modify and destroy the habitat of *Exocarpos menziesii* on Hawaii Island, and may forage on this species, with evidence of the activities of these animals reported in the areas where this species occurs (Service 2015, in litt.). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt; HAR–DLNR 2010, in litt.). Feral ungulate management is incorporated into the U.S. Army's Pohakuloa Training Area (PTA) management plan, and plants at PTA may be provided some protection within fenced management units in the training area (Evans 2015a, in litt.); however, it is reported that feral goats are still being removed from within the fenced area (Nadig 2015, in litt.). Any individuals of *E. menziesii* outside of fenced exclosures or outside of the managed area are at risk. Additionally, nonnative plants modify and destroy native habitat and outcompete this and other native species for water, nutrients, light, and space, or a nonnative plant may produce chemicals that inhibit growth of other plants, also negatively affecting habitat of *E. menziesii* (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74). Occurrences and numbers of individuals have declined on the island of Hawaii (HBMP 2010; Thomas 2014, in litt.), where *E. menziesii* was once widely distributed from the south to the west sides of the island, and are now restricted to seven locations. Consequently, *E. menziesii* experiences reduced reproductive vigor due to reduced levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby reducing the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Fire is a likely threat to this species; although the U.S. Army has constructed firebreaks and has standard operating procedures (SOPs) in place for prevention and suppression of wildfires at the PTA, wildfires may encroach from other areas (U.S. Army Garrison 2013, in litt.). The small number of individuals outside the larger occurrence at the PTA limits this species' ability to adapt to environmental changes. Fortini *et al.* (2013, p. 76) found that, as environmental conditions are altered by climate change, *E. menziesii* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *E. menziesii* described above.

The remaining occurrences of *Exocarpos menziesii* are at risk from modification and destruction by feral goats, mouflon, and sheep; from herbivory by these ungulates; and by the small number of remaining occurrences. Fire is a likely threat to this species. The effects of climate change are likely to exacerbate these threats. Because of these threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Festuca hawaiiensis (NCN) is a cespitose (growing in tufts or clumps) annual in the grass family (Poaceae) (O'Connor 1999, p. 1547). Typical habitat for this species is dry forest at 6,500 ft (2,000 m), in the montane dry ecosystem (O'Connor 1999, p. 1547). Historically, *F. hawaiiensis* occurred at Hualalai and Puu Huluhulu on the island of Hawaii, and possibly at Ulupalakua on Maui; however, it is no longer found at these sites (O'Connor 1999, p. 1547). Currently, *F. hawaiiensis* is only known from the U.S. Army's PTA on the island of Hawaii (HBMP 2010). These remaining four occurrences are within an area of less than 10 square miles (mi) (26 square kilometers (km)) and total approximately 1,500 individuals (U.S. Army Garrison 2013, in litt.; Evans 2015a, in litt.).

Habitat destruction and modification by feral goats and sheep is a threat to *Festuca hawaiiensis.* These ungulates also browse on native plants such as grasses, including *F. hawaiiensis.* Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Feral ungulate management is incorporated into the U.S. Army's PTA management plan, and these plants are provided some protection within fenced management units in the training area (Evans 2015a, in litt.); however, feral goats are still being removed from inside the fenced area (Nadig 2015, in litt.). In addition, any individuals of *F. hawaiiensis* outside of fenced exclosures or outside of the managed area are at risk. Nonnative plants, such as *Cenchrus setaceus* (*Pennisetum setaceum;* fountain grass), are naturalized in the area and outcompete *F. hawaiiensis* and other native plants. Occurrences and numbers of individuals are declining on the island of Hawaii, and *F. hawaiiensis* experiences reduced reproductive vigor due to reduced levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby reducing the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361; HBMP 2010). Fire is a likely threat to this species, especially because of the ingress of nonnative grass species. Although the U.S. Army has constructed firebreaks and has SOPs in place for prevention and suppression of wildfires at the PTA, fires may encroach from other areas, exacerbated by fuel loads provided by nonnative grasses (U.S. Army Garrison 2013, in litt.). Fortini *et al.* (2013, p. 76) found that, as environmental conditions are altered by climate change, *F. hawaiiensis* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *F. hawaiiensis* described above.

The remaining occurrences of *Festuca hawaiiensis* are at risk; *F. hawaiiensis* occurrences have decreased on Hawaii Island, as it no longer occurs at Hualalai and Puu Huluhulu, and the species may be extirpated from Maui. This species continues to be negatively affected by habitat modification and destruction by ungulates and by direct competition with nonnative plants, combined with herbivory by ungulates. Fire is a likely threat to the species and its habitat. The effects of climate change are likely to further exacerbate these threats. Because of the threats described above, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Gardenia remyi (nanu) is a tree in the coffee family (Rubiaceae) (Wagner *et al.* 1999, p. 1133). Typical habitat for *G. remyi* is mesic to wet forest from 190 to 3,000 ft (60 to 760 m), in the lowland mesic (Kauai, Molokai, and Hawaii Island) and lowland wet ecosystems (Kauai, Molokai, Maui, and Hawaii Island) (Wagner *et al.* 1999, p. 1133; TNCH 2007; HBMP 2010; Oppenheimer 2015, in litt.). Historically, this species was found on the island of Hawaii at Wao Kele O Puna NAR, Waiakea Forest Reserve, Pahoa, and Hakalau Nui. On Maui, this species was known from Wailuaiki and Waikamoi in the Koolau Forest Reserve, and from Papaaea and Kipahulu. On Molokai, this species was known from Keopukaloa, Pukoo, Honomuni, Halawa, and Kaluaaha (HBMP 2010). On Kauai, this species ranged across the island, and was known from Halelea, Kealia, Moloaa, and Lihue-Koloa Forest Reserves, including Hanakapiai Valley, Mahaulepu, and east Wahiawa Bog. Currently, *G. remyi* is known from 16 occurrences totaling approximately 90 individuals on the islands of Hawaii, Maui, Molokai, and Kauai (Wood 2005b, in litt.; Oppenheimer 2006, in litt; Perry 2006, in litt.; Welton 2008, in litt.; Agorastos 2010, in litt.; HBMP 2010; Perlman 2010, in litt.). An occurrence on east Maui has been observed to decline from 14 individuals in 1992, to only 1 individual by 2015 (Duvall 2015, in litt.).

Habitat modification and destruction by feral pigs, goats, and axis deer negatively affects *Gardenia remyi* and areas suitable for its reintroduction (Perry, in litt. 2006; PEPP 2008, p. 102; HBMP 2010). Feral pigs and signs of their activities have been reported at occurrences of *G. remyi* on the island of Hawaii, on Kauai, on east and west Maui, and on Molokai. Goats and signs of their activities are reported at the occurrences *G. remyi* on Kauai and Molokai. Axis deer and signs of their activities are reported at the occurrences of *G. remyi* on Molokai (HBMP 2010). Herbivory by these ungulates is a threat to *G. remyi,* as they browse on leaves and other parts of almost any woody or fleshy plant species. Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants, such as *Clidemia hirta, Hedychium gardnerianum, Psidium cattleianum* (strawberry guava), and *Tibouchina herbacea* on Hawaii Island (Perry 2006, in litt.); *Lantana camara* (lantana), *Psidium guajava,* and *Rubus argutus* on Kauai (Wood 2004, in litt.); *Ageratina adenophora* (Maui pamakani), *Rubus rosifolius* (thimbleberry), and *T. herbacea* on Maui (HBMP 2010); and *C. hirta* and *P. cattleianum* on Molokai (HBMP 2010), modify and destroy native habitat of *G. remyi* and outcompete this and other native plants for water, nutrients, light, and space in areas where *G. remyi* occurs on these islands. Landslides are a threat to occurrences and habitat of *G. remyi* on Hawaii Island (Perry 2006, in litt.). Lack of pollination was suggested as the cause for abortion of immature fruits that were seen among plants on Hawaii Island (PEPP 2010, p. 73). Similarly, Agorastos (2011, in litt.) reported no viable seed production in the wild or within *ex situ* collections and no recruitment in the wild among the 14 individuals observed on the island of Hawaii, Maui, and Molokai, for unknown reasons (Duvall 2015, in litt.; Oppenheimer 2015, in litt.). Some species of *Gardenia* are dioecious (male and female flowers on separate plants) and although the breeding system of *G. remyi* is currently unknown, this may be a cause of failure to produce viable seed in isolated individuals (Lorence 2015, in litt.). Predation of seeds by rats is reported as a threat to individuals on Kauai (NTBG 2008, in litt.). Fortini *et al.* (2013, p. 76) found that, as environmental conditions are altered by climate change, *G. remyi* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *G. remyi* described above.

The remaining occurrences of *Gardenia remyi* are at risk. *Gardenia remyi* continues to be negatively affected by habitat modification and destruction by ungulates, and by direct competition from nonnative plants, combined with herbivory by ungulates and seed predation by rats. Natural events such as landslides are a threat to occurrences on the island of Hawaii. Pollination and seed production are observed to be limited. Low numbers of individuals (90 total individuals distributed across 4 islands) makes this species more vulnerable to extinction because of the higher risks from genetic bottlenecks, random demographic fluctuations, and localized catastrophes. The effects of climate change are likely to exacerbate these threats. Because of the threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Huperzia stemmermanniae (NCN) is an epiphytic hanging fir-moss (a fern ally) in the club moss family (Lycopodiaceae) (Palmer 2003, pp. 257–259). This species is epiphytic on rough bark of living trees or fallen logs in *Metrosideros polymorpha-Acacia koa* forest on the island of Hawaii, from 3,200 to 3,800 ft (975 to 1,160 m), in the montane wet ecosystem (Medeiros *et al.* 1996b, p. 93; Palmer 2003, pp. 257, 259; TNCH 2007; HBMP 2010). There is little information available on the historical range of this species. *Huperzia stemmermanniae* was first collected in 1981, from two occurrences totaling 10 individuals in Laupahoehoe NAR on the island of Hawaii, and was mistakenly identified as *H. mannii* (Medeiros *et al.* 1996b, p. 93; HBMP 2010). One individual occurred in Kaapahu Valley on east Maui, but has not been relocated since 1995 (Perry 2006, in litt.; Welton 2008, in litt.; HBMP 2010; Conry 2012, in litt.; Perry 2015, in litt.). In 2006, there were estimated to be as many as 20 individuals in Laupahoehoe (Perry 2006, in litt.). Currently, there are only a few individuals remaining due to prolonged drought conditions (Perry 2015, in litt.).

Feral pigs, goats, axis deer, and cattle modify and destroy the habitat of *Huperzia stemmermanniae* on Maui, and feral pigs modify and destroy the habitat of this species on Hawaii Island (Medeiros *et al.* 1996b, p. 96; Wood 2003, in litt.; HBMP 2010). Herbivory by these ungulates is a threat to *H. stemmermanniae.* Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants, such as *Clidemia hirta, Miconia calvescens, Psidium cattleianum,* and *Cyathea cooperi* (Australian tree fern), modify and destroy the forest habitat that supports the native species upon which this epiphytic plant grows, and drought also negatively affects this species and its habitat (Medeiros *et al.* 1996b, p. 96; Perry 2006, in litt.; HBMP 2010). *Huperzia stemmermanniae* experiences reduced reproductive vigor due to reduced levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361; HBMP 2010). Fortini *et al.* (2013, p. 77) found that, as environmental conditions are altered by climate change, *H. stemmermanniae* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *H. stemmermanniae* described above.

The remaining occurrences of *Huperzia stemmermanniae* are at risk. The known individuals are restricted to a small area on Hawaii Island, and this species continues to be negatively affected by habitat modification and destruction by ungulates. The low numbers of individuals *H. stemmermanniae* reduces the probability of its long-term persistence. The effects of climate change are likely to further exacerbate these threats. Because of the threats described above, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Hypolepis hawaiiensis var. *mauiensis* (olua) is a small terrestrial member of the bracken fern family (Dennstaedtiaceae), and is recognized as a distinct taxon by Palmer (2003, pp. 168–169). *Hypolepis hawaiiensis* var. *mauiensis* occurs in wet forest, predominately in the montane wet ecosystem (Palmer 2003, pp. 168–170; Oppenheimer 2015, in litt.). This variety is historically known from west Maui (Palmer 2003, pp. 168–170). Currently, 5 to 10 individuals are known from openings between bogs on west Maui, and a few individuals are known from east Maui (Maui Nui Task Force (MNTF) 2010, in litt.).

Nonnative plants, such as *Tibouchina herbacea,* modify and destroy the habitat of *Hypolepis hawaiiensis* var. *mauiensis* on east and west Maui (HBMP 2010; MNTF 2010, in litt.). Nonnative plants also displace this and other native plant species by competing for water, nutrients, light, and space, or they may produce chemicals that inhibit growth of other plants (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stones 1990, p. 74; MNTF 2010, in litt.). Herbivory by slugs is a threat (Oppenheimer 2015, in litt.). This fern experiences reduced reproductive vigor due to low numbers of individuals, leading to diminished capacity to adapt to environmental changes, and thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Fortini *et al.* (2013, p. 78) found that, as environmental conditions are altered by climate change, *H. hawaiiensis* var. *mauiensis* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *H. hawaiiensis* var. *mauiensis* described above.

The remaining occurrences of *Hypolepis hawaiiensis* var. *mauiensis* are at risk. Nonnative plants modify and destroy native habitat, and also outcompete native plants, and this plant is threatened by herbivory by slugs. This fern is also vulnerable to the impacts of climate change, and the small number of remaining individuals limits its ability to adapt to environmental change. Because of these threats, we find that this variety is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Joinvillea ascendens ssp. *ascendens* (ohe) is an erect perennial herb in the joinvillea family (Joinvilleaceae) (Wagner *et al.* 1999, p. 1450). *Joinvillea ascendens* ssp. *ascendens* occurs in wet to mesic *Metrosideros polymorpha-Acacia koa* lowland and montane forest, and along intermittent streams, from 1,000 to 4,300 ft (305 to 1,300 m); in the lowland mesic (Kauai and Oahu), lowland wet (Oahu, Molokai, Maui, and Hawaii Island), montane wet (Kauai, Oahu, Molokai, Maui, and Hawaii Island), and montane mesic ecosystems (Kauai) (TNCH 2007; HBMP 2010). Historically, this subspecies was found in widely distributed occurrences on the islands of Kauai, Oahu, Molokai, Maui, and Hawaii Island (HBMP 2010). On Kauai, this subspecies was wide-ranging across the mountains and into coastal areas (HBMP 2010). On Oahu, this subspecies was known from the summit area of the Waianae Mountains, and ranged along the entire length of the Koolau Mountain range. On Molokai, this subspecies was known from the eastern half of the island ranging from Pelekunu Preserve and east to Halawa Valley. On west Maui, this subspecies occurred in the summit area, and on the northeastern side of east Maui it ranged from the Koolau FR to Kaapahu (Gates 2015, in litt.). On Hawaii Island, it occurred almost island-wide. Currently, *J. ascendens* ssp. *ascendens* is still found on the same islands, in only 56 occurrences totaling approximately 200 individuals (HBMP 2010; Conry 2012, in litt.).

Nonnative ungulates modify and destroy habitat on all of the islands where *Joinvillea ascendens* ssp. *ascendens* occurs (Moses 2006, in litt.; Oppenheimer 2006, in litt.; Welton and Haus 2008, p. 16; HBMP 2010; Perlman 2010, in litt.). Herbivory by feral pigs, goats, axis deer, black-tailed deer, and rats is a threat to this subspecies (HBMP 2010; Williams 2015, in litt.). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Many nonnative plant species, such as *Passiflora tarminiana* (banana poka), *Rubus ellipticus* (yellow Himalayan raspberry), and *Setaria palmifolia* (palmgrass) on Hawaii Island; *Clidemia hirta, Psidium cattleianum,* and *P. guajava* on Kauai; *C. hirta* and *Tibouchina herbacea* on Maui; *Juncus effusus* (Japanese mat rush) on Molokai; and *C. hirta* and *P. cattleianum* on Oahu, modify and destroy habitat and outcompete this subspecies (HBMP 2010). Randomly occurring natural events, such as landslides, are a threat to the occurrences of *J. ascendens* ssp. *ascendens* on Kauai and Molokai (HBMP 2010). Fire is likely to be a threat to this subspecies in the drier areas of the Waianae Mountains of Oahu (HBMP 2010). This subspecies is usually found as widely separated individuals. Seedlings have rarely been observed in the wild, and, although mature seeds germinate in cultivation, these seedlings also rarely survive to maturity. It is uncertain if this rarity of reproduction is typical, or if it is related to habitat disturbance, or possibly a lack of soil mycorrhizae (symbiotic relationship between fungi and plants) required for successful establishment (Wagner *et al.* 1999, p. 1451; Oppenheimer 2015, in litt.). Fortini *et al.* (2013, p. 76) found that, as environmental conditions are altered by climate change, *J. ascendens* ssp. *ascendens* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *J. ascendens* ssp. *ascendens* described above.

The remaining occurrences of *Joinvillea ascendens* ssp. *ascendens* are at risk. The known individuals continue to be negatively affected by habitat modification and destruction by ungulates, compounded with herbivory by ungulates and rats. The small number of remaining individuals, smaller distribution, and poor recruitment in the wild limits this subspecies' ability to adapt to environmental changes. Destruction by fire, landslides, rockfalls, and floods can occur at any time. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that this subspecies is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Kadua fluviatilis (previously *Hedyotis fluviatilis*) (kamapuaa) is a climbing shrub in the coffee family (Rubiaceae) family (Wagner *et al.* 1999, pp. 1142–1144). Typical habitat for this species on Kauai is mixed native shrubland and *Metrosideros* forest from 750 to 2,200 ft (230 to 680 m), in the lowland mesic ecosystem (TNCH 2007; HBMP 2010); and in open shrubland with sparse tree cover in the lowland mesic ecosystem (Wood 1998, in litt.; TNCH 2007). On Oahu, *K. fluviatilis* occurs along rocky streambanks in wet *Metrosideros* forest from 820 to 1,990 ft (250 to 607 m) in the lowland wet ecosystem (TNCH 2007; HBMP 2010).

Historically, *Kadua fluviatilis* was known from the island of Kauai in at least 5 occurrences ranging from the north coast across the central plateau to the south coast, and from the island of Oahu in at least 11 occurrences in the northern Koolau Mountains (HBMP 2010; Williams 2015, in litt.). Currently, during surveys on Oahu in 2013, only 20 to 25 individuals were observed in one occurrence (Wood 2005b, in litt., NTBG 2009, in litt.; HBMP 2010; Ching Harbin 2015, in litt.). On Kauai, *K. fluviatilis* is known from two occurrences totaling approximately 500 individuals (HBMP 2010).

Feral pigs and goats modify and destroy habitat of *Kadua fluviatilis* (HBMP 2010). Evidence of the activities of feral pigs has been reported at the occurrences on Kauai and Oahu (Wood 1998, in litt.; HBMP 2010). Feral goats and evidence of their activities have been observed at one location on Kauai (HBMP 2010). Herbivory by feral pigs and goats is a threat to *K. fluviatilis.* Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plant species, such as *Lantana camara, Paspalum conjugatum* (Hilo grass), *Psidium cattleianum, P. guajava, Rubus rosifolius,* and *Schinus terebinthifolius* (Christmas berry), degrade habitat and outcompete this and other native species for water, nutrients, light, and space, or may produce chemicals that inhibit growth of other plants (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 in Cuddihy and Stone 1990, p. 74; Wood 1998, in litt.; HBMP 2010). *Kadua fluviatilis* is negatively affected by landslides on Kauai (HBMP 2010). Fortini *et al.* (2013, p. 78) found that, as environmental conditions are altered by climate change, *K. fluviatilis* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *K. fluviatilis* described above.

The remaining occurrences of *Kadua fluviatilis* are at risk. Numbers of occurrences and individuals are decreasing on Oahu and Kauai, from 16 occurrences to 3, and from over 1,000 individuals to about 500 individuals (HBMP 2010; OTFM 2014, in litt.). This species continues to be negatively affected by habitat modification and destruction by feral pigs and goats, stochastic events such as landslides, and direct competition from nonnative plants, combined with herbivory by nonnative ungulates. Climate change is likely to further exacerbate these threats. Because of these threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Kadua haupuensis (NCN) is a shrub in the coffee family (Rubiaceae) (Lorence *et al.* 2010, p. 137). There is no historical information for this species as it was recently discovered and described from one occurrence just below and along cliffs in an isolated area on southern Kauai, from 980 to 1,640 ft (300 to 500 m), in the lowland mesic ecosystem (TNCH 2007; Lorence *et al.* 2010, pp. 137–144). Currently, however, there are no known extant individuals of *K. haupuensis;* the single natural occurrence is thought to be extirpated. Ten individuals were propagated from seed collected in 1999, with cuttings from these currently under cultivation. Seeds are in storage at NTBG's seed bank (Lorence 2015, in litt.).

Feral pigs modify and destroy the habitat of *Kadua haupuensis* on Kauai (Lorence *et al.* 2010, p. 140). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Predation of fruits and seeds by rats is a threat. Landslides are an additional threat to this species at its last known occurrence. Nonnative plants, such as *Caesalpinia decapetala* (wait-a-bit), *Passiflora laurifolia* (yellow granadilla), and various nonnative grasses, modify and destroy native habitat, outcompete native plants, and are found at the last known location of *K. haupuensis.* The small number of remaining individuals limits this species' ability to adapt to environmental change. Because of these threats, we find that *K. haupuensis* is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Labordia lorenciana (NCN) is a small tree in the Logania family (Loganiaceae) (Wood *et al.* 2007, pp. 195–197). This species occurs on the island of Kauai at 3,800 ft (1,160 m), in forest in the montane mesic ecosystem (Wood *et al.* 2007, pp. 197–198). Currently, there are four known individuals. Additional surveys for *L. lorenciana* have not been successful; however, experts believe this species may occur in other areas (Wood *et al.* 2007, p. 198).

Labordia lorenciana is at risk from habitat modification and destruction and herbivory by nonnative mammals, displacement of individuals through competition with nonnative plants, stochastic events, and problems associated with small populations. Feral pigs, goats, and black-tailed deer modify and destroy the habitat of *L. lorenciana* (Wood *et al.* 2007, p. 198; Kishida 2015, in litt.). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction by these animals (Anderson *et al.* 2007, in litt; HAR–DLNR 2010, in litt.). Predation of seeds by rats is a threat to this species (Wood *et al.* 2007, p. 198). Habitat destruction and modification by nonnative plants, and competition with nonnative plants including *Lantana camara, Passiflora tarminiana, Psidium cattleianum,* and *Rubus argutus,* are a threat to *Labordia lorenciana,* as these nonnative plants have the ability to spread rapidly and cover large areas in the forest understory (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74; Wood *et al.* 2007, p. 198). Randomly occurring natural events, such as landslides, flash floods, fallen tree limbs, and fire, are threats to *L. lorenciana* where it occurs on Kauai (Wood *et al.* 2007, p. 198). This species experiences reduced reproductive vigor as there is no *in situ* seedling recruitment and a very small number of individuals remain (Wood *et al.* 2007, p. 198). Infestation by the black twig borer (*Xylosandrus compactus*) is a threat to this species (Kishida 2015, in litt.). Because of these threats, we find that *L. lorenciana* is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Lepidium orbiculare (anaunau) is a small, many-branched shrub in the mustard family (Brassicaceae) (St. John 1981, pp. 371–373; Wagner *et al.* 1999, p. 409). This species occurs in mesic forest on the island of Kauai, in the lowland mesic ecosystem (Wagner *et al.* 1999, p. 409; TNCH 2007; HBMP 2010; PEPP 2014, p. 34). Historically, this species was known from widely scattered occurrences on Kauai (Wagner *et al.* 1999, p. 409). Currently, there is one occurrence of fewer than 50 individuals (Wagner *et al.* 2012, p. 19; PEPP 2014, p. 34; Smithsonian Institution 2015, in litt.).

Feral pigs and goats have been documented to modify and destroy habitat of other rare and endangered native plant species at the same location on Kauai (Lorence *et al.* 2010, p. 140; Kishida 2015, in litt.); therefore, we consider that activities of feral pigs and goats also pose a threat to *Lepidium orbiculare.* Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants, such as *Melinis minutiflora* (molasses grass) and *Stachytarpheta jamaicensis* (Jamaica vervain), degrade native habitat, outcompete native plants, and are found at the last known location of *L. orbiculare* (HBMP 2010). Landslides are an additional threat to this species. Because there are fewer than 50 individuals, *L. orbiculare* experiences reduced reproductive vigor due to reduced levels of genetic variability, leading to diminished capacity to adapt to environmental changes, and thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361; PEPP 2014, p. 34).

The remaining occurrence of *Lepidium orbiculare* is at risk and the species continues to be negatively affected by the threats described above. Because of these threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Microlepia strigosa var. *mauiensis* (NCN) is a terrestrial, medium-sized fern in the bracken fern family (Dennstaedtiaceae) (Palmer 2003, p. 186). Typical habitat for *M. strigosa* var. *mauiensis* is mesic to wet forest from 1,400 to 6,000 ft (425 to 1,830 m), in the lowland mesic (Oahu), montane mesic (Hawaii Island), and montane wet (Maui and Hawaii Island) ecosystems (Palmer 2003, p. 186; TNCH 2007: HBMP 2010). Little is known of the historical locations of *M. strigosa* var. *mauiensis;* however, it was wide-ranging on the islands of Hawaii, Maui, and Oahu (HBMP 2010). Currently, *M. strigosa* var. *mauiensis* is known from nine occurrences totaling fewer than 100 individuals on the islands of Oahu (about 40 individuals), Maui (fewer than 20 individuals on east and west Maui), and Hawaii (35 individuals last observed in 2004) (Palmer 2003, p. 186; Lau 2007, pers.comm.; Oppenheimer 2007 and 2008, in litt.; Welton 2008, in litt.; Ching 2011, in litt.; Ching Harbin 2015, in litt.; Oppenheimer 2015, in litt.).

Habitat modification and destruction by feral pigs and goats is a threat to *Microlepia strigosa* var. *mauiensis* (Oppenheimer 2007, in litt.; Bily 2009, in litt.; HBMP 2010). Herbivory by feral pigs is a threat to *M. strigosa* var. *mauiensis* (Oppenheimer 2007, in litt.; Bily 2009, in litt.; HBMP 2010). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants, such as *Ageratina adenophora, Juncus acuminatus* (rush), *Plantago major* (broad-leaved plantain), and *Tibouchina herbacea,* degrade habitat and outcompete this variety on Maui (Oppenheimer 2007, in litt.). Hybridization with other species and varieties of *Microlepia* is a threat to this plant on Oahu and is compounded by the low number of individuals (Kawelo 2010, in litt.). Because of these threats, we find that this variety is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Myrsine fosbergii (kolea) is a branched shrub or small tree in the myrsine family (Myrsinaceae) (Wagner *et al.* 1999, p. 940). Typical habitat for this species on Oahu is *Metrosideros*-mixed native shrubland, from 2,200 to 2,800 ft (670 to 850 m) (Wagner *et al.* 1999, p. 940; TNCH 2007; HBMP 2010). Typical habitat for this species on Kauai is *Metrosideros-Diospyros* (ohia-lama) lowland mesic forest and *Metrosideros-Cheirodendron* (ohia-olapa) montane wet forest, often on watercourses or stream banks, from 900 to 4,300 ft (270 to 1,300 m), in the lowland mesic, lowland wet, and montane wet ecosystems (TNCH 2007; HBMP 2010; Wagner *et al.* 2012, p. 53). *Myrsine fosbergii* was historically known from the summit ridges of the Koolau Mountains of Oahu (HBMP 2010). This species was first collected on Kauai in 1987. Currently, on Oahu, there are fewer than 30 individuals in the Koolau Mountains (lowland mesic and lowland wet ecosystems) (HBMP 2010; OTFM 2014, in litt.; Reynolds 2015, in litt.; Sailer 2015, in litt.). Propagation attempts of the Oahu plants have been unsuccessful (Ching Harbin 2015, in litt.). On Kauai, this species was once widely scattered in the northwest and central areas, but is currently known from only 55 remaining individuals (Wood 2005e and 2007c, in litt.; HBMP 2010).

Myrsine fosbergii is at risk from habitat modification and destruction by nonnative ungulates and plants. On Oahu, evidence of the activities of feral pigs has been reported at all summit occurrences (HBMP 2010). On Kauai, evidence of the activities of feral pigs has been reported at the remaining occurrence (Wood 2005e and 2007c, in litt.; HBMP 2010), and evidence of the activities of feral goats has also been reported (HBMP 2010). Herbivory by feral pigs and goats is a threat to *M. fosbergii* (Wood 2005e and 2007c, in litt.; HBMP 2010). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.;

HAR–DLNR 2010, in litt.). Nonnative plants, such as *Axonopus fissifolius* (narrow-leaved carpetgrass), *Clidemia hirta, Erigeron karvinskianus, Psidium cattleianum, P. guajava,* and *Rubus rosifolius,* compete with *M. fosbergii* and modify and destroy its native habitat on Oahu and Kauai (HBMP 2010). Hybridization is a threat to this species, as *M. fosbergii* hybridizes with other *Myrsine* species, and the number of non-hybrid individuals may actually be lower than estimated (Ching Harbin 2015, in litt.). Fortini *et al.* (2013, p. 82) found that, as environmental conditions are altered by climate change, *M. fosbergii* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *M. fosbergii* described above.

The remaining occurrences of *Myrsine fosbergii* are at risk from the threats described above. The effects of climate change are likely to exacerbate the threats described above. Because of these threats, we find that *M. fosbergii* is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Nothocestrum latifolium (aiea) is a small tree in the nightshade family (Solanaceae) (Symon 1999, p. 1263). Typical habitat for this species is dry to mesic forest in the dry cliff (Kauai, Oahu, Lanai, and Maui), lowland dry (Oahu, Lanai, and Maui), and lowland mesic (Oahu, Molokai, Lanai, and Maui) ecosystems (TNCH 2007; HBMP 2010). Historically, *N. latifolium* was known from the Waianae Mountains of Oahu, Molokai, Lanai, and Maui (HBMP 2010; Sailer 2015, in litt.). This species was collected once on Kauai in 1986, but has not been observed there before or after that time (Symon 1999, p. 1263; BISH 504035-Montgomery; Williams 2015, in litt.). Currently, on the island of Oahu, there is one individual remaining, with only one of the other previously extant individuals represented in an ex situ collection (Moses 2006, in litt.; Starr 2006, in litt.; HBMP 2010; Kawakami 2010, in litt.; Kawelo 2010, in litt.; Welton 2010, in litt.; Ching 2011, in litt.; Ching Harbin 2015, in litt.; Sailer 2015, in litt.). On Molokai, there a few individuals on the central south slope (Oppenheimer 2015, in litt.). There are 18 occurrences totaling approximately 1,600 individuals on east and west Maui (Ching 2011, in litt.; HBMP 2010; Oppenheimer 2015, in litt.). On Lanai, no individuals were found during surveys in 2012, and this species may be extirpated from this island, although there are plans to continue surveying suitable habitat (PEPP 2012, p. 129; Oppenheimer 2015, in litt.). In summary, the species' range on each island has decreased dramatically since 2001 (Kawelo 2005 and 2010, in litt.; HBMP 2010; Oppenheimer 2011, in litt.).

Feral pigs (Oahu, Maui, Kauai), goats (Maui, Kauai), mouflon (Lanai), feral cattle (Maui), axis deer (Lanai, Maui), and black-tailed deer (Kauai) modify and destroy habitat of *Nothocestrum latifolium* (HBMP 2010; Oppenheimer 2015, in litt.). Herbivory by these animals also poses a threat to this species. Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants, such as *Fraxinus uhdei* (tropical ash), *Grevillea robusta* (silk oak), *Lantana camara, Leucaena leucocephala* (koa haole), *Melinis minutiflora, Passiflora suberosa* (huehue haole), *Schinus terebinthifolius,* and *Toona ciliata* (Australian red cedar), outcompete *N. latifolium* and modify and destroy habitat at all known occurrences. Wildfire, and fire caused by military training activities, is a threat to this species and its habitat (Sailer 2015, in litt.). Low numbers of individuals limits this species' ability to adapt to environmental change. Infestation by the black twig borer is a threat to *N. latifolium* (Ching Harbin 2015, in litt.). This species continues to decline, and, for unknown reasons, there is an observed lack of regeneration in *N. latifolium* in the wild (HBMP 2010; Duvall 2015, in litt.). Fortini *et al.* (2013, p. 83) found that, as environmental conditions are altered by climate change, *N. latifolium* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *N. latifolium* described above.

The remaining occurrences of *Nothocestrum latifolium* are at risk from the threats described above. Because of these threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Ochrosia haleakalae (holei) is a tree in the dogbane family (Apocynaceae) (Wagner *et al.* 1999, p. 218). Typical habitat for this species is dry to mesic forest, sometimes wet forest, and often lava, from 2,300 to 4,000 ft (700 to 1,200 m), in the dry cliff (Maui), lowland mesic (Maui and Hawaii Island), and montane mesic (Maui) ecosystems (Medeiros *et al.* 1986, pp. 27–28; Wagner *et al.* 1999, p. 218; TNCH 2007; HBMP 2010). Historically, this species was known from east Maui and Hawaii Island (HBMP 2010). Currently, *O. haleakalae* is known from 4 occurrences totaling about 15 individuals on the island of Maui (Medeiros 2007, in litt.; Oppenheimer 2008, in litt.; HBMP 2010; Oppenheimer 2015, in litt.). On Hawaii Island, there are two occurrences totaling at least 150 individuals in Hawaii Volcanoes National Park, with 150 outplanted in nearby kipuka (vegetated areas surrounded by lava flows), and one individual in the Laupahoehoe section of Hilo Forest Reserve (Pratt 2005, in litt.; Bio 2008a, in litt.; HBMP 2010; Pratt 2011, in litt.; Conry 2012, in litt.; Orlando 2015, in litt.; Perry 2015, in litt.).

Feral pigs and goats modify and destroy the habitat of *Ochrosia haleakalae* on Maui and Hawaii Island; in addition, cattle modify and destroy the habitat of this species on Maui (Medeiros 1995, in litt.; Pratt 2005, in litt.; Oppenheimer 2015, in litt.). Herbivory by these animals also poses a threat to this species. Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plant species, such as *Cestrum diurnum* (day cestrum), *Fraxinus uhdei, Psidium cattleianum, P. guajava, Rubus argutus, Setaria palmifolia* (palmgrass), and *Toona ciliata,* modify and destroy habitat and outcompete native plants, including *O. haleakalae* (HBMP 2010). In dry areas, wildfires affecting the habitat of this species are exacerbated by the presence of introduced grass species such as *Pennisetum clandestinum* (kikuyu grass) (HBMP 2010; Oppenheimer 2015, in litt.). Herbivory and seed predation by slugs and rats is a threat to this species (Oppenheimer 2015, in litt.). There is low to no reproduction observed in the wild, and this reduced reproductive vigor is due to reduced levels of genetic variability resulting from low numbers of individuals. This decreases the species' capacity to adapt to environmental changes, and thereby lessens the probability of its long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361; Duvall 2015, in litt.). Fortini *et al.* (2013, p. 83) found that, as environmental conditions are altered by climate change, *O. haleakalae* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *O. haleakalae* described above.

Ochrosia haleakalae is at risk from habitat degradation and loss by feral pigs, goats, cattle, and nonnative plants; the displacement of individuals due to competition with nonnative plants for space, nutrients, water, air, and light; herbivory by feral pigs, goats, and cattle; seed predation by slugs and rats; and by the small number of remaining individuals. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Phyllostegia brevidens (NCN) is a scandent (climbing) subshrub in the mint family (Lamiaceae) (Wagner *et al.* 1999, pp. 814–815). This species occurs in wet forest on the islands of Maui and Hawaii from 2,900 to 3,200 ft (880 to 975 m), in the lowland wet (Maui), montane wet (Hawaii Island), and wet cliff (Maui) ecosystems (Wagner *et al.* 1999, pp. 814–815; TNCH 2007; HBMP 2010). *Phyllostegia brevidens* is historically known from Hilo Forest Reserve, Mauna Kea, and Kulani on Hawaii Island; and from Kipahulu Valley on Maui (Haleakala National Park) (Wagner *et al.* 1999, p. 815; HBMP 2010; Smithsonian Institution 2015, in litt.). Currently, there is one individual on the island of Maui and two individuals on Hawaii Island (PEPP 2009, p. 90; Wagner *et al.* 2012, p. 46; PEPP 2014, p. 136; Gates 2015, in litt.; Oppenheimer 2015, in litt.; Perry 2015, in litt.).

Feral pigs modify and destroy habitat of this species on Maui (PEPP 2014, p. 136). The two remaining individuals on Hawaii Island are currently fenced (Perry 2015, in litt.); however, owing to the potential for accidental damage or vandalism (irrespective of maintenance), fences do not guarantee protection from ungulate ingress. Herbivory by feral pigs also poses a threat to this species on Maui. Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants, such as *Clidemia hirta* and *Hedychium gardnerianum,* modify and destroy habitat and outcompete *P. brevidens* on Maui (PEPP 2009, p. 90). Herbivory by slugs is a threat to the remaining individual on Maui (PEPP 2014, p. 136). In addition, natural events such as landslides and erosion are threats to the occurrence on Maui (PEPP 2014, p. 136). The small number of remaining individuals limits this species' ability to adapt to environmental change. Fortini *et al.* (2013, p. 84) found that, as environmental conditions are altered by climate change, *P. brevidens* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *P. brevidens* described above.

The remaining occurrences of *Phyllostegia brevidens* are at risk. The species continues to be negatively affected by habitat modification and destruction by ungulates and nonnative plants, and by direct competition from nonnative plants, combined with herbivory by ungulates and slugs. The effects of climate change are likely to further exacerbate these threats. We find that *P. brevidens* is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Phyllostegia helleri (NCN) is a weakly erect to climbing shrub in the mint family (Lamiaceae) (Wagner *et al.* 1999, pp. 816–817). This species occurs on ridges or spurs from 2,800 to 4,000 ft (860 to 1,200 m) in diverse forest on Kauai in the lowland wet, montane wet, and wet cliff ecosystems (Wagner *et al.* 1999, p. 817; TNCH 2007; HBMP 2010). Historically, *P. helleri* was wide-ranging on the island of Kauai, from the north and east sides throughout the central plateau (Wagner *et al.* 1999, p. 817; HBMP 2010). Currently, this species is limited to one occurrence of four individuals (PEPP 2014, p. 35; Kishida 2015, in litt.).

Feral pigs and goats modify and destroy the habitat of *Phyllostegia helleri* on Kauai (HBMP 2010). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Herbivory on fruits and seeds by rats negatively affects the remaining individuals (HBMP 2010). The only known occurrence of this species is located at the base of cliffs, and landslides are an additional threat (HBMP 2010). Nonnative plants, such as *Erigeron karvinskianus, Kalanchoe pinnata* (air plant), *Psidium guajava, Rubus rosifolius,* and various grasses, modify and destroy native habitat, outcompete native plants, and are found at the last known occurrence of *Phyllostegia helleri* (HBMP 2010). This species experiences reduced reproductive vigor due to reduced levels of genetic variability, leading to diminished capacity to adapt to environmental changes, and thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Fortini *et al.* (2013, p. 84) found that, as environmental conditions are altered by climate change, *P. helleri* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *P. helleri* described above.

The remaining occurrence of *Phyllostegia helleri* is at risk. The numbers of individuals are decreasing on Kauai, as this species was wide-ranging on the island, extending from the north and east sides throughout the central plateau, and is now known from only one occurrence of four individuals. These four individuals continue to be negatively affected by habitat modification and destruction by ungulates and nonnative plants, direct competition by nonnative plants, and by seed predation by rats. Natural events such as landslides may damage or destroy the remaining four individuals. The small number of remaining individuals limits this species' ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that *P. helleri* is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Phyllostegia stachyoides (NCN) is a weakly erect to climbing subshrub in the mint family (Lamiaceae) (Wagner *et al.* 1999, p. 823). This species occurs in mesic to wet forest from 3,600 to 4,600 ft (1,000 to 1,400 m), in the montane wet (Hawaii Island, Maui, and Molokai) and montane mesic (Hawaii Island and Maui) ecosystems (Wagner *et al.* 1999, p. 823; TNCH 2007; HBMP 2010). *Phyllostegia stachyoides* is historically known from the eastern and central Molokai, west Maui, and wide-ranging occurrences on Hawaii Island (Wagner *et al.* 1999, p. 823; HBMP 2010; VanDeMark 2016, in litt.). Currently, occurrences on west Maui total about 15 individuals (Oppenheimer 2015, in litt.). Those on Molokai occur at 5 locations and total fewer than 30 individuals (Orlando 2015, in litt.; PEPP 2012, p. 156). Plants on Hawaii Island are now considered to be *P. ambigua* (VanDeMark 2016, in litt.).

Feral pigs, goats, and axis deer modify and destroy the habitat of *Phyllostegia stachyoides* on Maui, with evidence of the activities of these animals reported in areas where this species occurs (HBMP 2010; PEPP 2014, p. 141). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants, such as *Ageratina adenophora, Erigeron karvinskianus,* and *Tibouchina herbacea,* compete with *P. stachyoides,* modify and destroy its native habitat, and displace other native plant species (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74; PEPP 2014, pp. 141–142). Herbivory by slugs and rats on leaves and nutlets of *P. stachyoides* poses a threat to this species at known locations on Maui and Molokai (PEPP 2014, pp. 140–142). On Maui, stochastic events such as floods and drought (with ensuing erosion) pose a threat to small, isolated occurrences of *P. stachyoides;* rockfalls and landslides are a threat to occurrences on Molokai (PEPP 2014, pp. 140–142). This species experiences reduced reproductive vigor due to reduced levels of genetic variability, leading to diminished capacity to adapt to environmental changes, and thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Fortini *et al.* (2013, p. 84) found that, as environmental conditions are altered by climate change, *P. stachyoides* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *P. stachyoides* described above.

The remaining occurrences of *Phyllostegia stachyoides* are at risk. The known individuals are restricted to small areas on west Maui and Molokai, and continue to be negatively affected by habitat modification and destruction by ungulates and by direct competition with nonnative plants, combined with herbivory by slugs and rats. The small number of remaining individuals limits this species' ability to adapt to environmental changes. Flooding, drought, and the effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Portulaca villosa (ihi) is a perennial herb in the purslane family (Portulacaceae) (Wagner *et al.* 1999, p. 1074). *Portulaca villosa* occurs on dry, rocky, clay, lava, or coralline reef sites, from sea level to 1,600 ft (490 m), in the coastal (Lehua, Kaula, Oahu, Kahoolawe, Maui, and Hawaii Island) and lowland dry (Oahu, Molokai, Lanai, Kahoolawe, Maui, and Hawaii Island) ecosystems, and one reported occurrence in the montane dry (Hawaii Island) ecosystem (Wagner *et al.* 1999, p. 1074; TNCH 2007; HBMP 2010). *Portulaca villosa* is historically known from all the main Hawaiian Islands except Niihau and Kauai (Wagner *et al.* 1999, p. 1074). *Portulaca villosa* has been observed on the small islets of Kaula and Lehua (west of Kauai and Niihau), and on Nihoa (NWHI); however, the current status of these occurrences is unknown. This species has not been observed on Oahu since the 1960s, when it was locally abundant at Kaohikaipu Island (HBMP 2010). Historically, on the island of Hawaii, this species occurred in the coastal area of Hawaii Volcanoes National Park west of Kamoamoa, but was extirpated in 1993 by lava flows (Orlando 2015, in litt.). On the island of Lanai, two individuals were last observed in 1996 (HBMP 2010). Currently, *P. villosa* is known from a few individuals on Molokai, 2 individuals on east Maui and 24 individuals on west Maui, fewer than 15 individuals on Kahoolawe, and five occurrences totaling 10 individuals on Hawaii Island (MNTF 2010, in litt.; Evans 2015a, in litt.).

Axis deer (Maui and Lanai), goats (Maui), mouflon (Lanai), and cattle (Hawaii Island) modify and destroy the habitat of *Portulaca villosa* (HBMP 2010; Oppenheimer 2015, in litt.). These ungulates also forage directly on this species. Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants, such as *Lantana camara, Nicotiana glauca* (tree tobacco), *Pennisetum ciliare* (buffelgrass), and *Prosopis pallida* (kiawe, mesquite), compete with *Portulaca villosa,* modify and destroy its native habitat, displace other native plant species, and pose a threat to the known occurrences on Hawaii Island, Maui, Kahoolawe, and Molokai (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74). *P. villosa* occurs in drier coastal and lowland habitats, all of which are affected by wildfires. Some coastal habitat includes exposed cliffs, which erode and cause landslides and rockfalls in areas where *P. villosa* occurs (Kahoolawe), posing a threat to this species (HBMP 2010). This species experiences reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, and thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Fortini *et al.* (2013, p. 86) found that, as environmental conditions are altered by climate change, *P. villosa* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *P. villosa* described above.

The remaining occurrences of *Portulaca villosa* are at risk; the numbers of individuals are decreasing on Maui, Molokai, and Hawaii Island, and the species continues to be negatively affected by continued habitat modification and destruction by feral ungulates and nonnative plants, and by competition with nonnative plants. Because of its small and isolated remaining occurrences, natural events such as rockfalls, landslides, and wildfires may pose a threat to this species. The small number of remaining individuals limits this species' ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Pritchardia bakeri (Baker's loulu) is a small to medium-sized tree in the palm family (Arecaceae) (Hodel 2009, pp. 173–179; Hodel 2012, pp. 70–73). This species occurs in the lowland mesic ecosystem in the Koolau Mountains on Oahu, from 1,500 to 2,100 ft (457 to 640 m), in disturbed, windswept, and mostly exposed shrubby or grassy areas, and sometimes on steep slopes in these areas (Bacon *et al.* 2012, pp. 1–17; Hodel 2012, pp. 71–73). Currently, occurrences total fewer than 100 individuals (Ching Harbin 2015, in litt.).

Habitat modification and destruction by feral pigs impact the range and abundance of *Pritchardia bakeri.* Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants compete with and degrade and destroy native habitat of *P. bakeri,* and displace native plant species by competing for water, nutrients, light, and space, or they may produce chemicals that inhibit growth of other plants (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74). Stochastic events such as hurricanes modify and destroy the habitat of *P. bakeri,* and can directly damage or kill plants. Rats eat the fruit before they mature, leading to minimal or no recruitment (Hodel 2012, pp. 42, 73). This species experiences reduced reproductive vigor due to low levels of genetic variability caused by seed predation by rats and widely separated occurrences, leading to diminished capacity to adapt to environmental changes, and thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361; Hodel 2012, p. 73).

The remaining occurrences of *Pritchardia bakeri* are at risk; the known individuals are restricted to small areas on Oahu, and continue to be negatively affected by habitat degradation and loss by feral pigs and nonnative plants, fruit predation by rats, and the small number and reduced range of remaining individuals. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *P. bakeri* described above. Based on these threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Pseudognaphalium sandwicensium var. *molokaiense* (enaena) is a perennial herb in the sunflower family (Asteraceae) (Wagner *et al.* 1999, p. 321). Typical habitat for this variety is strand vegetation in dry consolidated dunes, in the coastal ecosystem (Wagner *et al.* 1999, p. 321; TNCH 2007; HBMP 2010). Historically, this variety was known from Molokai, Oahu, Maui, and Lanai (HBMP 2010; MNTF 2010, in litt.). Currently, *P. sandwicensium* var. *molokaiense* is known only from two locations on Molokai (as many as 20,000 individuals, depending on rainfall), and from fewer than 25 individuals on the northwest coast of Maui (Moses 2006, in litt.; Starr 2006, in litt.; Kallstrom 2008, in litt.; Oppenheimer 2015, in litt.). This variety was last observed on Lanai in 1960, and on Oahu (5 individuals) in the 1980s (HBMP 2010).

Goats and axis deer modify and destroy the habitat of *Pseudognaphalium sandwicensium* var. *molokaiense,* with evidence of the activities of these animals reported in the areas where this plant occurs (Moses 2006, in litt.; Starr 2006, in litt.; Kallstrom 2008, in litt; HBMP 2010). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Additionally, nonnative plants, such as *Atriplex semibaccata* (Australian saltbush), *Chenopodium murale* (aheahea, goosefoot), *Pennisetum ciliare, Prosopis pallida,* and *Setaria parviflora* (foxtail), compete with and displace native plant species by competing for water, nutrients, light, and space, or they may produce chemicals that inhibit growth of other plants (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74; Moses 2006, in litt.). This variety experiences reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, and thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Rockfalls and landslides are a threat to the occurrence of this variety on a sea cliff on west Maui (HBMP 2010). Fortini *et al.* (2013, p. 86) found that, as environmental conditions are altered by climate change, *P. sandwicensium* var. *molokaiense* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *P. sandwicensium* var. *molokaiense* described above.

The remaining occurrences of *Pseudognaphalium sandwicensium* var. *molokaiense* on Molokai and Maui are at risk; individuals no longer occur on Oahu and Lanai. Occurrences on Maui and Molokai continue to be negatively affected by habitat modification and destruction by ungulates, and by direct competition with nonnative plants. The small number of remaining occurrences limits this plant's ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that this variety is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Ranunculus hawaiensis (makou) is an erect or ascending perennial herb in the buttercup family (Ranunculaceae) (Duncan 1999, p. 1088). Typical habitat is mesic forest on grassy slopes and scree, and in open pastures, from 6,000 to 6,700 ft (1,800 to 2,000 m), in the montane mesic (Hawaii Island), montane dry (Hawaii Island), and subalpine (Hawaii Island and Maui) ecosystems (Bio 2008a, in litt; Pratt 2007, in litt.; Duncan 1999, p. 1088; TNCH 2007; HBMP 2010). Historically, *R. hawaiensis* was wide-ranging on the island of Hawaii. On Maui, this species was known from Haleakala National Park (HBMP 2010). In the 1980s and 1990s, this species numbered several hundred individuals on both islands. Currently, there are six occurrences totaling 14 individuals on Hawaii Island (Bio 2008a, in litt.; PEPP 2008, p. 108; Pratt 2008, in litt.; HBMP 2010; Agorastos 2011, in litt.; Imoto 2013, in litt.; Orlando 2015, in litt.). On Maui, a few individuals were observed on a cliff in 1994; however, this occurrence was not relocated in further surveys (PEPP 2013, p. 177). Additionally, no individuals were re-observed in Haleakala National Park (DLNR 2006, p. 61).

Feral pigs, mouflon, and cattle modify and destroy the habitat of *Ranunculus hawaiensis* on Hawaii Island, with evidence of the activities of these animals reported in the areas where this species occurs (HBMP 2010). These ungulates also forage on *R. hawaiensis.* Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants, such as *Ehrharta stipoides* (meadow ricegrass), *Holcus lanatus* (common velvetgrass), and various grasses, modify and destroy native habitat, outcompete native plants, and have been reported in areas where *R. hawaiensis* occurs (HBMP 2010). Drought and erosion pose a threat in the areas of the last known occurrences of *R. hawaiensis* on Maui (PEPP 2013, p. 177). This species experiences reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, and thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Fortini *et al.* (2013, p. 86) found that, as environmental conditions are altered by climate change, *R. hawaiensis* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *R. hawaiensis* described above.

The remaining occurrences of *Ranunculus hawaiensis* are at risk; the known individuals are restricted to small areas on Hawaii Island and continue to be negatively affected by habitat modification and destruction by feral ungulates, and by direct competition with nonnative plants, combined with predation by ungulates. Drought and erosion pose a threat in the areas of the last known occurrences on Maui. The small number of remaining individuals limits this species' ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Ranunculus mauiensis (makou) is an erect to weakly ascending perennial herb in the buttercup family (Ranunculaceae) (Duncan 1999, p. 1089). Typical habitat for *R. mauiensis* is open sites in mesic to wet forest and along streams, from 3,500 to 5,600 ft (1,060 to 1,700 m), in the montane wet (Kauai, Oahu, Molokai, and Maui), montane mesic (Kauai, Molokai, Maui, and Hawaii Island), and wet cliff (Molokai and Maui) ecosystems (Duncan 1999, p. 1089; TNCH 2007; HBMP 2010). Historically, *R. mauiensis* was known from Kauai, Oahu, Molokai, Maui, and Hawaii (HBMP 2010). Oahu occurrences have not been observed since the 1800s, and Hawaii Island occurrences have not been observed since 1980 (HBMP 2010). Currently, *R. mauiensis* is known from Kauai (53 individuals) and east Maui (112 individuals). Two individuals formerly known from Molokai have not been observed on recent surveys (Bily 2007, in litt.; Perlman 2007a, in litt.; Wood 2007b, in litt.; HBMP 2010; PEPP 2010, p. 105; Bakutis 2011, in litt.; PEPP 2011, p. 161; PEPP 2013, p. 177; Oppenheimer 2015, in litt.).

Feral pigs, goats, axis deer, black-tailed deer, and cattle modify and destroy the habitat of *Ranunculus mauiensis* on Kauai, Molokai, and Maui, with evidence of the activities of these animals reported in the areas where this species occurs (HBMP 2010; PEPP 2014, pp. 155–156). Ungulates are managed in Hawaii as game animals (except for cattle), but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants, such as *Buddleja asiatica* (dog tail), *Clidemia hirta, Erigeron karvinskianus, Hedychium gardnerianum, Lantana camara, Passiflora edulis* (passion fruit), *P. tarminiana, Psidium cattleianum, Rubus argutus, R. rosifolius,* and *Tibouchina herbacea,* modify and destroy the native habitat of *Ranunculus mauiensis* and displace native plant species by competing for water, nutrients, light, and space; they may also produce chemicals that inhibit the growth of other plants (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74; HBMP 2010; PEPP 2014, p. 155). Herbivory by slugs (Maui) and seed predation by rats (Maui, Kauai) are both reported as threats to *R. mauiensis* (HBMP 2010; PEPP 2014, pp. 154–155). Stochastic events such as drought (Maui), landslides (Kauai), and fire (Maui) are also reported as threats to *R. mauiensis* (HBMP 2010). Erosion is a threat to occurrences on Maui and Kauai (PEPP 2014, pp. 155–156). This species experiences reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of its long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Fortini *et al.* (2013, p. 86) found that, as environmental conditions are altered by climate change, *R. mauiensis* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *R. mauiensis* described above.

The remaining occurrences of *Ranunculus mauiensis* are at risk, the known individuals are restricted to small areas on Kauai and Maui, and continue to be negatively affected by habitat modification and destruction by ungulates, direct competition with nonnative plants, and herbivory and predation by slugs and rats. Because of its small, isolated occurrences, landslides, drought, and erosion also negatively affect this species. The small number of remaining individuals limits this species' ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Sanicula sandwicensis (NCN) is a stout, erect, perennial herb in the parsley family (Apiaceae) (Constance and Affolter 1999, p. 210). This species occurs from 6,500 to 8,500 ft (2,000 to 2,600 m) in shrubland and woodland on the islands of Maui and Hawaii Island, in the montane mesic (Hawaii Island and Maui), montane dry (Hawaii Island), and subalpine (Hawaii Island and Maui) ecosystems (Constance and Affolter 1999, p. 210; TNCH 2007; NTBG Database 2014, in litt.). *Sanicula sandwicensis* is historically known from Haleakala on Maui and from Mauna Kea, Mauna Loa, and Hualalai on Hawaii Island (Constance and Affolter 1999, p. 210). Currently, there are more than 50 individuals of *S. sandwicensis* on east and west Maui (MNTF 2010, in litt.; PEPP 2011, pp. 162–164; Oppenheimer 2015, in litt.). In 2008, an occurrence of fewer than 20 individuals was found in Hawaii Volcanoes National Park (Benitez *et al.* 2008, p. 59). Following ungulate removal, this occurrence increased to as many as 45 individuals, with many juvenile plants

(Orlando 2015, in litt.). A single individual was found farther east at about 7,400 ft (Orlando 2015, in litt.).

Feral pigs and goats modify and destroy the habitat of *Sanicula sandwicensis* on Maui, with evidence of the activities of these animals reported in the areas where this species occurs (PEPP 2011, pp. 162–164; Oppenheimer 2015, in litt.). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants modify and destroy the habitat of *S. sandwicensis* and displace native plant species by competing for water, nutrients, light, and space; they may also produce chemicals that inhibit the growth of other plants (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74; PEPP 2011, pp. 162–164). Those nonnative plants observed to directly affect *S. sandwicensis* and its habitat are *Ageratina adenophora, Anthoxanthum odoratum* (sweet vernalgrass), *Epilobium ciliatum* (willow herb), *Holcus lanatus* (common velvetgrass), *Pinus* spp., *Prunella vulgaris,* and *Rubus argutus* (PEPP 2011, pp. 162–164). Stochastic events such as drought, flooding, and fires are all reported to pose threats to this species (PEPP 2011, pp. 162–164). Erosion is a threat to occurrences on Maui (PEPP 2011, pp. 162–163). Herbivory by rats also is a threat because they eat the taproot, killing the plant (Oppenheimer 2015, in litt.). This species experiences reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of its long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Fortini *et al.* (2013, p. 88) found that, as environmental conditions are altered by climate change, *S. sandwicensis* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *S. sandwicensis* described above.

The remaining occurrences of *Sanicula sandwicensis* are at risk; the known individuals are restricted to small areas on Maui and Hawaii Island and continue to be negatively affected by habitat modification and destruction by feral pigs and goats and by direct competition with nonnative plants. Stochastic events such as drought, flooding, erosion, and fires are threats to this species. The small number of remaining individuals limits this species' ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Santalum involutum (iliahi) is a shrub or small tree in the sandalwood family (Santalaceae) (Harbaugh *et al.* 2010, pp. 827–838). Habitat for *S. involutum* is mesic and wet forest on Kauai, from 400 to 2,500 ft (120 to 750 m), in the lowland mesic and lowland wet ecosystems (TNCH 2007; Harbaugh *et al.* 2010, pp. 827–838). Historically, this species was known from northern Kauai at Kee, Hanakapiai, and Wainiha, and from southern Kauai at Wahiawa, but has not been observed in these areas for 30 years (Harbaugh *et al.* 2010, p. 835). Currently, approximately 50 to 100 individuals occur in isolated forest pockets on Kauai (Harbaugh *et al.* 2010, p. 835; Wood 2015, in litt.).

Feral pigs and goats modify and destroy the habitat of *Santalum involutum* on Kauai, with evidence of the activities of these animals reported in the areas where this species occurs (Harbaugh *et al.* 2010, pp. 835–836; Wood 2015, in litt.). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants modify and destroy the native habitat of *S. involutum* and displace native plant species by competing for water, nutrients, light, and space; they may also produce chemicals that inhibit the growth of other plants (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74; HBMP 2010). Nonnative plants reported to modify and destroy habitat of *S. involutum* include *Clidemia hirta, Hedychium gardnerianum, Lantana camara, Melinis minutiflora, Psidium cattleianum, P. guajava,* and *Rubus argutus* (Harbaugh *et al.* 2010, p. 836). Herbivory and seed predation by rats is a threat to this species (Harbaugh *et al.* 2010, p. 836; Wood 2015, in litt.). Wildfire is a threat to this species in mesic areas (Harbaugh *et al.* 2010, p. 836). This species experiences reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of its long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361).

The remaining occurrences of *Santalum involutum* are at risk; the known individuals are restricted to a small area on Kauai and continue to be negatively affected by habitat modification and destruction by ungulates, direct competition with nonnative plants, and by herbivory and fruit predation by rats. The small number of remaining individuals limits this species' ability to adapt to environmental changes. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *S. involutum* described above. Because of these threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Schiedea diffusa ssp. *diffusa* (NCN) is a reclining or weakly climbing vine in the pink family (Caryophyllaceae) (Wagner *et al.* 1999, pp. 511–512; Wagner *et al.* 2005, pp. 103–106). *Schiedea diffusa* ssp. *diffusa* occurs in wet forest from 3,000 to 5,300 ft (915 to 1,600 m) on Molokai, and to 6,700 ft (2,050 m) on Maui, in the lowland wet (Maui) and montane wet (Maui and Molokai) ecosystems (Wagner *et al.* 1999, p. 512; TNCH 2007; HBMP 2010). Historically, on Molokai, this subspecies was known from Kawela to Waikolu valleys, and on Maui it was wide-ranging on both the east and west mountains (Wagner *et al.* 2005, p. 106). Currently, *S. diffusa* ssp. *diffusa* is known only from east Maui in scattered occurrences (fewer than 50 individuals total), in a much smaller range, with some remaining in Haleakala National Park (HBMP 2010; Gates 2015, in litt.). Two occurrences were observed within Hanawi NAR in 2005; however, their current status is unknown (Vetter 2015, in litt.). On Molokai, there were two occurrences totaling fewer than 10 individuals; however, these have not been seen since the 1990s (HBMP 2010; Oppenheimer 2015, in litt.).

Feral pigs modify and destroy the habitat of *Schiedea diffusa* ssp. *diffusa* on Maui and Molokai, with evidence of the activities of these animals reported in the areas where this subspecies occurs (HBMP 2010; PEPP 2014, p. 159). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants, such as *Adiantum raddianum* (NCN), *Ageratina adenophora, Hypochaeris radicata* (hairy cat's ear), *Juncus planifolius* (rush), *Passiflora tarminiana, Prunella vulgaris, Rubus argutus,* and *R. rosifolius,* modify and destroy the native habitat of *S. diffusa* ssp. *diffusa* and displace native plant species by competing for water, nutrients, light, and space; they may also produce chemicals that inhibit the growth of other plants (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74; HBMP 2010; PEPP 2014, p. 159). Herbivory by slugs and seed predation by rats are both reported as threats to this subspecies (HBMP 2010; PEPP 2014, p. 159; Duvall 2015, in litt.). This subspecies experiences reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of its long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361).

The remaining occurrences of *Schiedea diffusa* ssp. *diffusa* are at risk. The known individuals are restricted to small areas on Maui and continue to be negatively affected by habitat modification and destruction by ungulates, direct competition with nonnative plants, and herbivory and predation by slugs and rats. The small number of remaining individuals limits this subspecies' ability to adapt to environmental changes. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *S. diffusa* ssp. *diffusa* described above. Because of these threats, we find that this subspecies is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Schiedea pubescens (maolioli) is a reclining or weakly climbing vine in the pink family (Caryophyllaceae) (Wagner *et al.* 1999, p. 519; Wagner *et al.* 2005, pp. 99–102). This species occurs in diverse mesic to wet *Metrosideros* forest from 2,000 to 4,000 ft (640 to 1,220 m) in the lowland wet, montane wet, montane mesic, and wet cliff ecosystems (Wagner *et al.* 1999, 519; Wagner *et al.* 2005, p 100; TNCH 2007; HBMP 2010). Historically, on Molokai, this species was known from Kalae to Pukoo ridge; on Lanai, it was known from the Lanaihale summit area but has not been observed since 1922; on Maui, it was known from the western mountains at Olowalu, Kaanapali, and Waihee, with a possible occurrence the eastern mountains at Makawao (HBMP 2010). Currently, this species is known from one occurrence on Molokai totaling fewer than 30 individuals. The occurrence on east Maui has not been re-observed, but this species is found at seven locations on west Maui (Wood 2001, in litt.; Oppenheimer 2006, in litt.; Bakutis 2010, in litt.; HBMP 2010; MNTF 2010, in litt.; Oppenheimer 2010, in litt.; PEPP 2014, pp. 162–163; Oppenheimer 2015, in litt.). It was determined that the report of 4 to 6 individuals of *S. pubescens* at the PTA on Hawaii Island was a misidentification of individuals from the species *Schiedea hawaiiensis* (Wagner *et al.* 2005, pp. 93, 95).

Feral pigs, goats, axis deer, and cattle modify and destroy the habitat of *Schiedea pubescens* on Maui and Molokai, with evidence of the activities of these animals reported in the areas where this species occurs (HBMP 2010; PEPP 2014, p. 162). Ungulates are managed in Hawaii as game animals (except for cattle), but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants, such as *Buddleja asiatica, Cestrum nocturnum* (night cestrum), *Clidemia hirta, Erigeron karvinskianus, Psidium cattleianum, Rubus rosifolius,* and *Tibouchina herbacea,* modify and destroy the native habitat of *S. pubescens* and displace native plant species by competing for water, nutrients, light, and space; they may also produce chemicals that inhibit the growth of other plants (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74; HBMP 2010; PEPP 2014, pp. 162–163). Herbivory by slugs and seed predation by rats are both reported to be threats to *S. pubescens* on Maui (HBMP 2010; PEPP 2014, p. 162; Duvall 2015, in litt.). Stochastic events such as drought, erosion, fire, and flooding are also reported as threats to *S. pubescens* (HBMP 2010; PEPP 2014, p. 162; Oppenheimer 2015, in litt.). This species is outcrossing; however, very low population sizes may have reduced its genetic variation (Weller 2015, in litt.). Fortini *et al.* (2013, p. 88) found that, as environmental conditions are altered by climate change, *S. pubescens* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *S. pubescens* described above.

The remaining occurrences of *Schiedea pubescens* are at risk. The known individuals are restricted to small areas on Molokai and Maui, and continue to be negatively affected by habitat modification and destruction by ungulates, direct competition with nonnative plants, and herbivory and predation by slugs and rats. Landslides, flooding, fire, and drought impact this species. The small number of remaining individuals limits this species' ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Sicyos lanceoloideus (anunu) is a perennial vine in the gourd family (Cucurbitaceae) (Telford 1999, p. 581; Wagner and Shannon 1999, p. 444). *Sicyos lanceoloideus* occurs on ridges or spurs in mesic forest from 1,800 to 2,700 ft (550 to 800 m), in the dry cliff (Oahu), lowland mesic (Oahu, Kauai), and montane mesic (Kauai) ecosystems (Telford 1999, p. 581; TNCH 2007; HBMP 2010). *Sicyos lanceoloideus* was historically found at Kalalau Valley and Waimea Canyon on Kauai and in the Waianae Mountains on Oahu (Telford 1999, p. 581). Currently, on Kauai, there are four individuals in three locations (Kishida 2015, in litt.). On Oahu, this species occurs in 5 locations in the Waianae Mountains totaling fewer than 35 individuals (HBMP 2010; U.S. Army 2014 database). Because this species is a vine, determining exact numbers is difficult (PEPP 2013, p. 189). In addition, occurrences and numbers vary widely as individuals have been observed to persist for fewer than 7 years (Sailer 2015, in litt.).

Feral pigs, goats, and black-tailed deer modify and destroy the habitat of *Sicyos lanceoloideus* on Kauai and Oahu, with evidence of the activities of these animals reported in the areas where this species occurs (HBMP 2010; PEPP 2013, p. 189; PEPP 2014, p. 166; Williams 2015, in litt.). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants, such as *Clidemia hirta, Lantana camara, Melia azedarach* (chinaberry), *Paspalum urvillei* (vasey grass), *Passiflora edulis, Pluchea carolinensis* (sourbush), *Psidium cattleianum, P. guajava, Ricinus communis* (castor bean), *Rubus argutus, Schinus terebinthifolius,* and *Stachytarpheta jamaicensis,* modify and destroy the native habitat of *Sicyos lanceoloideus,* and displace native plant species by competing for water, nutrients, light, and space; they may also produce chemicals that inhibit the growth of other plants (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74; HBMP 2010; Sailer 2015, in litt.). Drought is also reported as a threat to *S. lanceoloideus* (PEPP 2014, p. 166; HBMP 2010; Sailer 2015, in litt.). Fires are a threat to the occurrence in the Waianae Mountains of Oahu (Sailer 2015, in litt.). Because of the small remaining number of individuals, this species experiences reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of its long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Fortini *et al.* (2013, p. 89) found that, as environmental conditions are altered by climate change, *S. lanceoloideus* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *S. lanceoloideus* described above.

The remaining occurrences of *Sicyos lanceoloideus* are at risk. The known individuals are restricted to small areas on Kauai and Oahu and continue to be negatively affected by habitat modification and destruction by ungulates, direct competition with nonnative plants, and stochastic events such as drought and fire. The small number of remaining individuals limits this species' ability to adapt to environmental change. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Sicyos macrophyllus (anunu) is a perennial vine in the gourd family (Cucurbitaceae) (Telford 1999, p. 578; Wagner and Shannon 1999, p. 444). Typical habitat is wet *Metrosideros polymorpha* forest and *Sophora chrysophylla-Myoporum sandwicense* (mamane-naio) forest, from 4,000 to 6,600 ft (1,200 to 2,000 m) in the montane mesic (Hawaii Island), montane wet (Maui), and montane dry (Hawaii Island) ecosystems (Telford 1999, p. 578; TNCH 2007; HBMP 2010). Historically, *S. macrophyllus* was known from Puuwaawaa, Laupahoehoe, Puna, and South Kona on Hawaii Island, and from Kipahulu Valley on the island of Maui (HBMP 2010). Currently, *S. macrophyllus* is known from 10 occurrences totaling between 24 and 26 individuals on Hawaii Island (Bio 2008, pers. comm.; Pratt 2008, in litt.; HBMP 2010; Evans 2015b, in litt.; Orlando 2015, in litt.). This species has been outplanted at several sites in Hawaii Volcanoes National Park and is persisting (Orlando 2015, in litt.). The individual on Maui has not been observed since 1987 (HBMP 2010).

Feral pigs, mouflon, and cattle modify and destroy the habitat of *Sicyos macrophyllus* on the island of Hawaii, with evidence of the activities of these animals reported in the areas where this species occurs (HBMP 2010). Ungulates are managed in Hawaii as game animals (except for cattle), but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants, such as *Cenchrus setaceus, Delairea odorata* (German ivy), *Ehrharta stipoides,* and *Pennisetum clandestinum,* modify and destroy the native habitat of *S. macrophyllus* and displace native plant species by competing for water, nutrients, light, and space; they may also produce chemicals that inhibit the growth of other plants (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74; HBMP 2010). Seed predation by rats is reported to pose a threat to this species (HBMP 2010). Stochastic events such as fire are also reported as a threat to *S. macrophyllus* (HBMP 2010). This species experiences reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of its long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Fortini *et al.* (2013, p. 89) found that, as environmental conditions are altered by climate change, *S. macrophyllus* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *S. macrophyllus* described above.

The remaining occurrences of *Sicyos macrophyllus* are at risk. The only known individuals are restricted to small areas on Hawaii Island and continue to be negatively affected habitat modification and destruction by ungulates, direct competition with nonnative plants, and seed predation by rats. Fire is also a threat to this species. The small number of remaining individuals limits this species' ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Solanum nelsonii (popolo) is a sprawling or trailing shrub up to 3 ft (1 m) tall, in the nightshade family (Solanaceae) (Symon 1999, pp. 1273–1274). Typical habitat for this species is coral rubble or sand in coastal sites up to 490 ft (150 m), in the coastal ecosystem (Symon 1999, pp. 1273–1274; TNCH 2007; HBMP 2010). Historically, *S. nelsonii* was known from Kaalualu, Kamilo, and Kaulana Bay, and South Point (5 individuals total) on Hawaii Island; from Kealea Bay, Kawaewaae, and Leahi on Niihau; and from the Northwest Hawaiian Islands of Nihoa, Laysan, Pearl and Hermes, and Kure Atoll (Green Island) (Lamoureux 1963, p. 6; Clapp *et al.* 1977, p. 36; HBMP 2010). This species was last collected on Niihau in 1949 (HBMP 2010). The only known individual on Maui was reported to have disappeared in the mid-1990s after cattle had been allowed to graze in its last known habitat (HBMP 2010; Duvall 2015, in litt.). Currently, *S. nelsonii* occurs in the coastal ecosystem on the islands of Hawaii and Molokai (approximately 50 individuals), and on the Northwest Hawaiian Islands of Kure (an unknown number of individuals), Midway (approximately 260 individuals on Sand, Eastern, and Spit islands), Laysan (approximately 490 individuals), Pearl and Hermes (30 to 100 individuals), and Nihoa (8,000 to 15,000 individuals) (Aruch 2006, in litt.; Rehkemper 2006, in litt.; Tangalin 2006, in litt.; Bio 2008 a and 2008b, in litt.; Vanderlip 2011, in litt.; Conry 2012, in litt.; PEPP 2013, pp. 190–191).

Axis deer and feral cattle modify and destroy the habitat of *Solanum nelsonii* on the main Hawaiian islands of Maui, Molokai, and Hawaii, with evidence of the activities of these animals reported in the areas where this species occurs (HBMP 2010). Ungulates are managed in Hawaii as game animals (except for cattle), but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction, and herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants, such as *Lantana camara, Leucaena leucocephala, Pennisetum ciliare, Prosopis pallida,* and *Setaria verticillata* (bristly foxtail), modify and destroy the native habitat of *S. nelsonii* both on the main Hawaiian Islands and on some of the Northwest Hawaiian Islands (HBMP 2010). Nonnative plants displace native plant species by competing for water, nutrients, light, and space, or they may produce chemicals that inhibit the growth of other plants (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74; PEPP 2008, p. 110; HBMP 2010). Seed predation by rats has been reported as a threat to *S. nelsonii* on Molokai (PEPP 2014, p. 167). Stochastic events such as drought, erosion, fire, and flooding are also reported as threats to *S. nelsonii* (HBMP 2010; PEPP 2014, p. 167). In 2011, a tsunami swept over Midway Atoll's Eastern Island and Kure Atoll's Green Island, inundating *S. nelsonii* plants, spreading plastic debris, and destroying seabird nesting areas, reaching about 500 ft (150 m) inland (DOFAW 2011, in litt.; Starr 2011, in litt.; USFWS 2011, in litt.). Occurrences of this species on the main Hawaiian Islands and on some of the Northwest Hawaiian Islands experience reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of its long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). The effects of climate change resulting in sea-level rise will alter environmental conditions and ecosystem that support this species. Fortini *et al.* (2013, p. 89) found that, as environmental conditions are altered by climate change, *S. nelsonii* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *S. nelsonii* described above.

The remaining occurrences of *Solanum nelsonii* on the main Hawaiian Islands are restricted to small areas of Molokai and Hawaii Island, and continue to be negatively affected by habitat modification and destruction by ungulates, direct competition with nonnative plants, and herbivory and predation by rats. Even though most individuals of *S. nelsonii* in the Northwestern Hawaii Islands are found on lands managed by the Service as part of the Hawaiian Islands National Wildlife Refuge, the relatively isolated occurrences of *S. nelsonii* there are negatively affected by nonnative plants. The small number of remaining individuals limits this species' ability to adapt to environmental changes. A tsunami occurred and impacted habitat for this species, and sea level rise associated with global warming will modify and destroy habitat for *S. nelsonii* in the low-lying Northwestern Hawaiian Islands. Because of these threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Stenogyne kaalae ssp. *sherffii* (NCN) is a climbing vine in the mint family (Lamiaceae) (Wagner and Weller 1999, pp. 448–449; Weller and Sakai 1999, p. 838). This species occurs in the Koolau Mountains of Oahu, in diverse forest from 1,500 to 1,600 ft (450 to 490 m) in the lowland wet ecosystem (Wagner and Weller 1999, pp. 448–449; TNCH 2007; HBMP 2010; U.S. Army 2014 database). *Stenogyne kaalae* ssp. *sherffii* is historically known from diverse mesic forest in the Waianae Mountains of Oahu, and from the lowland wet ecosystem of the Koolau Mountains (although, as described in the proposed rule, it was thought to be a different species, *S. sherffii,* until the mid-1990s). This subspecies occurred within a very small range in the northern Koolau Mountains, but now all wild individuals are extirpated. There are propagules from collections from those plants that have been outplanted in the same areas (PEPP 2014, p. 169; Ching Harbin 2015, in litt.).

Feral pigs modify and destroy the habitat of *Stenogyne kaalae* ssp. *sherffii* on Oahu, with evidence of the activities of these animals reported in the areas where this subspecies occurred (HBMP 2010; PEPP 2014, p. 169). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat destruction and modification, and herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants, such as *Blechnum appendiculatum* (NCN), *Clidemia hirta, Cyclosorus parasiticus* (NCN), *Psidium cattleianum,* and *Rubus rosifolius,* destroy and modify the native habitat of *S. kaalae* ssp. *sherffii* and displace native plant species by competing for water, nutrients, light, and space; they may also produce chemicals that inhibit the growth of other plants (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74; HBMP 2010). This subspecies experiences reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of its long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Fortini *et al.* (2013, p. 90) found that, as environmental conditions are altered by climate change, *S. kaalae* ssp. *sherffii* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *S. kaalae* ssp. *sherffii* described above.

Any remaining occurrences of *Stenogyne kaalae* ssp. *sherffii* are at risk; the last known wild individuals were restricted to a very small area on Oahu, and the habitat continues to be negatively affected by habitat modification and destruction by ungulates and direct competition with nonnative plants. The small number of remaining individuals (outplanted only) limits this subspecies' ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that this subspecies is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Wikstroemia skottsbergiana (akia) is a shrub or small tree in the akia family (Thymelaceae) (Peterson 1999, p. 1290). *Wikstroemia skottsbergiana* occurs in wet forest on the island of Kauai, in the lowland wet ecosystem (Peterson 1999, p. 1290; TNCH 2007). *Wikstroemia skottsbergiana* is historically known from the Wahiawa Mountains, Hanalei Valley, and Kauhao Valley, on the island of Kauai (Peterson 1999, p. 1290). Currently, this species is limited to 30 individuals at one location (PEPP 2012, p. 26; Wood 2015, in litt.).

Feral pigs and goats destroy and modify the habitat of *Wikstroemia skottsbergiana* on Kauai, with evidence of the activities of these animals reported in the areas where this species occurs (DLNR 2005, in litt.; Wood 2015, in litt.). Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat destruction and modification or herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants destroy and modify the native habitat of *W. skottsbergiana* and displace native plant species by competing for water, nutrients, light, and space; they may also produce chemicals that inhibit the growth of other plants (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74; HBMP 2010). Predation of seeds by rats is a threat to this species (DLNR 2005, in litt.). Landslides are a threat to the only known occurrence of this species (Wood 2015, in litt.). This species experiences reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of its long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361; DLNR 2005, in litt.).

The remaining occurrences of *Wikstroemia skottsbergiana* are at risk. The known individuals are restricted to a very small area on Kauai and continue to be negatively affected by habitat modification and destruction by ungulates, direct competition with nonnative plants, and seed predation by rats. The small number of remaining individuals limits this species' ability to adapt to environmental changes. Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *W. skottsbergiana* described above. Because of these threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Animals

Band-Rumped Storm-Petrel (*Oceanodroma castro*)—Hawaii Population

The band-rumped storm-petrel, a small seabird, is a member of the family Hydrobatidae (order Procellariiformes) and a member of the Northern Hemisphere subfamily Hyrdrobatinae (Slotterback 2002, p. 2). This seabird is found in several areas of the subtropical Pacific and Atlantic Oceans (del Hoyo *et al.* 1992 *in* Bird Life International 2015, in litt.). The Atlantic breeding populations are restricted to islands in the eastern portions: Cape Verde, Ascension, Madeira, and the Azores Islands (Allan 1962, p. 274; Harrison 1983, p. 274). Wintering birds may occur as far west as the mid-Atlantic; however, Atlantic breeding populations are not within the borders of the United States or in areas under U.S. jurisdiction. Three widely separated breeding areas occur in the Pacific: in Japan, Hawaii, and Galapagos (Richardson 1957, p. 19; Harris 1969, p. 96; Harrison 1983, p. 274). The Japanese population, which breeds on islets off the east coast of Japan (Hidejima and Sanganjima *in* Allan 1962, p. 274; Harris 1969, p. 96), ranges within 860 mi (1,400 km) east and south of the breeding colonies. Populations in Japan and Galapagos total as many as 23,000 pairs (Boersma and Groom 1993, p. 114); however, a recent survey on Hidejima Island revealed only 117 burrows, some of which were occupied by Leach's storm petrels (*Oceanodroma leucorhoa*) (Biodiversity Center of Japan 2014, p. 1). Surveyors noted that the nesting area had been affected by extensive erosion caused by the 2011 earthquake and tsunami (Biodiversity Center of Japan 2014, p. 1).

When Polynesians arrived about 1,500 years ago, the band-rumped storm-petrel probably was common on all of the main Hawaiian Islands (Harrison *et al.* 1990, pp. 47–48). As evidenced by bones found in middens on Hawaii Island (Harrison *et al.* 1990, pp. 47–48) and in excavation sites on Oahu and Molokai (Olson and James 1982, pp. 30, 33), band-rumped storm-petrels were once numerous enough to be harvested for food and possibly for their feathers (Harrison *et al.* 1990, p. 48).

In Hawaii, band-rumped storm-petrels are known to nest in remote cliff locations on Kauai and Lehua Island, in steep open to vegetated cliffs, and in little vegetated, high-elevation lava fields on Hawaii Island (Wood *et al.* 2002, p. 17–18; VanderWerf *et al.* 2007, pp. 1, 5; Joyce and Holmes 2010, p. 3; Banko 2015 in litt.; Raine 2015, in litt.). Vocalizations were heard in Haleakala Crater on Maui in 1992 (Johnston 1992, *in* Wood *et al.* 2002, p. 2), on Lanai (Penniman 2015, in litt.), and in Hawaii Volcanoes National Park (Orlando 2015, in litt.). Based on the scarcity of known breeding colonies in Hawaii and their remote, inaccessible locations today compared to prehistoric population levels and distribution, the band-rumped storm-petrel appears to be significantly reduced in numbers and range following human occupation of the Hawaiian Islands, likely as a result of predation by nonnative mammals and habitat loss.

Taxonomists have typically combined the Pacific populations of band-rumped storm-petrel into a single taxon, and currently the American Ornithologist's Union (AOU) regards the species as monotypic (2015, in litt.). However, molecular studies are ongoing and indicate genetic differences between populations in different oceans and archipelagos (Friesen *et al.* 2007b, pp. 18590–18952; Smith *et al.* 2007, p. 770; Taylor *et al.,* in prep *in* Raine 2015, in litt.) and between sympatric populations that breed in different seasons (*e.g.,* in the Galapagos Islands; Smith and Friesen 2007, pp. 1599–1560; Smith *et al.* 2007, p. 756).

Band-rumped storm-petrels are regularly observed in coastal waters around Kauai, Niihau, and Hawaii Island (Harrison *et al.* 1990, p. 49; Holmes and Joyce 2009, 4 pp.), and in ''rafts'' (regular concentrations) of a few birds to as many as 100, possibly awaiting nightfall before coming ashore to breeding colonies. Kauai likely has the largest population, with an estimated 221 nesting pairs in cliffs along the north shore of the island in 2002, and additional observations on the north and south side of the island in 2010 (Harrison *et al.* 1990, p. 49; Wood *et al.* 2002, pp. 2–3; Holmes and Joyce 2009, 4 pp.; Joyce and Holmes 2010, pp. 1–3). Audio detections for Kauai indicate this species may be predominantly breeding on the Na Pali coast and Waimea Canyon, with a very small number in Wainiha Valley (Raine 2015, in litt.). The band-rumped storm-petrel is also known from Lehua Island (as detected there by auditory surveys) (VanderWerf *et al.* 2007, p.1; Raine 2015, in litt.), Maui (Mitchell *et al.* 2005, in litt.), Kahoolawe (Olson 1992, pp. 38, 112), Lanai (Penniman 2015, in litt.) and Hawaii Island (Mitchell *et al.* 2005, in litt.; Orlando 2015, in litt.). Additional surveys have been conducted on several islands in recent years, including surveys confirming the presence of band-rumped storm-petrels at the PTA on Hawaii Island, but further data are not yet available (Swift 2015, in litt.). The species likely once nested in coastal Maui, where the remains of a chick were found in 1999, and islands such as Niihau and Kaula, where surveys have not been conducted, likely have suitable nesting habitat and may harbor the species (Penniman 2015, in litt.). We do not have a current estimate of total numbers in Hawaii at this time.

Nesting sites are in burrows and in crevices, holes, and on protected ledges along cliff faces, where a single egg is laid (Allan 1962, p. 274–275; Harris 1969, pp. 104–105; Slotterback 2002, p. 11). Predation by nonnative animals on nests and adults during the breeding season is the greatest threat to the Hawaiian population of the band-rumped storm-petrel. These predators include feral cats (*Felis catus*), barn owls (*Tyto alba*), small Indian mongoose (*Herpestes auropunctatus*), black rats (*Rattus rattus*), Norway rats (*R. norvegicus*), and Polynesian rats (*R. exulans*) (Scott *et al.* 1986, pp. 1, 363–364; Tomich 1986, pp. 37–45; Harrison *et al.* 1990, pp. 47–48; Slotterback 2002, p. 19; Raine 2015, in litt.). Attraction of fledglings to artificial lights and collisions with structures, such as communication towers and utility lines, is also a threat (Reed *et al.* 1985, p. 377; Telfer *et al.* 1987, pp. 412–413; Harrison *et al.* 1990, p. 49; Banko *et al.* 1991, p. 651; Cooper and Day 1998, p. 18; Podolsky *et al.* 1998, pp. 21, 27–30; Holmes and Joyce 2009, p. 2). Monitoring of power lines on Kauai has recorded over 1,000 strikes by seabirds annually (mostly Newell's shearwaters (*Puffinus newelli*); Travers *et al.* 2014, pp. 19, 42) that may result in injury or death. Recent studies of attraction of seabirds to artificial lights indicate that 40 percent of those downed by exhaustion (from circling the lights) are killed by collisions with cars or other objects (Anderson 2015, p. 4–13). The small numbers of these birds and their nesting areas on remote cliffs make population-level impacts difficult to document. However, the band-rumped storm-petrel has similar behavior, life-history traits, and habitat needs to the Newell's shearwater, a threatened species that has sustained major losses as a result of light attraction and collisions with lines or other objects (Banko *et al.* 1991, p. 651; Banko 2015, in litt.; Raine 2015, in litt.). Therefore, we conclude that these are threats to the band-rumped storm-petrel as well. Erosion and landslides at nest sites caused by the actions of nonnative ungulates is a threat in some locations on the island of Kauai (Raine 2015, in litt.). Nonnative plants outcompete native plants and can also affect nesting sites of the band-rumped storm-petrel by accelerating erosion, leading to landslides and rockfalls (Wood *et al.* 2002, pp. 7–19). Regulatory mechanisms (*e.g.,* the Migratory Bird Treaty Act (MBTA; 16 U.S.C. 703 *et seq.*)) contribute minimally to the active recovery and management of this species (USFWS 2013, in litt.). The small population size and limited distribution of the band-rumped storm-petrel in Hawaii is a threat to this population (Soulé 1987, p. 8; Lande 1988, pp. 1455, 1458–1459; Harrison *et al.* 1990, p. 50; Furness 2003, p. 33). During the breeding season, a single hurricane or landslide caused by erosion could cause reproductive failure and kill a significant number of adult birds. Commercial fisheries and ocean pollution have negative impacts to seabirds, and also are likely to have negative impacts to the band-rumped storm petrel, although the information about the impacts of fisheries and plastics on storm-petrel species is limited. In this rule, our listing determination applies only to the Hawaiian population of the band-rumped storm-petrel (see Distinct Population Segment (DPS) Analysis, below). Because of the deleterious and cumulative effects to the band-rumped storm-petrel caused by the threats described above, we find that the Hawaii population is endangered throughout its range, and, therefore, we find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Yellow-Faced Bees (*Hylaeus* spp.)

Bees in the genus *Hylaeus* (family Colletidae), which includes the seven species in this final rule, are commonly known as yellow-faced bees or masked bees for their yellow-to-white facial markings. All *Hylaeus* bees roughly resemble small wasps in appearance; however, *Hylaeus* bees have plumose (branched) hairs on the body that are longest on the sides of the thorax, which readily distinguish them from wasps (Michener 2000, in litt.). Bees in the family Colletidae are also referred to as plasterer bees because they line their nests with a self-secreted, cellophane-like material. Eggs hatch and develop into larvae (immature stage) and as larvae grow, they molt through three successive stages (instars), then change into pupae (a resting form) in which they metamorphose and emerge as adults (Michener 2000, in litt.). The diet of the larval stages is unknown, although it is presumed the larvae feed on stores of pollen and nectar collected and deposited in the nest by the adult female.

Yellow-Faced Bee (*Hylaeus anthracinus*)

Hylaeus anthracinus was historically known from numerous coastal and lowland dry forest habitats up to 2,000 ft (610 m) in elevation on the islands of Hawaii, Maui, Lanai, Molokai, and Oahu, and in some areas was ''locally abundant.'' Between 1997 and 1998, surveys for Hawaiian *Hylaeus* were conducted at 43 sites that were either historical collecting localities or potential suitable habitat. *Hylaeus anthracinus* was observed at 13 of the 43 survey sites, but was not found at any of the 9 historically occupied sites (Daly and Magnacca 2003, p. 217). Several of the historical collection sites have been urbanized or are dominated by nonnative vegetation (Liebherr and Polhemus 1997, pp. 346–347; Daly and Magnacca 2003, p. 55; Magnacca 2007, pp. 186–188). There has been a dramatic decline in abundance or presence of *H. anthracinus* since surveys conducted in 1999 through 2002, noted on surveys conducted between 2011 and 2013 (Magnacca 2015, in litt.). Currently, *H. anthracinus* is known from 15 small patches of coastal and lowland dry forest habitat (Magnacca 2005a, in litt., p. 2); 5 locations on the island of Hawaii in the coastal ecosystem; 2 locations on Maui in the coastal and lowland dry ecosystems; 1 location on Kahoolawe in the lowland dry ecosystem; 3 locations on Molokai in the coastal ecosystem, and 4 locations on Oahu in the coastal ecosystem (Daly and Magnacca 2003, p. 217; Magnacca 2005a, in litt., p. 2; Magnacca and King 2013, pp. 13–14; Graham 2015, in litt.). These 15 locations supported small populations of *H. anthracinus,* but the number of individual bees is unknown. In 2004, a single individual was collected in montane dry forest on the island of Hawaii (possibly a vagrant); however, the presence of additional individuals has not been confirmed at this site (Magnacca 2005a, in litt., p. 2). Although this species was previously unknown from the island of Kahoolawe, it was observed at one location on the island in 2002 (Daly and Magnacca 2003, p. 55). Additionally, during surveys between 1997 and 2008, *H. anthracinus* was absent from 17 other sites with potentially suitable habitat from which other species of *Hylaeus* were collected (Daly and Magnacca 2003, pp. 4, 55) on Hawaii Island, Maui, Lanai, Molokai, and Oahu.

Habitat destruction and modification by urbanization and land use conversion lead to the direct fragmentation of foraging and nesting areas used by *Hylaeus anthracinus.* Habitat destruction and modification by nonnative plants adversely impacts native plant species by modifying the availability of light, altering soil-water regimes, modifying nutrient cycling, altering the fire characteristics (increasing the fire cycle), and ultimately converting native dominated plant communities to nonnative plant communities, and results in removal of food sources and nesting sites for *H. anthracinus* (Graham 2015, in litt.). Habitat modification and destruction by nonnative animals such as feral pigs, goats, axis deer, and cattle, is considered one of the primary factors underlying degradation of native vegetation in the Hawaiian Islands, and these habitat changes also remove food sources and nesting sites for *H. anthracinus* (Stone 1985, pp. 262–263; Cuddihy and Stone 1990, pp. 60–66, 73). Fire is a threat to *H. anthracinus,* as it destroys native coastal and lowland plant communities on which the species depends, and opens habitat for increased invasion by nonnative plants. Because of the greater frequency, intensity, and duration of fires that have resulted from the human alteration of landscapes and the introduction of nonnative plants, especially grasses, fires are now more destructive to the coastal and lowland dry ecosystems (Brown and Smith 2000, p. 172). A single grass-fueled fire often kills most native trees and shrubs in the area (D'Antonio and Vitousek 1992, p. 74) and could destroy food and nesting resources for *H. anthracinus.* The number and size of wildfires are increasing in the main Hawaiian Islands; however, their occurrences and locations are unpredictable, and could affect habitat for yellow-faced bees at any time (Gima 1998, in litt.; County of Maui 2009, Ch. 3, p. 3; Hamilton 2009, in litt.; Honolulu Advertiser 2010, in litt.; Pacific Disaster Center 2011, in litt.). Random, naturally occurring events such as hurricanes, tsunami, and drought can also modify and destroy habitat of *H. anthracinus* by creating disturbed areas conducive to invasion by nonnative plants and by eliminating food and nesting resources (Kitayama and Mueller-Dombois 1995, p. 671; Businger 1998, pp. 1–2; Magnacca 2015, in litt.). Predation by nonnative ants including the big-headed ant (*Pheidole megacephala*), the yellow crazy ant (*Anoplolepis gracilipes*), *Solenopsis papuana* (NCN), and *S. geminata* (NCN) on *Hylaeus* egg, larvae, and pupal stages is a threat to *H. anthracinus,* and ants also compete with *H. anthracinus* for their nectar food and nesting resources (Howarth 1985, p. 155; Hopper *et al.* 1996, p. 9; Holway *et al.* 2002, pp. 188, 209; Daly and Magnacca 2003, p. 9; Lach 2008, p. 155; Graham 2015, in litt.). Predation by nonnative western yellow jacket wasps (*Vespula pensylvanica*) is a threat to *H. anthracinus* because the wasp is an aggressive, generalist predator, and occurs in great numbers in many habitat types, from sea level to over 8,000 ft (2,450 m), including areas where *H. anthracinus* and other yellow-faced bees occur (Gambino *et al.* 1987, p. 169; Graham 2015, in litt.). Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and their habitat from nonnative ungulates. Competition with nonnative bees (honeybees, carpenter bees, sweat bees (*Lasioglossum* spp.), and alien *Hylaeus* bees) for nectar and pollen, and by exclusion from foraging, is a potential threat to *H. anthracinus* (Magnacca 2007, p. 188; Graham 2015, in litt.; Magnacca 2015, in litt.). The small number of populations and individuals of *H. anthracinus* makes this species more vulnerable to extinction because of the higher risks from genetic bottlenecks, random demographic fluctuations, and localized catastrophes such as hurricanes, tsunami, and drought (Daly and Magnacca 2003, p. 3; Magnacca 2007, p. 173; Magnacca 2015, in litt.). Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *H. anthracinus* described above. In addition, disease has been suggested as a threat, as pathogens carried by nonnative bees, wasps, and ants could be transmitted to *H. anthracinus* through shared food sources (Graham 2015, in litt.); however, we have no reports of this type of disease transmission at this time.

The remaining populations of *Hylaeus anthracinus* and its habitat are at risk. The known individuals are restricted to 15 locations on Hawaii, Maui, Kahoolawe, Molokai, and Oahu and continue to be negatively affected by habitat destruction and modification by urbanization and land-use conversion, and by habitat destruction and removal of food and nesting sites by nonnative ungulates and nonnative plants. Habitat destruction by fire is a threat. Randomly occurring events such as hurricanes and drought modify habitat and remove food and nesting sources for *H. anthracinus.* Predation by nonnative ants and wasps is a threat. Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and their habitat from nonnative ungulates. Competition with nonnative bees for food and nesting sites is a threat. The small number of remaining populations limits this species' ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that *H. anthracinus* is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Yellow-Faced Bee (*Hylaeus assimulans*)

Historically, *Hylaeus assimulans* was known from numerous coastal and lowland dry forest habitats up to 2,000 ft (610 m) in elevation on the islands of Maui (coastal and lowland dry ecosystems), Lanai (lowland dry ecosystem), and Oahu (coastal and lowland dry ecosystem). There are no collections from Molokai although it is likely *H. assimulans* occurred there because all other species of *Hylaeus* known from Maui, Lanai, and Oahu also occurred on Molokai (Daly and Magnacca 2003, pp. 217–229). Between 1997 and 1998, surveys for Hawaiian *Hylaeus* were conducted at 25 sites on Maui, Kahoolawe, Lanai, Molokai, and Oahu. *Hylaeus assimulans* was absent from 6 of its historical localities on Maui, Lanai, and Oahu, and was not observed at the remaining 19 sites with potentially suitable habitat (Daly and Magnacca 2003, pp. 56, 217; Magnacca 2005b, in litt., p. 2; Magnacca 2007, pp. 177, 181, 183; Xerces Society 2009, p. 4). Currently, *H. assimulans* is known from a few small patches of coastal and lowland dry forest habitat (Magnacca 2005b, in litt., p. 2) in two locations on Maui in the lowland dry ecosystem; one location on Kahoolawe in the coastal ecosystem; and two locations on Lanai in the lowland dry ecosystem (Daly and Magnacca 2003, p. 58; Magnacca 2005b, in litt., p. 2). This species has likely been extirpated from Oahu because it has not been observed since Perkin's 1899 surveys, and was not found during recent surveys of potentially suitable habitat on Oahu at Kaena Point, Makapuu, and Kalaeloa (Daly and Magnacca 2003, p. 217; Magnacca 2005b, in litt., p. 2).

Habitat destruction and modification by urbanization and land use conversion lead to fragmentation of, and eventual loss, of foraging and nesting areas used by *Hylaeus assimulans.* Habitat destruction and modification by nonnative plants (*Asystasia gangetica* (Chinese violet), *Atriplex semibaccata, Cenchrus ciliaris* (buffelgrass), *Chloris barbata* (swollen fingergrass), *Digitaria insularis* (sourgrass), *Leucaena leucocephala, Melinis minutiflora, Pluchea indica* (Indian fleabane), *P. carolinensis, Prosopis pallida, Schinus terebinthifolius,* and *Verbesina encelioides* (golden crown-beard) adversely impact native plant species by modifying the availability of light, altering soil-water regimes, modifying nutrient cycling, altering the fire characteristics, and ultimately converting native dominated plant communities to nonnative plant communities, and results in removal of food sources and nesting sites for *H. assimulans* (Xerces Society 2009, p. 21; 76 FR 55170, September 6, 2011, p. 55184). Habitat modification and destruction by nonnative animals such as feral pigs, goats, axis deer, and cattle is considered one of the primary factors underlying destruction of native vegetation in the Hawaiian Islands, and these habitat changes also remove food sources and nesting sites of *H. assimulans* (Stone 1985, pp. 262–263; Cuddihy and Stone 1990, pp. 60–66, 73). Fire is a threat to *H. assimulans,* as it destroys native plant communities on which the species depends, and opens habitat for increased invasion by nonnative plants. Because of the greater frequency, intensity, and duration of fires that have resulted from the human alteration of landscapes and the introduction of nonnative plants, especially grasses, fires are now more destructive to the coastal and lowland dry ecosystems (Brown and Smith 2000, p. 172), and a single grass-fueled fire often kills most native trees and shrubs in the area (D'Antonio and Vitousek 1992, p. 74) and could destroy food and nesting resources for *H. assimulans.* The numbers of wildfires and the acreages involved are increasing in the main Hawaiian Islands; however, their occurrences and locations are unpredictable, and could affect habitat for yellow-faced bees at any time (Gima 1998, in litt.; County of Maui 2009, ch. 3, p. 3; Hamilton 2009, in litt.; Honolulu Advertiser 2010, in litt.; Pacific Disaster Center 2011, in litt.). Random, naturally occurring events such as hurricanes, tsunami, and drought modify and destroy habitat of *H. assimulans* by creating disturbed areas conducive to invasion by nonnative plants, eliminating food and nesting sources (Kitayama and Mueller-Dombois 1995, p. 671; Businger 1998, pp. 1–2; Magnacca 2015, in litt.). Predation by nonnative ants (the big-headed ant, the yellow crazy ant, *Solenopsis papuana,* and *S. geminata*) on *Hylaeus* egg, larvae, and pupal stages is a threat to *H. assimulans;* additionally, ants compete with *H. assimulans* for their nectar food source (Howarth 1985, p. 155; Hopper *et al.* 1996, p. 9; Holway *et al.* 2002, pp. 188, 209; Daly and Magnacca 2003, p. 9; Lach 2008, p. 155). Predation by nonnative western yellow jacket wasps is a threat to *H. assimulans* because the wasp is an aggressive, generalist predator, and occurs in great numbers in many habitat types, from sea level to over 8,000 ft (2,450 m), including areas where *H. assimulans* and other yellow-faced bees occur (Gambino *et al.* 1987, p. 169). Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and their habitat from nonnative ungulates. Competition with nonnative bees (honeybees, carpenter bees, sweat bees, and alien *Hylaeus* bees) for nectar and pollen is a threat to *H. assimulans* (Magnacca 2007, p. 188; Graham 2015, in litt; Magnacca 2015, in litt.). The small number of populations and individuals of *H. assimulans* makes this species more vulnerable to extinction because of the higher risks from genetic bottlenecks, random demographic fluctuations, and localized catastrophes such as hurricanes and drought (Daly and Magnacca 2003, p. 3; Magnacca 2007, p. 173). Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *H. assimulans* described above.

The remaining populations of *Hylaeus assimulans* and its habitat are at risk. The known individuals are restricted to 5 locations: 2 on Maui, 1 on Kahoolawe, and 2 on Lanai, and is likely extirpated from Oahu. This species continues to be negatively affected by habitat destruction and modification by urbanization and land-use conversion, and by habitat destruction and removal of food and nesting sites by nonnative ungulates and nonnative plants. Habitat destruction by fire is a threat. Randomly occurring events such as hurricanes and drought modify habitat and remove food and nesting sources for *H. assimulans.* Predation by nonnative ants and wasps is a threat. Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and their habitat from nonnative ungulates. Competition with nonnative bees for food and nesting sites is a threat. The small number of remaining populations limits this species' ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that *H. assimulans* is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Yellow Faced Bee (*Hylaeus facilis*)

Historically, *Hylaeus facilis* was known from Maui, Lanai, Molokai, and Oahu, in dry shrubland to wet forest from sea level to 3,000 ft (1,000 m) (Gagne and Cuddihy 1999, p. 93; Daly and Magnacca 2003, pp. 81, 83). Perkins (1899, p. 77) remarked *H. facilis* was among the most common and widespread *Hylaeus* species on Oahu, Maui, Lanai, and Molokai (Magnacca 2007, p. 183). Although the species was collected in a wide range of habitat types, it likely prefers dry to mesic forest and shrubland (Magnacca 2005c, in litt., p. 2), which are increasingly rare and patchily distributed habitats (Smith 1985, pp. 227–233; Juvik and Juvik 1998, p. 124; Gagne and Cuddihy 1999, pp. 66–67, 75; Magnacca 2005c, in litt., p. 2). Researchers believe the wet forest site on Oahu where *H. facilis* was observed likely had a more open understory (more mesic conditions), and represented an outlier or residual population (Perkins 1899, p.76; Liebherr and Polhemus 1997; p. 347). *Hylaeus facilis* has almost entirely disappeared from most of its historical range (Maui, coastal and lowland mesic; Lanai, lowland dry and lowland mesic; and Oahu, coastal and lowland dry) (Daly and Magnacca 2003, p. 7; Magnacca 2007, p. 183). Between 1998 and 2006, 39 sites on Maui, Lanai, Molokai, and Oahu were surveyed, including 13 historical sites. *Hylaeus facilis* was absent from all 13 locations (Magnacca 2007, p. 183) and was not observed at 26 additional sites with potentially suitable habitat (Daly and Magnacca 2003, pp. 7, 81–82; Magnacca 2007, p. 183). Likely extirpated from Lanai, *H. facilis* is currently known from only two locations, one on Molokai in the coastal ecosystem, and one on Oahu in the coastal ecosystem (Daly and Magnacca 2003, pp. 81–82; Magnacca 2005c, in litt., p. 2). In addition, in 1990, a single individual was collected on Maui near Makawao at 1,500 ft (460 m); however, this site is urbanized and devoid of native plants, and it is likely this collection was a vagrant individual.

Habitat destruction and modification by urbanization and land use conversion lead to fragmentation of, and eventual loss of, foraging and nesting areas used by *Hylaeus facilis.* Habitat destruction and modification by nonnative plants adversely impacts native plant species by modifying the availability of light, altering soil-water regimes, modifying nutrient cycling, altering the fire characteristics, and ultimately converting native dominated plant communities to nonnative plant communities, and results in removal of food sources and nesting sites for the *H. facilis.* In addition to the nonnative plant species noted above that modify and destroy habitat of *H. assimulans, Urochloa mutica, Prosopis pallida, Psidium cattleianum,* and *Rubus* spp. are noted to negatively affect the habitat of *H. facilis* (Cuddihy and Stone 1990, p. 105; Hawaii Division of Forestry and Wildlife (DOFAW) 2007, pp. 20–22). Habitat modification and destruction by nonnative animals such as feral pigs, goats, axis deer, and cattle is considered one of the primary factors underlying destruction of native vegetation in the Hawaiian Islands, and these habitat changes also remove food sources and nesting sites for *H. facilis* (Stone 1985, pp. 262–263; Cuddihy and Stone 1990, pp. 60–66, 73). Fire is a threat to *H. facilis,* as it destroys native plant communities on which the species depends, and opens habitat for increased invasion by nonnative plants. Because of the greater frequency, intensity, and duration of fires that have resulted from the human alteration of landscapes and the introduction of nonnative plants, especially grasses, fires are now more destructive to the coastal and lowland dry ecosystems (Brown and Smith 2000, p. 172), and a single grass-fueled fire often kills most native trees and shrubs in the area (D'Antonio and Vitousek 1992, p. 74) and could destroy food and nesting resources for *H. facilis.* The numbers of wildfires and the acreages involved are increasing in the main Hawaiian Islands; however, their occurrences and locations are unpredictable, and could affect habitat for yellow-faced bees at any time (Gima 1998, in litt.; County of Maui 2009, ch. 3, p. 3; Hamilton 2009, in litt.; Honolulu Advertiser 2010, in litt.; Pacific Disaster Center 2011, in litt.). Random, naturally occurring events such as hurricanes, tsunami, and drought modify and destroy habitat of *H. facilis* by creating disturbed areas conducive to invasion by nonnative plants, eliminating food and nesting resources (Kitayama and Mueller-Dombois 1995, p. 671; Businger 1998, pp. 1–2; Magnacca 2015, in litt.). Predation by nonnative ants (the big-headed ant, the yellow crazy ant, *Solenopsis papuana,* and *S. geminata*) on *Hylaeus* egg, larvae, and pupal stages is a threat to *H. facilis;* additionally, ants compete with *H. facilis* for their nectar food source (Howarth 1985, p. 155; Hopper *et al.* 1996, p. 9; Holway *et al.* 2002, pp. 188, 209; Daly and Magnacca 2003, p. 9; Lach 2008, p. 155). Predation by nonnative western yellow jacket wasps is a threat to *H. facilis* because the wasp is an aggressive, generalist predator, and occurs in great numbers in many habitat types, from sea level to over 8,000 ft (2,450 m), including areas where *H. facilis* and other yellow-faced bees occur (Gambino *et al.* 1987, p. 169). Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and their habitat from nonnative ungulates. Competition with nonnative bees (honeybees, carpenter bees, sweat bees, and alien *Hylaeus* bees) for nectar and pollen is a threat to *H. facilis* (Magnacca 2007, p. 188; Magnacca 2015, in litt.). The small number of populations and individuals of *H. facilis* makes this species more vulnerable to extinction because of the higher risks from genetic bottlenecks, random demographic fluctuations, and localized catastrophes such as hurricanes and drought (Daly and Magnacca 2003, p. 3; Magnacca 2007, p. 173). Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *H. facilis* described above.

The remaining populations of *Hylaeus facilis* and its habitat are at risk. The known individuals are restricted to one location on Molokai and one location on Oahu, and continue to be negatively affected by habitat destruction and modification by urbanization and land-use conversion, and by habitat destruction and removal of food and nesting sites by nonnative ungulates and nonnative plants. Habitat destruction by fire is a threat. Randomly occurring events such as hurricanes and drought modify habitat and remove food and nesting sources for *H. facilis.* Predation by nonnative ants and wasps is a threat. Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and their habitat from nonnative ungulates. Competition with nonnative bees for food and nesting sites is a threat. The small number of remaining populations limits this species' ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that *H. facilis* is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Yellow-Faced Bee (*Hylaeus hilaris*)

Historically, *Hylaeus hilaris* was known from coastal habitat on Maui, Lanai, and Molokai; and lowland dry habitat on Maui. It is believed to have occurred along much of the coast of these islands because its primary hosts, *H. anthracinus, H. assimulans,* and *H. longiceps* likely occurred throughout this habitat. First collected on Maui in 1879, *H. hilaris* has only been collected twice in the last 100 years. *Hylaeus hilaris* was absent from three of its historical population sites revisited by researchers between 1998 and 2006 (Magnacca 2007, p. 181). It was also not observed in 2003 at 10 additional sites with potentially suitable habitat (Daly and Magnacca 2003, pp. 103, 106). Currently, the only known population of *H. hilaris* is located on Molokai, in the coastal ecosystem (Daly and Magnacca 2003, pp. 103, 106; Magnacca 2005d, in litt., p. 2; Magnacca 2007, p. 181).

Because *Hylaeus hilaris* is an obligate parasite on *H. anthracinus, H. assimulans,* and *H. longiceps,* its occurrences are determined by the remaining populations of these three species. Habitat destruction and modification by urbanization and land use conversion leads to fragmentation of, and eventual loss of, foraging and nesting areas of *H. hilaris,* and of those *Hylaeus* species that *H. hilaris* is dependent upon. Habitat destruction and modification by nonnative plants adversely impacts native plant species by modifying the availability of light, altering soil-water regimes, modifying nutrient cycling, altering the fire characteristics, and ultimately converting native dominated plant communities to nonnative plant communities, and results in removal of food sources and nesting sites for the *Hylaeus* species that *H. hilaris* is dependent upon. Nonnative plant species that modify and destroy habitat of *H. hilaris* are noted in the description for *H. assimulans,* above. Habitat modification and destruction by nonnative animals such as feral pigs, goats, axis deer, and cattle is considered one of the primary factors underlying destruction of native vegetation in the Hawaiian Islands, and these habitat changes also remove food sources and nesting sites for the host species of *H. hilaris* (Stone 1985, pp. 262–263; Cuddihy and Stone 1990, pp. 60–66, 73). Fire is a threat to *H. hilaris,* as it destroys native plant communities, and opens habitat for increased invasion by nonnative plants. Because of the greater frequency, intensity, and duration of fires that have resulted from the human alteration of landscapes and the introduction of nonnative plants, especially grasses, fires are now more destructive to the coastal and lowland dry ecosystems (Brown and Smith 2000, p. 172), and a single grass-fueled fire often kills most native trees and shrubs in the area (D'Antonio and Vitousek

1992, p. 74) and could destroy food and nesting resources for *H. hilaris.* The numbers of wildfires and the acreages involved are increasing in the main Hawaiian Islands; however, their occurrences and locations are unpredictable, and could affect habitat for yellow-faced bees at any time (Gima 1998, in litt.; County of Maui 2009, ch. 3, p. 3; Hamilton 2009, in litt.; Honolulu Advertiser 2010, in litt.; Pacific Disaster Center 2011, in litt.). Random, naturally occurring events such as hurricanes, tsunami, and drought can modify and destroy habitat of *H. hilaris* by creating disturbed areas conducive to invasion by nonnative plants, eliminating food and nesting sources of its host species (Kitayama and Mueller-Dombois 1995, p. 671; Businger 1998, pp. 1–2; Magnacca 2015, in litt.). Predation by nonnative ants (the big-headed ant, the long-legged ant, *Solenopsis papuana,* and *S. geminata*) on *Hylaeus* egg, larvae, and pupal stages is a threat to *H. hilaris;* additionally, ants compete with the yellow-faced bees that *H. hilaris* is dependent on for their food resources (Howarth 1985, p. 155; Hopper *et al.* 1996, p. 9; Holway *et al.* 2002, pp. 188, 209; Daly and Magnacca 2003, p. 9; Lach 2008, p. 155). Predation by nonnative western yellow jacket wasps is a threat to *H. hilaris* because the wasp is an aggressive, generalist predator, and occurs in great numbers in many habitat types, from sea level to over 8,000 ft (2,450 m), including areas where *H. hilaris* and other yellow-faced bees occur (Gambino *et al.* 1987, p. 169). Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and their habitat from nonnative ungulates. Competition with nonnative bees (honeybees, carpenter bees, sweat bees, and alien *Hylaeus* bees) for nectar and pollen is a threat to the host yellow-faced bees of *H. hilaris* (Magnacca 2007, p. 188; Graham 2015, in litt.; Magnacca 2015, in litt.). The small number of populations and individuals of *H. hilaris* makes this species more vulnerable to extinction because of the higher risks from genetic bottlenecks, random demographic fluctuations, and localized catastrophes such as hurricanes and drought (Daly and Magnacca 2003, p. 3; Magnacca 2007, p. 173). Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *H. hilaris* described above.

The remaining populations of *Hylaeus hilaris* and its habitat are at risk. There is one known occurrence on Molokai. *Hylaeus hilaris* and its host species continue to be negatively affected by habitat destruction and modification by urbanization and land-use conversion, and by habitat destruction and removal of food and nesting sites (for host species) by nonnative ungulates and nonnative plants. Habitat destruction by fire is a threat. Randomly occurring events such as hurricanes and drought modify habitat and remove food and nesting sources for *H. hilaris* and its host species. Predation by nonnative ants and wasps is a threat. Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and their habitat from nonnative ungulates. Competition with nonnative bees for food and nesting sites is a threat. The small number of remaining populations limits this species' ability to adapt to environmental changes, especially because it is an obligate parasite of other rare *Hylaeus* bees. Because of these threats, we find that *H. hilaris* is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Yellow-Faced Bee (*Hylaeus kuakea*)

Because the first collection of *Hylaeus kuakea* was not made until 1997, its historical range is unknown (Magnacca 2005e, in litt., p. 2; Magnacca 2007, p. 184). Phylogenetically, *H. kuakea* belongs in a species-group primarily including species inhabiting mesic forests (Magnacca and Danforth 2006, p. 405). Only four individuals (all males) have been collected from two different sites in the Waianae Mountains of Oahu in the lowland mesic ecosystem (Magnacca 2007, p. 184). The species has never been collected in any other habitat type or area, including some sites that have been more thoroughly surveyed (Magnacca 2011, in litt.). Not all potentially suitable habitat has been surveyed due to the remote and rugged locations, small size, rareness, and distant spacing among large areas of nonnative forest (Smith 1985, pp. 227–233; Juvik and Juvik 1998, p. 124; Wagner *et al.* 1999, pp. 66–67, 75).

Habitat destruction and modification by feral pigs leads to fragmentation of, and eventual loss of, foraging and nesting areas of *Hylaeus kuakea.* Habitat destruction and modification by nonnative plants adversely impacts native plant species by modifying the availability of light, altering soil-water regimes, modifying nutrient cycling, altering the fire characteristics, and ultimately converting native dominated plant communities to nonnative plant communities, and results in removal of food sources and nesting sites for *H. kuakea.* Nonnative plant species that modify and destroy habitat of *H. kuakea* are noted in the descriptions for *H. assimulans* and *H. facilis,* above. Fire is a threat to *H. kuakea* because it destroys native plant communities and opens habitat for increased invasion by nonnative plants. Because of the greater frequency, intensity, and duration of fires that have resulted from the human alteration of landscapes and the introduction of nonnative plants, especially grasses, fires are now more destructive, including in lowland mesic areas (Brown and Smith 2000, p. 172), and a single grass-fueled fire often kills most native trees and shrubs in the area (D'Antonio and Vitousek 1992, p. 74) and could destroy food and nesting resources for *H. kuakea.* The numbers of wildfires and the acreages involved are increasing in the main Hawaiian Islands; however, their occurrences and locations are unpredictable, and could affect habitat for yellow-faced bees at any time (Gima 1998, in litt.; County of Maui 2009, ch. 3, p. 3; Hamilton 2009, in litt.; Honolulu Advertiser 2010, in litt.; Pacific Disaster Center 2011, in litt.). Random, naturally occurring events such as hurricanes and drought can modify and destroy habitat of *H. kuakea* by creating disturbed areas conducive to invasion by nonnative plants, eliminating food and nesting resources (Kitayama and Mueller-Dombois 1995, p. 671; Businger 1998, pp. 1–2). Predation by nonnative ants (the big-headed ant, the long-legged ant, *Solenopsis papuana,* and *S. geminata*) on *Hylaeus* egg, larvae, and pupal stages is a threat to *H. kuakea;* additionally, ants compete with *H. kuakea* for their nectar food source (Howarth 1985, p. 155; Hopper *et al.* 1996, p. 9; Holway *et al.* 2002, pp. 188, 209; Daly and Magnacca 2003, p. 9; Lach 2008, p. 155). Predation by nonnative western yellow jacket wasps is a threat to *H. kuakea* because the wasp is an aggressive, generalist predator, and occurs in great numbers in many habitat types, from sea level to over 8,000 ft (2,450 m), including areas where *H. kuakea* and other yellow-faced bees occur (Gambino *et al.* 1987, p. 169). Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and their habitat from nonnative ungulates. Competition with nonnative bees (honeybees, carpenter bees, sweat bees, and alien *Hylaeus* bees) for nectar and pollen is a threat to *H. kuakea* (Magnacca 2007, p. 188; Graham 2015, in litt.; Magnacca 2015, in litt.). The small number of populations and individuals of *H. kuakea* makes this species more vulnerable to extinction because of the higher risks from genetic bottlenecks, random demographic fluctuations, and localized catastrophes such as hurricanes and drought (Daly and Magnacca 2003, p. 3; Magnacca 2007, p. 173). Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *H. kuakea* described above.

The remaining populations of *Hylaeus kuakea* and its habitat are at risk. The known individuals are restricted to mesic forest in one area of one island (Oahu), and continue to be negatively affected by habitat destruction and removal of food and nesting sites by nonnative ungulates and nonnative plants. Habitat destruction by fire is a threat. Randomly occurring events such as hurricanes and drought modify habitat and remove food and nesting sources for *H. kuakea.* Predation by nonnative ants and wasps is a threat. Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and their habitat from nonnative ungulates. Competition with nonnative bees for food and nesting sites is a threat. The small number of remaining populations limits this species' ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that *H. kuakea* is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Yellow-faced bee (*Hylaeus longiceps*)

Hylaeus longiceps is historically known from coastal and lowland dry shrubland habitat up to 2,000 ft (610 m) in numerous locations on the islands of Maui, Lanai, Molokai, and Oahu. Perkins (1899, p. 98) noted *H. longiceps* was locally abundant, and probably occurred throughout much of the leeward and lowland areas on these islands. *Hylaeus longiceps* is now restricted to small populations in patches of coastal and lowland dry habitat on the Maui, Lanai, Molokai, and Oahu (Magnacca 2005f, in litt., p. 2; Magnacca and King 2013, pp. 13, 16). Twenty-five sites that were either historical collecting localities or contained potentially suitable habitat for this species were surveyed between 1997 and 2008 (Magnacca and King 2013, p. 16). *Hylaeus longiceps* was observed at only seven of the surveyed sites: Three sites on Lanai (in the coastal and lowland dry ecosystems), two sites on Oahu (in the coastal ecosystem), and one site on each of the islands of Maui (in the coastal ecosystem) and Molokai (in the coastal ecosystem) (Daly and Magnacca 2003, p. 135; Magnacca and King 2013, pp. 11–12).

Most of the coastal and lowland habitat of *Hylaeus longiceps* has been developed or degraded, and is no longer suitable (Liebherr and Polhemus 1997, pp. 346–347; Magnacca 2007, pp. 186–188). Habitat destruction and modification by axis deer (Lanai) and urbanization (Maui and Molokai) leads to fragmentation of, and eventual loss of, foraging and nesting areas of *H. longiceps* (Daly and Magnacca 2003, pp. 217–229). Habitat modification and destruction by human impacts in areas accessible by four-wheel drive vehicles on Lanai is a threat because these vehicles can destroy plants used as food sources and destroy ground nesting sites for *H. longiceps* (Daly and Magnacca 2003, p. 135). Habitat destruction and modification by nonnative plants adversely affects native plant species used by *H. longiceps* as a food source by modifying the availability of light, altering soil-water regimes, modifying nutrient cycling, altering the fire characteristics, and ultimately converting native-dominated plant communities to nonnative plant communities. Nonnative plant species that modify and destroy habitat of *H. longiceps* are noted in the descriptions for *H. assimulans* and *H. facilis,* above. Fire is a threat to *H. longiceps* because it destroys native plant communities, and opens habitat for increased invasion by nonnative plants. Because of the greater frequency, intensity, and duration of fires that have resulted from the human alteration of landscapes and the introduction of nonnative plants, especially grasses, fires are now more destructive to the coastal and lowland dry ecosystems (Brown and Smith 2000, p. 172), and a single grass-fueled fire often kills most native trees and shrubs in the area (D'Antonio and Vitousek 1992, p. 74) and could destroy food and nesting resources for *H. longiceps.* The numbers of wildfires and the acreages involved are increasing in the main Hawaiian Islands; however, their occurrences and locations are unpredictable, and could affect habitat for yellow-faced bees at any time (Gima 1998, in litt.; County of Maui 2009, ch. 3, p. 3; Hamilton 2009, in litt.; Honolulu Advertiser 2010, in litt.; Pacific Disaster Center 2011, in litt.). Random, naturally occurring events such as hurricanes, tsunami, and drought modify and destroy habitat of *H. longiceps* by creating disturbed areas conducive to invasion by nonnative plants, eliminating food and nesting resources (Kitayama and Mueller-Dombois 1995, p. 671; Businger 1998, pp. 1–2; Magnacca 2015, in litt.). Predation by, and competition for food sources, by nonnative ants and the nonnative western yellow jacket wasp is a threat to *H. longiceps* (see *H. kuakea,* above) (Gambino *et al.* 1987, p. 169; Howarth 1985, p. 155; Hopper *et al.* 1996, p. 9; Holway *et al.* 2002, pp. 188, 209; Daly and Magnacca 2003, p. 9; Lach 2008, p. 155). Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and their habitat from nonnative ungulates. Competition with nonnative bees (honeybees, carpenter bees, sweat bees, and alien *Hylaeus* bees) for nectar and pollen is a threat to *H. longiceps* (Magnacca 2007, p. 188; Graham 2015, in litt.; Magnacca 2015, in litt.). The small number of populations and individuals of *H. longiceps* makes this species more vulnerable to extinction because of the higher risks from genetic bottlenecks, random demographic fluctuations, and localized catastrophes such as hurricanes and drought (Daly and Magnacca 2003, p. 3; Magnacca 2007, p. 173). Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *H. longiceps* described above.

The remaining population of *Hylaeus longiceps* and its habitat are at risk. The known individuals are restricted to seven locations, three on Lanai, two on Oahu, and one each on Maui and Molokai, and continue to be negatively affected by habitat destruction and modification by urbanization and land-use conversion, by habitat destruction and removal of food and nesting sites by nonnative ungulates and nonnative plants, and by recreational use vehicles on Lanai. Habitat destruction by fire is a threat. Randomly occurring events such as hurricanes and drought may modify habitat and remove food and nesting sources for *H. longiceps.* Predation by nonnative ants and wasps is a threat. Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and their habitat from nonnative ungulates. Competition with nonnative bees for food and nesting sites is a threat. The small number of remaining populations limits this species' ability to adapt to environmental changes. Because of these threats, we find that *H. longiceps* is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Yellow-Faced Bee (*Hylaeus mana*)

Hylaeus mana is known only from lowland mesic forest dominated by native *Acacia koa* in the Koolau Mountains of Oahu, at 1,400 ft (430 m). Few other *Hylaeus* species have been found in this type of forest on Oahu (Daly and Magnacca 2003, p. 138). This type of native forest is increasingly rare and patchily distributed because of competition and encroachment into habitat by nonnative plants (Smith 1985, pp. 227–233; Juvik and Juvik 1998, p. 124; Wagner *et al.* 1999, pp. 66–67, 75). Decline of this forest type could lead to decline in populations and numbers of *H. mana.* Three additional population sites were discovered on Oahu in 2012, including a new observation of the species at the original site (Magnacca and King 2013, pp. 17–18). The three new sites are within a narrow range of lowland mesic forest at 1,400 ft (430 m), bordered by nonnative plant habitat at lower elevations and wetter native forest habitat above (Magnacca and King 2013, pp. 17–18). *Hylaeus mana* was most often observed on *Santalum freycinetianum* var. *freycinetianum,* which suggests that *H. mana* may be closely associated with this plant species (Magnacca and King 2013, p. 18). Additional surveys may reveal more populations; however, the extreme rarity of this species, its absence from many survey sites, the fact that it was not discovered until very recently, and the limited range of its possible host plant, all suggest that few populations remain (Magnacca 2005g, in litt., p. 2; Magnacca and King 2013, pp. 17–18).

Habitat destruction and modification by feral pigs leads to fragmentation of, and eventual loss of, foraging and nesting areas of *Hylaeus mana* (Daly and Magnacca 2003, pp. 217–229). Habitat destruction and modification by nonnative plants adversely impacts native plant species used by *H. mana* as a food source by modifying the availability of light, altering soil-water regimes, modifying nutrient cycling, altering the fire characteristics, and ultimately converting native dominated plant communities to nonnative plant communities. Nonnative plant species that modify and destroy habitat of *H. mana* are noted in the descriptions for *H. assimulans* and *H. facilis,* above, and can outcompete native canopy species such as *Acacia koa,* the known preferred native canopy type of *H. mana* (GISD 2011, in litt.; State of Hawaii 2013, in litt. (S.C.R. No. 74)). Fire is a threat to *H. mana,* as it destroys native plant communities on which the species depends, and opens habitat for increased invasion by nonnative plants. Because of the greater frequency, intensity, and duration of fires that have resulted from the human alteration of landscapes and the introduction of nonnative plants, especially grasses, fires are now more destructive, including in lowland mesic ecosystems (Brown and Smith 2000, p. 172). A single grass-fueled fire often kills most native trees and shrubs in the area (D'Antonio and Vitousek 1992, p. 74) and could destroy food and nesting resources for *H. mana.* The numbers of wildfires and the acreages involved are increasing in the main Hawaiian Islands; however, their occurrences and locations are unpredictable, and could affect habitat for yellow-faced bees at any time (Gima 1998, in litt.; County of Maui 2009, ch. 3, p. 3; Hamilton 2009, in litt.; Honolulu Advertiser 2010, in litt.; Pacific Disaster Center 2011, in litt.). Random, naturally occurring events such as hurricanes and drought can modify and destroy habitat of *H. mana* by creating disturbed areas conducive to invasion by nonnative plants (Kitayama and Mueller-Dombois 1995, p. 671; Businger 1998, pp. 1–2). Predation and competition for food sources by nonnative ants and the nonnative western yellow jacket wasp are threats to *H. mana* (see *H. kuakea,* above) (Howarth 1985, p. 155; Gambino *et al.* 1987, p. 169; Hopper *et al.* 1996, p. 9; Holway *et al.* 2002, pp. 188, 209; Daly and Magnacca 2003, p. 9; Lach 2008, p. 155). Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and their habitat from nonnative ungulates. Competition with nonnative bees (honeybees, carpenter bees, sweat bees, and alien *Hylaeus* bees) for nectar and pollen is a threat to *H. mana* (Magnacca 2007, p. 188; Graham 2015, in litt.; Magnacca 2015, in litt.). The small number of populations and individuals of *H. mana* makes this species more vulnerable to extinction because of the higher risks from genetic bottlenecks, random demographic fluctuations, and localized catastrophes such as hurricanes and drought (Daly and Magnacca 2003, p. 3; Magnacca 2007, p. 173). Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *H. mana* described above.

The remaining populations of *Hylaeus mana* and its habitat are at risk. The known individuals are restricted to three locations of native koa forest on Oahu, and continue to be negatively affected by habitat destruction and removal of food and nesting sites by nonnative ungulates and nonnative plants. Habitat destruction by fire is a threat. Randomly occurring events such as hurricanes and drought may modify habitat and remove food and nesting sources for *H. mana.* Predation by nonnative ants and wasps is a threat. Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and their habitat from nonnative ungulates. Competition with nonnative bees for food and nesting sites is a threat. The small number of remaining populations limits this species' ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that *H. mana* is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Orangeblack Hawaiian Damselfly (*Megalagrion xanthomelas*)

The orangeblack Hawaiian damselfly was once Hawaii's most abundant damselfly species likely because of its ability to use a variety of aquatic habitats for breeding sites. Historically, the orangeblack Hawaiian damselfly probably occurred on all of the main Hawaiian Islands (except Kahoolawe) in suitable aquatic habitat within the anchialine pool, coastal, lowland dry, and lowland mesic ecosystems (Perkins 1913, p. clxxviii; Zimmerman 1948, p. 379; Polhemus 1996, p. 30). Its historical range on Kauai is unknown. On Oahu, it was recorded from Honolulu, Kaimuki, Koko Head, Pearl City, Waialua, the Waianae Mountains, and Waianae (Polhemus 1996, pp. 31, 33). On Molokai, it was known from Kainalu, Meyer's Lake (Kalaupapa Peninsula), Kaunakakai, Mapulehu, and Palaau (Polhemus 1996, pp. 33–41). On Lanai, small populations occurred on Maunalei Gulch, and in ephemeral coastal ponds at the mouth of Maunalei Gulch drainage, at Keomuku, and in a mixohaline (brackish water) habitat at Lopa (Polhemus 1996, pp. 37–41; HBMP 2010). On Maui, this species was recorded from an unspecified locality in the west Maui Mountains (Polhemus 1996, pp. 41–42; Polhemus *et al.* 1999, pp. 27–29). On Hawaii Island, it was known from Hilo, Kona, and Naalehu (Polhemus 1996, pp. 42–47).

Currently, the orangeblack Hawaiian damselfly occurs on Oahu, Molokai, Lanai, Maui, and Hawaii Island. In 1994, on Oahu, a very small population was discovered in pools of an intermittent stream (Englund 2001, p. 256). On Molokai, populations occur at the mouths of two streams, and in wetlands on the south coast (Polhemus 1996, p. 47). On Lanai, a large population occurs in an artificial pond (Polhemus 1996, p. 47). The species is present on west Maui at a stream and near anchialine pools on east Maui (Polhemus *et al.* 1999, p. 29). Several large populations exist in coastal wetlands on Hawaii Island at 14 locations (Polhemus 1996, pp. 42–47; Orlando 2015, in litt.). The species is believed to be extirpated from Kauai (Asquith and Polhemus 1996, p. 91).

Past and present land use and water management practices, including agriculture, urban development, ground water development, and destruction of perched aquifer and surface water resources, and feral ungulates (pigs, goats, axis deer), modify and destroy habitat of the orangeblack Hawaiian damselfly (Harris *et al.* 1993, pp. 9–13; Meier *et al.* 1993, pp. 181–183). Nonnative plant species such as *Urochloa mutica* form dense, monotypic stands that can completely eliminate any open water habitat of the orangeblack Hawaiian damselfly (Smith 1985, p. 186). Stochastic events such as drought, flooding, and hurricanes can also modify and destroy habitat, and kill individuals. Predation of the orangeblack Hawaiian damselfly by nonnative fish and nonnative aquatic invertebrates on the orangeblack Hawaiian damselfly is a significant threat; predation by Jackson's chameleons (*Trioceros jacksonii*) may occur as well (Sailer 2015, in litt.). Hawaiian damselflies evolved with few, if any, predatory fish, and the reduced defensive and evasive behaviors of most of the fully aquatic species, including the orangeblack Hawaiian damselfly, makes them particularly vulnerable to predation by nonnative fish (Englund 1999, pp. 225–225, 235; Haines 2015, in litt.). The damselfly is not observed in any bodies of water that support nonnative fish (Henrickson 1988, p. 183; McPeek 1990a, pp. 92–96). Nonnative backswimmers (aquatic true bugs; Heteroptera) are voracious predators and frequently feed on prey much larger than themselves, such as tadpoles, small fish, and other aquatic invertebrates and may be a potential threat to damselfly's aquatic larvae (naiads) (Borror *et al.* 1989, p. 296). In addition, the nonnative bullfrog (*Rana catesbeiana, Lithobates catesbeianus*), found in ponds and along streams, is a generalist predator, and eats insects and crustaceans as well as a wide variety of small vertebrates (Bury and Whelan 1985, p. 4). Predation by the bullfrog is a threat to the orangeblack Hawaiian damselfly (Englund *et al.* 2007, pp. 215, 219; Haines 2015, in litt.). Also, caddisflies (*Trichoptera* spp.) compete with native aquatic invertebrates for resources and space (Flint *et al.* 2003, p. 38; Haines 2015, in litt.) and reduce prey abundance for orangeblack Hawaiian damselfly larvae.

Hawaii State law (State Water Code) does not provide for permanent or minimal instream flow standards, and channel modifications or revisions to flow standards can be undertaken at any time by the Water Commission, without regard for changes that degrade or destroy habitat, food resources, or aquatic life stages of the orangeblack Hawaiian damselfly. Therefore, existing regulatory mechansims do not adequately address the threat of modification and destruction of the aquatic habitat of the orangeblack Hawaiian damselfly (Hawaii Administrative Rule (HAR)-State Water Code, title 13, chapter 169–36; Tango 2010, in litt.).

The remaining populations and habitat of the orangeblack Hawaiian damselfly are at risk; numbers are decreasing on Oahu, Molokai, Lanai, Maui, and Hawaii Island, and both the species and its habitat continue to be negatively affected by modification and destruction by development and water management practices, drought, feral ungulates, and by nonnative plants, combined with predation by nonnative fish and other nonnative vertebrates. Competition with caddisflies is a potential threat to the orangeblack Hawaiian damselfly. The orangeblack damselfly was once the most common Hawaiian damselfly in the State, and occurred in any suitable aquatic habitat. Populations no longer occur on Kauai. The Oahu populations were described from seven locations, and this species now only occurs at one location. The populations on Molokai have declined from five to three. Populations on Lanai have declined from four to one in an artificial pond. On Maui, there are only two populations, one on east Maui, and one on west Maui. Of the 21 known populations on Hawaii Island, only 14 remain. Because of the dramatic decline in numbers and populations, and because of the ongoing threats described above, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Anchialine Pool Shrimp (*Procaris hawaiana*)

The shrimp family Procarididae is represented by a small number of species globally, with only two species within the genus *Procaris* (Magnacca 2015, in litt.). *Procaris hawaiana* is an endemic anchialine pool shrimp species known only from the islands of Maui and Hawaii. The second species, *P. ascensionis,* is restricted to similar habitat on Ascension Island in the South Atlantic Ocean. Of the anchialine pools on Hawaii Island, only 25 are known to contain *P. hawaiana.* During nocturnal-diurnal surveys conducted from 2009 to 2010, 19 pools within Manuka NAR were found to contain *P. hawaiana.* Five additional pools located on unencumbered State land adjacent to Manuka NAR also contained *P. hawaiana.* An additional separate pool also contains *P. hawaiana,* along with the endangered anchialine pool shrimp *Vetericaris chaceorum* (Holthuis 1973, pp. 12–19; Maciolek 1983, pp. 607–614; Brock 2004, pp. 30–57). On Maui, *P. hawaiana* occurs in two anchialine pools (Holthuis 1973, pp. 12–19; Maciolek 1983, pp. 607–614; Brock 2004, pp. 30–57).

Like other anchialine pool shrimp species, *Procaris hawaiana* inhabits extensive networks of water-filled interstitial spaces (cracks and crevices) leading to and from the open pools where they can be detected, a trait which has precluded accurate estimates of population size (Holthuis 1973, p. 36; Maciolek 1983, pp. 613–616). Surveys for many rare species of anchialine pool shrimp, including *P. hawaiana,* often involve baiting in likely habitat to determine presence or absence. Absence, and presumably extirpation, of shrimp species from suitable habitat is the best or only measure of species decline as population sizes are not easily determined or monitored (Holthuis 1973, pp. 7–12; Maciolek 1983, pp. 613–616), but owing to the potential for shrimp to move between pools through subterranean connections, the lack of sighting on one or several visits to a site is not definitive evidence that the species is extirpated (Kinzie 2015, in litt.). Extirpation of anchialine pool shrimp has been documented definitively in some cases; for example, *Halocaridina rubra* disappeared from an anchialine pool at Honokohau Harbor (Hawaii Island) as a result of the use of the pool for dumping of used oil, grease, and oil filters (Brock 2004, p. 14). To date, however, *P. hawaiana* is not known to have been extirpated from any of the pools where it has been documented to occur (Wada 2016, in litt.).

Habitat modification and destruction by human activities is a significant threat to *Procaris hawaiana.* It is estimated that up to 90 percent of existing anchialine pools in Hawaii have been destroyed by filling and bulldozing (Baily-Brock and Brock 1993, p. 354; Brock 2004, p. i). Anchialine pools are used as dumping pits for bottles, cans, and used oil and grease, and these activities are a known cause of the disappearance of other anchialine pool shrimp species from the pools. Trampling damage from use of anchialine pools for swimming and bathing has been documented (Brock 2004, pp. 13–17). Although a permit from the State is required to collect anchialine pool shrimp, unpermitted collection of shrimp is ongoing (Fuku-Bonsai 2015, in litt.). A single person with a handnet could do irreparable damage to a population of *P. hawaiana* (Yamamoto 2015, in litt.), but collection by permitted individuals is not prohibited at State Parks or City and County property where some anchialine pools occur. Predation by nonnative fish is a direct threat to *P. hawaiana.* Nonnative fish (tilapia, *Oreochromis mossambica*) also outcompete native herbivorous species of shrimp that serve as a prey-base for *P. hawaiana,* disrupting the delicate ecological balance in the anchialine pool system, and leading to decline of the pools and the shrimp inhabiting them (Brock 2004, pp. 13–17). Although anchialine pools within State of Hawaii NARs are provided some protection, these areas are remote and signage does not prevent human use and damage of the pools (see *Factor B*). The persistence of *P. hawaiana* is hampered by the small number of extant populations and the small geographic range of the known populations. The populations of *P. hawaiana* are at risk of extinction because of their increased vulnerability to loss of individuals from disturbance, habitat destruction, and the effects of invasive species and because of the reduction in genetic variability that may make the species less able to adapt to changes in the environment (Harmon and Braude 2010, pp. 125–128). In addition, large-scale water extraction from underground water sources negatively affects the habitat and *P. hawaiana* directly (Conry 2012, in litt.). A threat from development upslope of anchialine pool habitat is infiltration of waste water or application of fertilizer and pesticides that may enter the ground water system of the anchialine pools and consequently affect the pool's ecosystem health, food sources of the pool shrimp, or the pool shrimp directly (Kinzie 2015, in litt.; Yamamoto *et al.* 2015, pp. 75–83). Sea-level rise and coastal inundation resulting from the effects of climate change is a threat to *P. hawaiana* (Sakihara 2015, in litt.). Sea-level rise would increase surface connectivity between isolated anchialine pools, and exacerbate the spread of nonnative fish into pools not yet occupied by nonnative fish (Sakihara 2015, in litt.).

Procaris hawaiana and its habitat are at risk. There are a total of 700 known anchialine pools in the State of Hawaii. *Procaris hawaiana* is restricted to 25 anchialine pools out of 600 on Hawaii Island and to 2 anchialine pools on Maui. These 27 anchialine pools continue to be negatively affected by habitat destruction and modification by human use of the pools for bathing and for dumping of trash and nonnative fish; filling and bulldozing; water extraction; contamination; predation by and competition with nonnative fish; and collection for the aquarium trade. The small number of populations (27) limits this species' ability to adapt to environmental changes. Because of these threats, we find that this species is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

Distinct Population Segment (DPS) Analysis

Band-Rumped Storm-Petrel (Oceanodroma castro)

Under the Act, we have the authority to consider for listing any species, subspecies, or, for vertebrates, any distinct population segment (DPS) of these taxa if there is sufficient information to indicate that such action may be warranted. To guide the implementation of the DPS provisions of the Act, we, and the National Marine Fisheries Service (National Oceanic and Atmospheric Administration—Fisheries), published the Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act (DPS Policy) in the **Federal Register** on February 7, 1996 (61 FR 4722). Under our DPS Policy, we use two elements to assess whether a population segment under consideration for listing may be recognized as a DPS: (1) The population segment's discreteness from the remainder of the species to which it belongs, and (2) the significance of the population segment to the species to which it belongs. If we determine that a population segment being considered for listing is a DPS, then the population segment's conservation status is evaluated based on the five listing factors established by the Act to determine if listing it as either endangered or threatened is warranted. In the proposed rule (80 FR 58820; September 30, 2015), we evaluated the Hawaii population of the band-rumped storm-petrel to determine whether it meets the definition of a DPS under our DPS Policy.

Discreteness

Under the DPS Policy, a population segment of a vertebrate taxon may be considered discrete if it satisfies either one of the following conditions: (1) It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors (quantitative measures of genetic or morphological discontinuity may provide evidence of this separation); or (2) it is delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the Act. The Hawaii population of the band-rumped storm-petrel meets the first criterion: it is markedly separated from other populations of this species by physical (geographic) and physiological (genetic) factors, as described below.

The band-rumped storm-petrel is widely distributed in the tropics and subtropics, with breeding populations in numerous island groups in the Atlantic and in Hawaii, Galapagos, and Japan in the Pacific (Harrison 1983, p. 274; Carboneras *et al.* 2014, p. 1 and Fig. 2). The geographic separation of these breeding populations is widely recognized, with strong genetic differentiation between the two ocean basins and among individual populations (Friesen *et al.* 2007a, p. 1768; Smith *et al.* 2007, p. 768). Whether individual populations merit taxonomic separation remains unclear, and further study is needed (Friesen *et al.* 2007b, p. 18591; Smith *et al.* 2007, p. 770; reviewed in Howell 2012, pp. 349, 369–370); some populations, such as those in the Galapagos and Cape Verde islands, may warrant full species status (Smith *et al.* 2007, p. 770). Like other storm-petrels, the band-rumped storm-petrel is a highly pelagic (open-ocean) seabird (Howell 2012, p. 349). In addition, like other species in the seabird order Procellariiformes, band-rumped storm-petrels exhibit strong philopatry, or fidelity to their natal sites

(Allan 1962, p. 274; Harris 1969, pp. 96, 113, 120; Harrison *et al.* 1990, p. 49; Smith *et al.* 2007, pp. 768–769). Both of these characteristics contribute to isolation of breeding populations, in spite of the absence of physical barriers such as land masses within ocean basins (Friesen *et al.* 2007a, pp. 1777–1778).

Band-rumped storm-petrels from Hawaii are likely to encounter individuals from other populations only very rarely. The approximate distances from Hawaii to other known breeding sites are much greater than the birds' average foraging range of 860 mi (1,200 km): 4,000 mi (6,600 km) to Japan and 4,600 mi (7,400 km) to Galapagos (the two other Pacific populations), and 7,900 mi (12,700 km) to Madeira, 7,300 mi (11,700 km) to the Azores, and 9,700 mi (15,600 km) to Ascension Island (in the Atlantic). Data from at-sea surveys of the eastern tropical Pacific conducted since 1988 show that the density of band-rumped storm-petrels attenuates north and northwest of Galapagos and that the species rarely occurs in a broad area southeast of Hawaii (Pitman, Ballance, and Joyce 2015, unpublished). This pattern suggests a gap in the at-sea distribution of this species, and low likelihood of immigration on an ecological timescale, between Hawaii and Galapagos. We are not aware of any data describing the at-sea distribution of this species between Hawaii and Japan, but the absence of breeding records from western Micronesia (Pyle and Engbring 1985, p. 59) indicates a distributional gap between these two archipelagoes as well. Other than occasional encounters in their foraging habitat, the vast expanses of ocean between Japan, Hawaii, and Galapagos provide for no other sources of potential connectivity between band-rumped storm-petrel populations in the Pacific, such as additional breeding sites.

Even those disparate breeding populations of pelagic seabirds that do overlap at sea may remain largely isolated otherwise and exhibit genetic differentiation (*e.g.,* Walsh and Edwards 2005, pp. 290, 293). Despite the birds' capacity to move across large areas of ocean, genetic differentiation among breeding populations of band-rumped storm-petrels is high (Friesen *et al.* 2007b, p. 18590; Smith *et al.* 2007, p. 768), even between populations nesting in different seasons on the same island (in Galapagos; Smith and Friesen 2007, p. 1599). Genetic analysis found low relatedness (1) between Atlantic and Pacific populations; (2) among Japan, Hawaii, and Galapagos populations; or (3) among Cape Verde, Ascension, and northeast Atlantic breeding populations (Smith *et al.* 2007, p. 768). Hawaiian birds have not been well-sampled for genetic analysis, but the few individuals from Hawaii included in a rangewide analysis showed that Hawaiian birds differed from all other populations, and were most closely related to birds from Japan (Friesen *et al.* 2007b, p. 18590).

We have determined that the Hawaii population of the band-rumped storm-petrel is discrete from the rest of the taxon because its breeding and foraging range are markedly separated from those of other populations. The Hawaii population is geographically isolated from populations in Japan and Galapagos, as well as from populations in very distant island groups in the central and western Atlantic Ocean. Molecular evidence indicates that the genetic structure of the species reflects the spatial or temporal separation of individual populations; the scant molecular data from Hawaii suggest that this holds for the Hawaii population as well.

Significance

Under our DPS Policy, once we have determined that a population segment is discrete, we consider its biological and ecological significance to the larger taxon to which it belongs. This consideration may include, but is not limited to: (1) Evidence of the persistence of the discrete population segment in an ecological setting that is unusual or unique for the taxon, (2) evidence that loss of the population segment would result in a significant gap in the range of the taxon, (3) evidence that the population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historical range, or (4) evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics. We have found substantial evidence that the Hawaii population of the band-rumped storm-petrel meets two of the significance criteria listed above: the loss of this population would result in a significant gap in the range of the taxon, and this population persists in a unique ecological setting. As described above, the physical isolation that defines the discreteness of Hawaii population is likely reflected in genetic differentiation from other populations, but at this time we lack sufficient data to consider genetic characteristics as an independent factor in our determination of the Hawaii population's significance to the rest of the taxon. Genetic patterns on an ocean-basin or species-wide scale, however, have implications for connectivity and potential gaps in the band-rumped storm-petrel's range (described below).

Dispersal between populations of seabird species with ranges fragmented by large expanses of ocean may play a vital role in the persistence of individual populations (Bicknell *et al.* 2012, p. 2872). No evidence currently exists of such dispersal among Pacific populations of band-rumped storm-petrels at frequencies or in numbers that would change the population status between years, for example, by providing immigrants that compensate for breeding failure or adult mortality resulting from predation, as has been hypothesized for Leach's storm-petrel in the Atlantic (Bicknell *et al.* 2012, p. 2872). Given the remnant population of band-rumped storm-petrels in Hawaii and recently documented decline in Japan (Biodiversity Center of Japan 2014, p. 1), we would not expect to see exchange on such short timescales. However, genetic evidence is suggestive of exchange between these two populations on an evolutionary timescale (Friesen *et al.* 2007b, p. 18590).

The loss of this population would result in a significant gap in the range of the band-rumped storm-petrel. As noted above, seabirds in the order Procellariiformes, including the band-rumped storm-petrel, exhibit very high natal site fidelity, and so are slow to recolonize extirpated areas or range-gaps (Jones 2010, p. 1214), and may lack local adaptations; they thus face a potentially increased risk of extinction with the loss of individual populations (Smith *et al.* 2007, p. 770). The Hawaii population of the band-rumped storm petrel constitutes the entire Central Pacific distribution of the species, located roughly half-way between the populations in Galapagos and Japan (see Figure 1, below), and its loss would create a gap of approximately 8,500 mi (13,680 km) between them and significantly reducing the likelihood of connectivity and genetic exchange. Such exchange would be reliant on chance occurrences, such as severe storms that could result in birds being displaced to the opposite side of the Pacific Ocean basin, and such chance dispersal events would not necessarily result in breeding.

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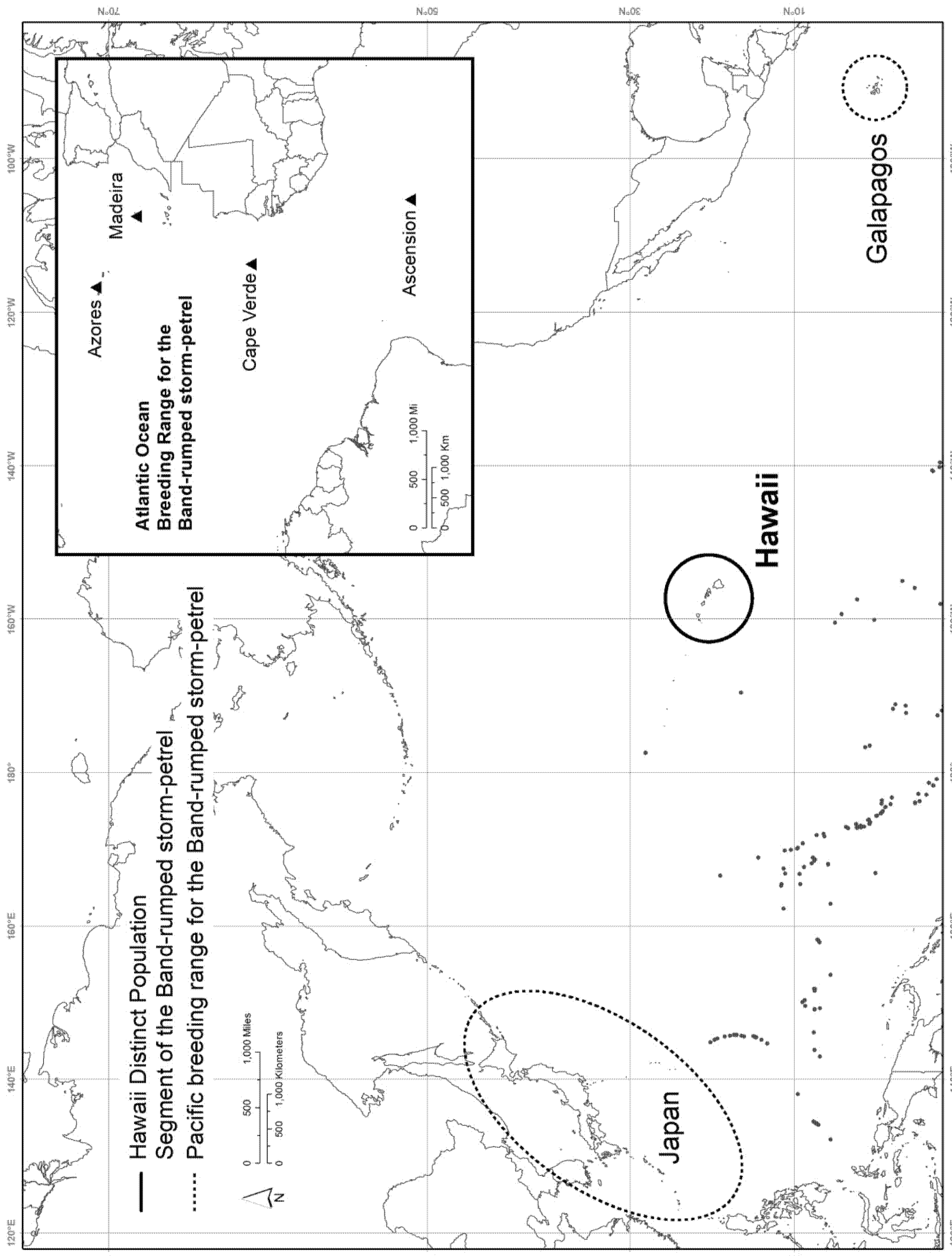

Figure 1. Location of the Hawaii Distinct Population Segment of the band-rumped storm-petrel and the two other breeding locations for the species in the Pacific Ocean. Atlantic breeding locations also provided for context.

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The Hawaii population of the band-rumped storm-petrel is significant also because it persists in a unique ecological setting. This is the only population of the species known to nest at high-elevation sites (above 6,000 ft (1,800 m)) (Banko *et al.* 1991, pp. 651–653; Athens *et al.* 1991, p. 95). In prehistory, the species likely nested in lowland habitats and more accessible habitats in Hawaii as well as in the high-elevation and otherwise remote areas where the species is found today; archaeological evidence suggests that band-rumped storm-petrels were once sufficiently common at both high (5,260 and 6,550 ft (1,600 and 2,000 m)) and low elevations on Hawaii Island to be used as a food source by humans (Ziegler pers. comm. *in* Harrison *et al.* 1990, pp. 47–48; Athens *et al.* 1991, pp. 65, 78–80; Banko *et al.* 1991, p. 650). In lowland areas, the species was common enough for the Hawaiians to name it and to identify it by its call (Harrison *et al.* 1990, p. 47; Banko *et al.* 1991, p. 650). In addition to the impacts of harvest by humans in prehistory, seabirds in Hawaii, including the band-rumped storm-petrel, were negatively affected by the proliferation of nonnative predators such as rats and pigs, and, later, cats and mongoose, and by loss of habitat (reviewed in Duffy 2010, pp. 194–196). Predation and habitat loss combined likely led to the extirpation of the band-rumped storm-petrel from coastal and lowland habitats and other accessible nesting areas, as occurred in the endangered Hawaiian petrel (*Pterodroma sandwichensis*) and threatened Newell's shearwater (*Puffinus newelli*), which have similar nesting habits and life histories (Olson and James 1982, p. 43; Slotterback 2002, p. 6; Troy *et al.* 2014, pp. 315, 325–326). The band-rumped storm-petrel's persistence in sites such as the Southwest Rift Zone (6,900 ft (2,100 m)) on Mauna Loa (Hawaii Island) has required them to surmount physiological challenges posed by nesting in high-elevation conditions (cold temperatures, low humidity, and less oxygen). They may possess special adaptations for this, such as reduction in porosity and other eggshell modifications to reduce the loss of water and carbon dioxide during incubation at high elevation (Rahn *et al.* 1977, p. 3097; Carey *et al.* 1982, p. 716; Carey *et al.* 1983, p. 349). In sum, the remnant distribution of band-rumped storm-petrel breeding sites in only the most remote and rugged terrain in Hawaii reflects the conditions necessary for the species' persistence in Hawaii (relatively undisturbed habitat in areas least accessible to predators) and also reflects unique adaptations that facilitate the species' persistence in high-elevation areas.

We have determined that the Hawaii population of band-rumped storm-petrel is significant to the rest of the taxon. Its loss would result in a gap in the range of the species of more than 8,500 mi (13,680 km), reducing and potentially precluding connectivity between the two remaining populations in the Pacific Basin. In addition, the Hawaii population nests at high elevation on some islands, constituting a unique ecological setting represented nowhere else in the species' breeding range.

DPS Conclusion

We have evaluated the Hawaii population of band-rumped storm-petrel to determine if it meets the definition of a DPS, considering its discreteness and significance as required by our policy. We have found that this population is markedly separated from other populations by geographic distance, and this separation is likely reflected in the population's genetic distinctiveness. The Hawaii population is significant to the rest of the species because its loss would result in a significant gap in the species' range; Hawaii is located roughly half-way between the other two populations in the Pacific Ocean, and little or no evidence exists of current overlap at sea between the Hawaii population and either the Japan or Galapagos populations. The Hawaii population of band-rumped storm-petrel also nests at high elevation in Hawaii—conditions at high elevation constitute an ecological setting unique to the species. We conclude that the Hawaii population of band-rumped storm-petrel is a distinct vertebrate population segment under our February 7, 1996, DPS Policy (61 FR 4722), and that it warrants review for listing under the Act. Therefore, we have incorporated the Hawaii DPS of the band-rumped storm-petrel in our evaluation of threats affecting the other 48 species addressed in this rule (summarized above; see also Summary of Factors Affecting the 49 Species From the Hawaiian Islands, below).

Summary of Factors Affecting the 49 Species From the Hawaiian Islands

Section 4 of the Act (16 U.S.C. 1533), and its implementing regulations (50 CFR part 424), set forth the procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. A species may be determined to be an endangered or threatened species due to one or more of the five factors described in section 4(a)(1) of the Act: (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; and (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. Each of these factors is discussed below.

In considering factors that might constitute threats to a species, we must look beyond the exposure of the species to a factor to evaluate whether the species responds to the factor in a way that causes impacts to the species or is likely to cause impacts in the future. If a species responds negatively to such exposure, the factor may be a threat and, during the status review, our aim is to determine whether impacts are or will be of an intensity or magnitude to place the species at risk. The factor is a threat if it drives, or contributes to, the risk of extinction of the species such that the species warrants listing as an endangered or threatened species as those terms are defined by the Act. This does not necessarily require empirical proof of a threat. The combination of exposure and some corroborating evidence of how the species is likely affected could suffice. In sum, the mere identification of factors that could affect a species negatively is not sufficient to compel a finding that listing is appropriate; we require evidence that these factors act on the species to the point that the species meets the definition of an endangered or threatened species.

If we determine that the threats posed to a species by one or more of the five listing factors are, or are likely to become, of such magnitude and/or intensity that the species meets the definition of either endangered or threatened under section 3 of the Act, that species may then be listed as endangered or threatened. The Act defines an endangered species as ''in danger of extinction throughout all or a significant portion of its range,'' and a threatened species as ''likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.'' The threats to each of the individual 49 species are summarized in Table 2, and discussed in detail below.

We acknowledge that the specific threats to the individual species in this final rule are not all completely understood. Scientific study of each of the 49 species is limited because of their rarity and the challenging logistics associated with conducting field work in Hawaii (areas are typically remote, difficult to access, challenging work environments, and expensive to survey in a comprehensive manner). However, information is available on many of the threats that act on Hawaiian ecosystems, and, for some ecosystems, these threats are well studied and understood. Each of the native species that occurs in Hawaiian ecosystems suffers from exposure to those threats to differing degrees. For the purposes of our listing determination, the best available scientific information leads us to conclude that the threats that act at the ecosystem level also act on each of the species that occurs in those ecosystems. In some cases we have additionally identified species-specific threats, such as loss of host plants.

The following threats affect the 49 species in one or more of the ecosystems addressed in this rule:

(1) Modification and destruction of habitat, including streams, ponds, and anchialine pools, by urban development and water extraction. Human activities also contribute to increased sedimentation in anchialine pools.

(2) Habitat destruction and modification by feral ungulates including pigs, goats, axis deer, black-tailed deer, mouflon, sheep, and cattle. The disturbance of soils by these animals causes erosion and creates fertile seedbeds for nonnative plants, leading to further habitat degradation. Ungulates also trample seedlings.

(3) Habitat destruction and modification by nonnative plants. Nonnative plants modify availability of light, alter soil-water regimes, modify nutrient cycling, alter fire regimes, and ultimately convert native dominated plant communities to nonnative plant communities. They also cause or contribute to loss of host plants used for food and nesting by the yellow-faced bees.

(4) Habitat destruction by wildfires caused naturally or by humans. Fires also destroy the native plant seedbank, and contribute to habitat conversion of native forest to nonnative grasslands (grass/fire cycle).

(5) Habitat destruction and modification, or direct damage and death, by stochastic events including drought, erosion, flooding, tree falls, rock falls, landslides, hurricanes, and tsunamis.

(6) Illegal collection of anchialine pool shrimp for personal use or commercial trade.

(7) Herbivory or defoliation of native plants by ungulates, rats, slugs, and black twig borers, which have been observed to contribute to the decline or death of 35 the 39 plant species (except for *Cyperus neokunthianus, Cyrtandra hematos, Lepidium orbiculare,* and *Stenogyne kaalae* ssp. *sherffii*). Herbivory also destroys seeds and fruit and contributes to lack of reproduction in the wild and low genetic diversity compounding the decline of native plants.

(8) Predation of the band-rumped storm-petrel by rats, barn owls, cats, and mongoose.

(9) Predation of the orangeblack Hawaiian damselfly by bullfrogs, backswimmers, Jackson's chameleons, and nonnative fish.

(10) Predation of the anchialine pool shrimp by nonnative fish.

(11) Predation of *Hylaeus* bees by ants and wasps.

(12) Competition for food and nesting sites of the *Hylaeus* yellow-faced bees by nonnative ants, wasps, and bees, and competition for food and habitat of the orangeblack Hawaiian damselfly by caddisflies. Competition for space and food resources of the anchialine pool shrimp by nonnative fish.

(13) Injury and mortality of the band-rumped storm-petrel caused by artificial lighting, communication towers, and power lines.

(14) Injury and mortality of the band-rumped storm-petrel by the activities of fisheries and encounters with marine debris.

(15) Low numbers and/or no reproduction of all 49 species exacerbated by one or more of the above threats, combined with inability of the species to adapt to sea-level rise or other factors associated with climate change.

Existing regulatory mechanisms do not ameliorate these threats for any of the 49 species such that listing is not warranted. Each of the threats listed above is discussed in more detail below, and summarized in Table 2.

TABLE 2—SUMMARY OF PRIMARY THREATS IDENTIFIED FOR EACH OF THE 49 HAWAIIAN ISLANDS SPECIES

Species	Ecosystem	Factor A					Factor B	Factor C			Factor D	Factor E	
		Agriculture and urban development	Ungulates	Non-native plants	Fire	Stochastic events	Over-utilization	Predation/ herbivory by ungulates	Predation/ herbivory by other NN vertebrates	Predation/ herbivory by NN invertebrates	Inadequate existing regulatory mechanisms	Other species-specific threats	Climate change
PLANTS:													
Asplenium diellaciniatum	MM		P, G, BTD	X				X			X	LN	X.
Calamagrostis expansa	MW		P	X				X	R		X	LN	X, Ft.
Cyanea kauaulaensis	LW			X		E, F, L			R	S	X	LN, NR	X.
Cyclosorus boydiae	LW, MW	X, WE	P	X		DR, F, L		X			X	LN	X, Ft.
Cyperus neokunthianus	LW		P	X							X	LN	X.
Cyrtandra hematos	MW		P, G	X							X	HY, LN, NR.	X, Ft.
Deparia kaalaana	LM, LW		P	X		DR, F		X		S	X	LN	X.
Dryopteris glabra var. *pusilla*	MW		P, BTD	X		L			R	S	X	LN	X, Ft.
Exocarpos menziesii	LM, MM, MD		G, M, SH	X	X			X			X	LN	X, Ft.
Festuca hawaiiensis	MD		G, SH	X	X			X			X	LN	X, Ft.
Gardenia remyi	LM, LW		P, G, D	X		L		X	R		X	LN, NR	X, Ft.
Huperzia stemmermanniae	MW		P, G, D, C	X		DR		X			X	LN	X, Ft.
Hypolepis hawaiiensis var. *mauiensis*	MW			X						S	X	LN	X, Ft.
Joinvillea ascendens ssp. *ascendens*	LM, LW, MW, MM.		P, G, D, BTD.	X	X	L		X	R		X	LN, NR	X, Ft.
Kadua fluviatilis	LM, LW		P, G	X		L		X			X	LN	X, Ft.
Kadua haupuensis	LM		P	X		L			R		X	LN	X.
Labordia lorenciana	MM		P, G, BTD	X	X	F, L, TF		X	R	BTB	X	LN, NR	X.
Lepidium orbiculare	LM		P, G	X		L					X	LN	X.
Microlepia strigosa var. *mauiensis*	LM, MW, MM		P, G	X				X			X	HY, LN	X.
Myrsine fosbergii	LM, LW, MW		P, G	X				X			X	HY, LN	X, Ft.
Nothocestrum latifolium	LD, LM, DC		P, G, D, BTD, M, C.	X	X			X		BTB	X	LN, NR	X, Ft.
Ochrosia haleakalae	LM, MM, DC		P, G, C	X	X			X	R	S	X	LN, NR	X, Ft.
Phyllostegia brevidens	LW, MW, WC		P	X		E, L		X		S	X	LN	X, Ft.
Phyllostegia helleri	LW, MW, WC		P, G	X		L			R		X	LN	X, Ft.
Phyllostegia stachyoides	MW, MM		P, G, D	X		DR, E, F, L, RF.		X	R	S	X	LN	X, Ft.
Portulaca villosa	CO, LD, MD		G, D, M, C.	X	X	L, RF		X			X	LN	X, Ft.
Pritchardia bakeri	LM		P	X		HUR			R		X	LN	X.
Pseudognaphalium sandwicensium var. *molokaiense*	CO		G, D	X		L, RF		X			X	LN	X, Ft.
Ranunculus hawaiensis	MM, MD, SA		P, M, C	X		DR, E		X			X	LN	X, Ft.
Ranunculus mauiensis	MW, MM, WC		P, G, D, BTD, C.	X	X	DR, E, L		X	R	S	X	LN	X, Ft.
Sanicula sandwicensis	MM, MD, SA		P, G	X	X	DR, E, F		X	R		X	LN	X, Ft.
Santalum involutum	LM, LW		P, G	X	X			X	R		X	LN	X.
Schiedea diffusa ssp. *diffusa*	LW, MW		P	X					R	S	X	LN	X.
Schiedea pubescens	LW, MW, MM, WC.		P, G, D, C	X	X	DR, E, F		X	R	S	X	LN	X, Ft.
Sicyos lanceoloideus	LM, MM, DC		P, G, BTD	X	X	DR		X			X	LN	X, Ft.
Sicyos macrophyllus	MW, MM, MD		P, M, C	X	X			X	R		X	LN	X, Ft.
Solanum nelsonii	CO		D, C	X	X	DR, E, F, TS		X	R		X	LN, SL	X, Ft.
Stenogyne kaalae ssp. *sherffii*	LW		P	X							X	LN	X, Ft.
Wikstroemia skottsbergiana	LW		P, G	X		L			R		X	LN	X.
ANIMALS:													
Band-rumped storm-petrel (*Oceanodroma castro*)	CO, SA, DC, WC		G	X		E, L, HUR			R, O, CA, MO.		X	LI, ST, H, LN.	X.
Orangeblack Hawaiian damselfly (*Megalagrion xanthomelas*)	AP, CO, LD, LM	X, WE	P, G, D	X		DR, F, HUR			FS, BF, JC	BS	X	LN, CD	X.
Anchialine pool shrimp (*Procaris hawaiana*)	AP	X, WE					X		FS		X	FS, H, LN, RU, SD, SL.	X.
Yellow-faced bee (*Hylaeus anthracinus*)	CO, LD	X	P, G, D, SH, C.	X	X	DR, HUR, TS.				A, W,	X	LN, W, B, LHP.	X.
Yellow-faced bee (*Hylaeus assimulans*)	CO, LD	X	P, G, D, M, C.	X	X	DR, HUR, TS.				A, W	X	LN, W, B, LHP.	X.
Yellow-faced bee (*Hylaeus facilis*)	CO, LD, LM	X	P, G, D, C	X	X	DR, HUR, TS.				A, W	X	LN, W, B, LHP.	X.

Yellow-faced bee (*Hylaeus hilaris*)	CO, LD	X	P, G, D, C	X	X	DR, HUR, TS.				A, W	X	LN, W, B, LHP.	X.
Yellow-faced bee (*Hylaeus kuakea*)	LM		P	X	X	DR, HUR				A, W	X	LN, W, B, LHP.	X.
Yellow-faced bee (*Hylaeus longiceps*)	CO, LD	X	D	X	X	DR, HUR, TS.				A, W	X	LN, W, B, LHP, RU.	X.
Yellow-faced bee (*Hylaeus mana*)	LM		P	X	X	DR, HUR				A, W	X	LN, W, B, LHP.	X.

Factor A = Habitat Modification; Factor B = Overutilization; Factor C = Disease or Predation; Factor D = Inadequacy of Regulatory Mechanisms: the Xs in this column indicate that existing regulatory mechanisms do not ameliorate the threats to the species such that listing is not warranted (we do not identify Factor D, in and of itself, as a threat to the species); Factor E = Other Species-Specific Threats.

AP = Anchialine Pools; CO = Coastal; LD = Lowland Dry; LM = Lowland Mesic; LW = Lowland Wet; MW = Montane Wet; MM = Montane Mesic; MD = Montane Dry; SA = Subalpine; DC = Dry Cliff; WC = Wet Cliff.

A = Ants, B = Bees (*competition*); BF = Bullfrog; BS = Backswimmer; BTB = Black Twig Borer; BTD = Black-tailed Deer; C = Cattle; CA = Cats; CD = Caddisflies; D = Axis Deer; ; FS = Fish; G = Goats; JC = Jackson's Chameleons; M = Mouflon; MO = Mongoose; O = Barn Owls; P = Pigs; R = Rats; S = Slugs; SH = Sheep; W = Wasps (*competition, predation*).

DR = Drought; E = Erosion; F = Flooding; Ft = assessed in Fortini *et al.* (2013) climate change vulnerability analysis; H = Human (*fisheries, marine debris, contamination*); HUR = Hurricanes; HY = Hybridization; L = Landslides; LHP = Loss of Host Plants; LI = Lights; LN = Low Numbers; NR = No Regeneration; RF = Rockfalls; RU = Recreational Use (*swimming, fishing, dumping trash and nonnative fish*); SD = Sedimentation; SL = Sea Level Rise; ST = Structures; TF = Tree Fall; TS = Tsunami; WE = Water Extraction.

Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Their Habitat or Range

The Hawaiian Islands are located over 2,000 mi (3,200 km) from the nearest continent. This isolation has allowed the few plants and animals transported to the islands by wind, water, or birds to evolve into many varied and endemic species. The only native terrestrial mammals on the Hawaiian Islands include two bat taxa, the Hawaiian hoary bat (*Lasiurus cinereus semotus*), and an extinct, unnamed insectivorous bat (Ziegler 2002, p. 245). The native plants of the Hawaiian Islands therefore evolved in the absence of mammalian predators, browsers, or grazers, and subsequently, many native species lost unneeded defenses against threats typical of continental environments such as herbivory and competition with aggressive, weedy plant species (Loope 1992, p. 11; Gagne and Cuddihy 1999, p. 45; Wagner *et al.* 1999, pp. 3–6). For example, Carlquist (*in* Carlquist and Cole 1974, p. 29) notes, ''Hawaiian plants are notably nonpoisonous, free from armament, and free from many characteristics thought to be deterrents to herbivores (oils, resins, stinging hairs, coarse texture).'' In addition, species restricted to highly specialized habitats (*e.g.,* Hawaiian damselflies) or food and nesting sources (*e.g.,* Hawaiian yellow-faced bees) are particularly vulnerable to changes in their habitat (Carlquist and Cole 1974, pp. 28–29; Loope 1992, pp. 3–6).

Habitat Destruction and Modification by Agriculture and Urban Development

Past land use practices such as agriculture or urban development have resulted in little or no native vegetation below 2,000 ft (600 m) throughout the Hawaiian Islands (TNC 2006). These land use practices negatively affect the anchialine pool, coastal, lowland dry, and lowland mesic ecosystems, including streams and wetlands that occur within these areas. Hawaii's agricultural industries (*e.g.,* sugar cane, pineapple) have been declining in importance, and large tracts of former agricultural lands are being converted into residential areas or left fallow (TNC 2007). In addition, Hawaii's population has increased almost 10 percent in the past 10 years, further increasing demands on limited land and water resources in the islands (Hawaii Department of Business, Economic Development and Tourism 2013, in litt.).

Development and urbanization of anchialine pool, coastal, lowland dry, and lowland mesic ecosystems on Oahu, Molokai, Maui, Lanai, and Hawaii Island are a threat to some species:

- On Oahu, the plant *Cyclosorus boydiae,* the orangeblack Hawaiian damselfly, and the yellow-faced bees *Hylaeus anthracinus, H. assimulans, H. facilis,* and *H. longiceps.*
- On Molokai, the orangeblack Hawaiian damselfly and the yellow-faced bees *Hylaeus anthracinus, H. facilis, H. hilaris, and H. longiceps.*
- On Maui, the plant *Cyclosorus boydiae,* the orangeblack Hawaiian damselfly, the anchialine pool shrimp *Procaris hawaiana,* and the yellow-faced bees *Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris, and H. longiceps.*
- On Lanai, the orangeblack Hawaiian damselfly, and the yellow-faced bees *Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris, and H. longiceps.*
- On Hawaii Island, the orangeblack Hawaiian damselfly, the anchialine pool shrimp *Procaris hawaiana,* and the yellow-faced bee *Hylaeus anthracinus.* (Daly and Magnacca 2003, pp. 55, 173; Palmer 2003, p. 88; Magnacca 2007, p. 188; Magnacca and King 2013, pp. 22–25).

Although we are unaware of any comprehensive, site-by-site assessment of wetland development in Hawaii (Erikson and Puttock 2006, p. 40), Dahl (1990, p. 7) estimated that at least 12 percent of lowland to upper-elevation wetlands in Hawaii had been converted to non-wetland habitat by the 1980s. If only coastal plain (below 1,000 ft (300 m)) marshlands and wetlands are considered, it is estimated that 30 percent were developed or converted to agricultural use (Kosaka 1990, in litt.). Records show the modification and reduction in area of these marshlands and wetlands that provided habitat for many damselfly species, including the orangeblack Hawaiian damselfly (Englund 2001, p. 256; Rees and Reed 2013, Fig 2S). Once modified, these areas then lack the aquatic habitat features that the orangeblack Hawaiian damselfly requires for essential life-history needs, such as pools of intermittent streams, ponds, and coastal springs (Polhemus 1996 pp. 30–31, 36). Although the filling of wetlands is regulated by section 404 of the Clean Water Act (33 U.S.C. 1251 *et seq.*), the loss of riparian or wetland habitats utilized by the orangeblack Hawaiian damselfly may still occur due to Hawaii's population growth and development, with concurrent demands on limited developable land and water resources. The State's Commission of Water Resource Management (CWRM) recognizes the need to update the 2008 water resource protection plan, and an update is currently under development (CWRM 2014, in litt.). In addition, marshes have been slowly filled and converted to meadow habitat as a result of sedimentation from increased storm water runoff from upslope development, the accumulation of uncontrolled growth of invasive vegetation, and blockage of downslope drainage (Wilson Okamoto & Associates, Inc. 1993, pp. 3–4–3–5). Agriculture and urban development have thus contributed to habitat destruction and modification, and continue to be a threat to the habitat of the orangeblack Hawaiian damselfly and the fern, *Cyclosorus boydiae.*

On Hawaii Island, it is estimated that up to 90 percent of the anchialine pools have been destroyed or altered by human activities, including bulldozing and filling of pools (Brock 2004, p. i; Bailey-Brock and Brock 1993, p. 354). Dumping of trash and nonnative fish has affected anchialine pools on this island (Brock 2004, pp. 13–17) (see *Factor E. Other Natural or Manmade Factors Affecting Their Continued Existence,* below). Brock also noted that garbage like bottles and cans appear to have no net negative impact, while the dumping of used oil, oil filters, and grease has resulted in the disappearance of the anchialine pool shrimp *Halaocaridina rubra* from a pool adjacent to Honokohau Harbor on Hawaii Island. Lua O Palahemo (where *Procaris hawaiana* occurs) on Hawaii Island is accessible to the public, and dumping has occurred there (Brock 2004, pp. 13–17). We are not aware of any dumping activities within the two Maui anchialine pools known to be occupied by *P. hawaiana;* however, this threat remains a possibility (Brock 2004, pp. 13–17).

Destruction and modification of *Hylaeus* habitat by urbanization and land use conversion, including agriculture, has led to the fragmentation of foraging and nesting habitat of these species. In particular, because native host plant species are known to be essential to the yellow-faced bees for foraging of nectar and pollen, any further loss of this habitat may reduce their long-term chances for recovery. Additionally, further destruction and modification of *Hylaeus* habitat is also likely to facilitate the introduction and spread of nonnative plants within these areas (see ''Habitat Destruction and Modification by Nonnative Plants,'' below).

Habitat Destruction and Modification by Nonnative Ungulates

Nonnative ungulates have greatly affected the native vegetation, as well as the native fauna, of the Hawaiian

Islands. Impacts to the native species and ecosystems accelerated following the arrival of Captain James Cook in 1778. The Cook expedition and subsequent explorers intentionally introduced a European race of pigs (*i.e.,* boars) and other livestock such as goats to serve as food sources for seagoing explorers (Tomich 1986, pp. 120–121; Loope 1998, p. 752). The mild climate of the islands, combined with lack of competitors or predators, led to the successful establishment of large populations of these feral mammals, to the detriment of native Hawaiian species and ecosystems (Cox 1992, pp. 116–117). The presence of introduced mammals is considered one of the primary factors underlying the modification and destruction of native vegetation and habitats of the Hawaiian Islands (Cox 1992, pp. 118–119). All of the 11 ecosystems on the main islands (except Kahoolawe) are currently affected by habitat destruction resulting from the activities of various combinations of nonnative ungulates, including pigs (*Sus scrofa*), goats (*Capra hircus*), axis deer (*Axis axis*), black-tailed deer (*Odocoileus hemionus columbianus*), sheep (*Ovis aries*), mouflon (*Ovis gmelini musimon*) and mouflon-sheep hybrids, and cattle (*Bos taurus*). Habitat destruction or modification by ungulates is a threat to 37 of the 39 plant species, the band-rumped storm-petrel, the orangeblack Hawaiian damselfly, and the seven yellow-faced bees (see Table 2).

Pigs (*Sus scrofa*)

The destruction or modification of habitat by pigs is currently a threat to four of the ecosystems (lowland mesic, lowland wet, montane wet, and montane mesic) in which these species occur. Feral pigs are known to cause deleterious impacts to ecosystem processes and functions throughout their worldwide distribution (Campbell and Long 2009, p. 2319). Pigs have been described as having the most pervasive and disruptive nonnative influences on the unique ecosystems of the Hawaiian Islands and are widely recognized as one of the greatest current threats (Aplet *et al.* 1991. p. 56; Anderson and Stone 1993, p. 195; Anderson *et al.* 2007, in litt.). Introduced European pigs hybridized with smaller, domesticated Polynesian pigs, became feral, and invaded forested areas, especially mesic and wet forests, from low to high elevations; they are present on all the main Hawaiian Islands except Lanai and Kahoolawe, where they have been eradicated (Tomich 1986, pp. 120–121; Munro (1911–1930) 2007, p. 85). By the early 1900s, feral pigs were already recognized as a serious threat to these areas, and an eradication project was conducted by the Hawaii Territorial Board of Agriculture and Forestry, which removed 170,000 pigs from forests Statewide (Diong 1982, p. 63).

Feral pigs are extremely destructive and have both direct and indirect impacts on native plant communities. While rooting in the earth in search of invertebrates and plant material, pigs directly affect native plants by disturbing and destroying vegetative cover and by trampling plants and seedlings. It has been estimated that at a conservative rooting rate of 2 square yards (sq yd) (1.7 square meters (sq m)) per minute and only 4 hours of foraging per day, a single pig could disturb over 1,600 sq yd (1,340 sq m) (or approximately 0.3 acres (ac) (0.1 hectares (ha)) of groundcover per week (Anderson *et al.* 2007, in litt.). Feral pigs are a major vector for the establishment and spread of invasive nonnative plant species, such as *Passiflora tarminiana* and *Psidium cattleianum,* by dispersing seeds carried on their hooves and coats and in their feces (which also serve to fertilize disturbed soil) (Diong 1982, pp. 169–170; Matson 1990, p. 245; Siemann *et al.* 2009, p. 547). Pigs also feed directly on native plants such as Hawaiian tree ferns. Pigs preferentially eat the core of tree-fern trunks, and these cored trunks then fill with rainwater and serve as breeding sites for introduced mosquitoes that spread avian malaria, with devastating consequences for Hawaii's native forest birds (Baker 1975, p. 79). Additionally, rooting pigs contribute to erosion, especially on slopes, by clearing vegetation and creating large areas of disturbed soil (Smith 1985, pp. 190, 192, 196, 200, 204, 230–231; Stone 1985, pp. 254–255, 262–264; Medeiros *et al.* 1986, pp. 27–28; Scott *et al.* 1986, pp. 360–361; Tomich 1986, pp. 120–126; Cuddihy and Stone 1990, pp. 64–65; Aplet *et al.* 1991, p. 56; Loope *et al.* 1991, pp. 1–21; Gagne and Cuddihy 1999, p. 52; Nogueira-Filho *et al.* 2009, pp. 3677–3682; Dunkell *et al.* 2011, pp. 175–177). The resulting erosion alters native plant communities by damaging individual plants, contributing to watershed degradation, and changing nutrient availability for plants; erosion also affects aquatic animals by increasing sedimentation in streams and pools (Vitousek *et al.* 2009, pp. 3074–3086; Nogueira-Filho *et al.* 2009, p. 3681; Cuddihy and Stone 1992, p. 667). The following 15 plants are at risk from erosion and landslides resulting from the activities of feral pigs: *Cyclosorus boydiae, Dryopteris glabra* var. *pusilla, Gardenia remyi, Joinvillea ascendens* ssp. *ascendens, Kadua fluviatilis, K. haupuensis, Labordia lorenciana, Lepidium orbiculare, Phyllostegia brevidens, P. helleri, P. stachyoides, Ranunculus hawaiensis, R. mauiensis, Sanicula sandwicensis,* and *Schiedea pubescens.* Thirty-two of the 39 plants (all except for *Cyanea kauaulaensis, Exocarpos menziesii, Festuca hawaiiensis, Hypolepis hawaiiensis* var. *mauiensis, Portulaca villosa, Pseudognaphalium sandwicensium* var. *molokaiense,* and *Solanum nelsonii*) are at risk of habitat destruction and modification by feral pigs, and the orangeblack Hawaiian damselfly and six of the seven yellow-faced bees (all except *Hylaeus longiceps*) are at risk of habitat destruction and modification by feral pigs (see Table 2).

Goats (*Capra hircus*)

Feral goats currently destroy and modify habitat in 10 of the 11 ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane wet, montane mesic, montane dry, subalpine, dry cliff, and wet cliff) in which these species occur. Goats, native to the Middle East and India, were successfully introduced to the Hawaiian Islands in the late 1700s. Actions to control feral goat populations began in the 1920s (Tomich 1986, pp. 152–153). However, goats still occupy a wide variety of habitats on all the main islands (except for Kahoolawe; see below), where they consume native vegetation, trample roots and seedlings, strip tree bark, accelerate erosion, and promote the invasion of nonnative plants (van Riper and van Riper 1982, pp. 34–35; Stone 1985, p. 261; Kessler 2010, pers. comm.). Kahoolawe was negatively affected by ungulates beginning in 1793, with introduction of goats and the addition of sheep (up to 15,000) and cattle (about 900) by ranchers between 1858 and 1941, with the goat population estimated to be as high as 50,000 individuals by 1988 (KIRC 2014, in litt.; KIRC 2015, in litt.). Beginning in 1941, the U.S. military used the entire island as a bombing range, and in 1994, control of Kahoolawe was returned to the State and the Kahoolawe Island Reserve Commission. The remaining ungulates were eradicated in 1993 (McLeod 2014, in litt.). Because they are able to access extremely rugged terrain, and have a high reproductive capacity (Clark and Cuddihy 1980, pp. C–19–C2–20; Culliney 1988, p. 336; Cuddihy and Stone 1990, p. 64), goats are believed to have completely eliminated some plant species from certain islands (Atkinson and Atkinson 2000, p. 21). Goats are highly destructive to native vegetation and contribute to erosion by: (1) Eating young trees and young shoots of plants before they become established; (2) creating trails that damage native vegetative cover; (3) destabilizing substrate and creating gullies that convey water; and (4) dislodging stones from ledges that results in rockfalls and landslides that damage or destroy native vegetation below (Cuddihy and Stone 1990, pp. 63–64). Feral goats forage along some cliffs where band-rumped storm-petrels nest on Kauai, and may trample nests and increase erosion (Scott *et al.* 1986, pp. 8, 352–357; Tomich 1986, pp. 152–153). The band-rumped storm-petrel and the following 12 plants are at risk from landslides or erosion caused by feral goats: *Gardenia remyi, Joinvillea ascendens* ssp. *ascendens, Kadua fluviatilis, Labordia lorenciana, Lepidium orbiculare, Phyllostegia helleri, P. stachyoides, Portulaca villosa, Pseudognaphalium sandwicensium* var. *molokaiense, Ranunculus mauiensis, Sanicula sandwicensis,* and *Schiedea pubescens.* Twenty-four of the 39 plants (all except for *Calamagrostis expansa, Cyanea kauaulaensis, Cyclosorus boydiae, Cyperus neokunthianus, Deparia kaalaana, Dryopteris glabra* var. *pusilla, Hypolepis hawaiiensis* var. *mauiensis, Kadua haupuensis, Phyllostegia brevidens, Pritchardia bakeri, Ranunculus hawaiensis, Schiedea diffusa* ssp. *diffusa, Sicyos macrophyllus, Solanum nelsonii,* and *Stenogyne kaalae* ssp. *sherffii*), the band-rumped storm-petrel, the orangeblack Hawaiian damselfly, and four of the yellow-faced bees (*Hylaeus anthracinus, H. assimulans, H. facilis,* and *H. hilaris*) are at risk of habitat destruction and modification by feral goats.

Axis Deer (*Axis axis*)

Axis deer destroy and modify 6 of the 11 ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane wet, and montane mesic) in which these species are found. Axis deer were introduced to the Hawaiian Islands for hunting opportunities on Molokai in 1868, on Lanai in 1920, and on Maui in 1959 (Hobdy 1993, p. 207; Erdman 1996, pers. comm. *in* Waring 1996, in litt., p. 2; Hess 2008, p. 2). Axis deer are primarily grazers, but also browse numerous palatable plant species including those grown as commercial crops (Waring 1996, p. 3; Simpson 2001, in litt.). They prefer the low, openly vegetated areas for browsing and grazing, but during episodes of drought (*e.g.,* from 1998 to 2001 on Maui (Medeiros 2010, pers. comm.)), axis deer move into urban and forested areas in search of food (Waring 1996, p. 5; Nishibayashi 2001, in litt.). Like goats, axis deer are highly destructive to native vegetation and contribute to erosion by eating young trees and young shoots of plants before they can become established. Other axis deer impacts include stripping bark from mature trees, creating trails, promoting erosion by destabilizing substrate, creating gullies that convey water, and dislodging stones from ledges that can result in rockfalls and landslides that directly damage vegetation (Cuddihy and Stone 1990, pp. 63–64).

On Molokai, axis deer likely occur at all elevations from sea level to almost 5,000 ft (1,500 m) at the summit area (Kessler 2011, pers. comm.). The most current population estimate for axis deer on the island of Molokai is between 4,000 and 5,000 individuals (Anderson 2003, p. 119). Little management for deer control has been implemented on Molokai, and this figure from more than a decade ago is likely an underestimate of the axis deer population on this island today (Scott *et al.* 1986, p. 360; Anderson 2003, p. 30; Hess 2008, p. 4). On Lanai, axis deer were reported to number approximately 6,000 to 8,000 individuals in 2007 (The Aloha Insider 2008, in litt; WCities 2010, in litt.). On Maui, five adult axis deer were released east of Kihei in 1959 (Hobdy 1993, p. 207; Hess 2008, p. 2). In 2013, the Maui Axis Deer Working Group estimated that there may be 8,000 deer on southeast Maui alone, based on helicopter surveys (Star Advertiser 2015, in litt.; Hawaii News Now 2014, in litt.) According to Medeiros (2010, pers. comm.) axis deer can be found in all but high-elevation ecosystems (subalpine and alpine) and montane bogs on Maui, and are increasing in numbers at such high rates that native forests are changing in unprecedented ways. Additionally, Medeiros (2010, pers. comm.) asserted that native plants will only survive in habitat that is fenced or otherwise protected from the browsing and trampling effects of axis deer. Kessler (2010, pers. comm.) and Hess (2010, pers. comm.) reported the presence of axis deer up to 9,000 ft (2,700 m) on Maui, and Kessler suggests that no ecosystem is safe from the negative impacts of these animals. Montane bogs are also susceptible to impacts from axis deer. As the native vegetation is removed by browsing and trampling, the soil dries out, and nonnative plants invade. Eventually, the bog habitat and its associated native plants and animals are replaced by grassland or shrubland dominated by nonnative plants (Mitchell *et al.* 2005, p. 6–32).

While axis deer are allowed as game animals on these three islands, the State does not permit their introduction to other Hawaiian Islands. In 2010–2011, axis deer were illegally introduced to Hawaii Island as a game animal (Kessler 2011, pers. comm.; Aila 2012, in litt.), and deer have now been observed across the southern portion of the island including in Kohala, Kau, Kona, and Mauna Kea (HDLNR 2011, in litt.). The Hawaii Department of Lands and Natural Resources (HDLNR) Division of Forestry and Wildlife (HDOFAW) has developed a response-and-removal plan, including a partnership now underway with the Hawaii Department of Agriculture (HDOA), the Big Island Invasive Species Committee (BIISC), Federal natural resource management agencies, ranchers, farmers, private landowners, and concerned citizens (Big Island.com, June 6, 2011). Also, in response to the introduction of axis deer to Hawaii Island, the Hawaii Invasive Species Council drafted House Bill 2593 to amend House Revised Statutes (H.R.S.) 91, which allows agencies to adopt emergency rules in the instances of imminent peril to public health, including to livestock and poultry health (BigIsland.com 2011, in litt.; Martin 2012, in litt.). This emergency rule became permanent on June 21, 2012, when House Bill 2593 was enacted into law as Act 194 (State of Hawaii 2012, in litt.).

The following 16 species in this rule are at risk from the activities of axis deer: *Gardenia remyi, Huperzia stemmermanniae, Joinvillea ascendens* ssp. *ascendens, Nothocestrum latifolium, Phyllostegia stachyoides, Portulaca villosa, Pseudognaphalium sandwicensium* var. *molokaiense, Ranunculus mauiensis, Schiedea pubescens, Solanum nelsonii,* the orangeblack Hawaiian damselfly, and five of the yellow-faced bees (*Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris,* and *H. longiceps*).

Black-Tailed Deer (*Odocoileus hemionus columbianus*)

Black-tailed deer destroy and modify habitat in 5 of the 11 ecosystems (lowland mesic, lowland wet, montane wet, montane mesic, and dry cliff) in which these species occur. The black-tailed deer is one of nine subspecies of mule deer (Natural History Museum 2015, in litt.). Black-tailed deer were first introduced to Kauai in 1961, for the purpose of sport hunting (Tomich 1986, pp. 131–134). Currently, these deer are only known from the western side of the island, where they feed on a variety of native (*e.g., Acacia koa* and *Coprosma* spp.) and nonnative plants (van Riper and van Riper 1982, pp. 42–46; Tomich 1986, p. 134). In addition to their direct impacts on native plants (browsing), black-tailed deer likely affect native plants indirectly by serving as a primary vector for the spread of introduced plants by carrying their seeds or other propagules on their coats and hooves and in feces. Black-tailed deer have been noted as a cause of habitat alteration in the Kauai ecosystems (NTBG 2007, in litt.; HBMP 2010). Seven of the 39 plants (*Asplenium diellaciniatum, Dryopteris glabra* var. *pusilla, Joinvillea ascendens* ssp. *ascendens, Labordia lorenciana, Nothocestrum latifolium, Ranunculus mauiensis,* and *Sicyos lanceoloideus*) are at risk of habitat destruction and modification by black-tailed deer.

Sheep (*Ovis aries*)

Four of the ecosystems on Hawaii Island (lowland dry, lowland mesic, montane mesic, and montane dry) in which these species occur are currently threatened by habitat destruction and modification due to the activities of feral sheep. Sheep were introduced to Hawaii Island in 1791, when Captain Vancouver brought five rams and two ewes from California (Tomich 1986, pp. 156–163). Soon after, stock was brought from Australia, Germany, and the Mediterranean for sheep production (Tomich 1986, pp. 156–163; Cuddihy and Stone 1990, pp. 65–66), and by the early 1930s, herds reached close to 40,000 individuals (Scowcroft and Conrad 1992, p. 627). Capable of acquiring the majority of their water needs by consuming vegetation, sheep can inhabit dry forests in remote regions of the mountains of Mauna Kea and Mauna Loa, including the saddle between the two volcanoes. Feral sheep browse and trample native vegetation and have decimated large areas of native forest and shrubland on Hawaii Island (Tomich 1986, pp. 156–163; Cuddihy and Stone 1990, pp. 65–66). Browsing results in the erosion of top soil that alters moisture regimes and micro-environments, leading to the loss of native plants and animals (Tomich 1986, pp. 156–163; Cuddihy and Stone 1990, pp. 65–66). In addition, nonnative plant seeds are dispersed into native forest by adhering to sheep's wool coats (DOFAW 2002, p. 3). In 1962, game hunters intentionally crossbred feral sheep with mouflon sheep and released them on Mauna Kea, where they have done extensive damage to the montane dry ecosystem (Tomich 1986, pp. 156–163). Over the past 30 years, attempts to protect the vegetation of Mauna Kea and the saddle area between the two volcanoes have been only sporadically effective (Hess 2008, pp. 1, 4). Currently, a large population of sheep (and mouflon hybrids) extends from Mauna Kea into the saddle and northern part of Mauna Loa, including State forest reserves, where they trample and browse all vegetation, including endangered plants (Hess 2008, p. 1). One study estimated as many as 2,500 mouflon within just the Kau district of the Kahuku Unit (Volcanoes National Park) in 2006 (Hess *et al.* 2006, p. 10). Two of the 39 plants, *Exocarpos menziesii* and *Festuca hawaiiensis,* and the yellow-faced bee *Hylaeus anthracinus,* are reported to be at risk of habitat destruction and modification by feral sheep (see Table 2).

Mouflon (*Ovis gmelini musimon*)

Mouflon destroy and modify habitat in 6 of the 11 ecosystems on Maui, Lanai, and Hawaii Island (lowland dry, lowland mesic, montane mesic, montane dry, subalpine, and dry cliff) in which these species occur. Native to central Asia, mouflon were introduced to the islands of Lanai and Hawaii in the 1950s as game species, and are now widely established on these islands (Tomich 1986, pp. 163–168; Cuddihy and Stone 1990, p. 66; Hess 2008, p. 1). Due to their high reproductive rate, the original population of 11 mouflon on the island of Hawaii increased to more than 2,500 individuals in 36 years, even though they were hunted for game (Hess 2008, p. 3). Mouflon have decimated vast areas of native shrubland and forest through grazing, browsing, and bark stripping (Stone 1985, p. 271; Cuddihy and Stone 1990, pp. 63, 66; Hess 2008, p. 3). Mouflon also create trails and pathways through vegetation, resulting in soil compaction and increased runoff and erosion. In some areas, the interaction of browsing and soil compaction has led to a shift from native forest to grassy scrublands (Hess 2008, p. 3). Mouflon only gather in herds when breeding, thus complicating control techniques and hunting efficiency (Hess 2008, p. 3; Ikagawa 2011, in litt.). Currently, many of the current and proposed fence exclosures on Hawaii Island constructed to protect rare species and habitat are designed to exclude feral pigs, goats, and sheep and are only 4 ft (1.3 m) in height; a fence height of at least 6 ft (2 m) is necessary to exclude mouflon (Ikagawa 2011, in litt.). Five of the 39 plant species (*Exocarpos menziesii, Nothocestrum latifolium, Portulaca villosa, Ranunculus hawaiensis,* and *Sicyos macrophyllus*), and the yellow-faced bee *Hylaeus assimulans,* are at risk from habitat destruction and modification resulting from the activities of mouflon (see Table 2).

Cattle (*Bos taurus*)

Cattle destroy and modify habitat in 7 of the 11 ecosystems on Maui and Hawaii Island (coastal, lowland dry, lowland mesic, lowland wet, montane wet, montane mesic, and montane dry) in which these species occur. Cattle, the wild progenitors of which were native to Europe, northern Africa, and southwestern Asia, were introduced to the Hawaiian Islands in 1793, and large feral herds (as many as 12,000 on the island of Hawaii) developed as a result of restrictions on killing cattle decreed by King Kamehameha I (Cuddihy and Stone 1990, p. 40). While small cattle ranches were developed on Kauai, Oahu, Molokai, west Maui, and Kahoolawe, very large ranches of tens of thousands of acres were created on east Maui and Hawaii Island (Stone 1985, pp. 256, 260; Broadbent 2010, in litt.). Feral cattle can be found today on the islands of Molokai, Maui, and Hawaii. Feral cattle eat native vegetation, trample roots and seedlings, cause erosion, create disturbed areas into which alien plants invade, and spread seeds of alien plants carried in their feces and on their bodies. The forest in areas grazed by cattle rapidly degrades into grassland pasture, and plant cover remains reduced for many years following removal of cattle from an area. Increased nitrogen availability through the feces of cattle contributes to the ingress of nonnative plant species (Kohala Mountain Watershed Partnership (KMWP) 2007, pp. 54–55; Laws *et al.* 2010, in litt.). Furthermore, several alien grasses and legumes purposely introduced for cattle forage have become invasive weeds (Tomich 1986, pp. 140–150; Cuddihy and Stone 1990, p. 29). According to Kessler (2011, pers. comm.) approximately 300 individuals roam east Maui as high as the subalpine ecosystem (*i.e.,* to 9,800 ft (3,000 m)), and feral cattle are occasional observed on west Maui. Feral cattle (more than 100 individuals) are reported from remote regions of Hawaii Island, including the back of Pololu and Waipio Valleys in the Kohala Mountains, and the Kona Unit of the Hakalau Forest National Wildlife Refuge (NWR) (KMWP 2007, p. 55; USFWS 2010, pp. 3–15, 4–86). Nine of the 39 plant species (*Huperzia stemmermanniae, Nothocestrum latifolium, Ochrosia haleakalae, Portulaca villosa, Ranunculus hawaiensis, R. mauiensis, Schiedea pubescens, Sicyos macrophyllus,* and *Solanum nelsonii*) and four of the yellow-faced bees (*Hylaeus anthracinus, H. assimulans, H. facilis,* and *H. hilaris*) are currently at risk of habitat destruction or modification due to the activities of feral cattle.

In summary, 37 of the 39 plant species (all except *Cyanea kauaulaensis* and *Hypolepis hawaiiensis* var. *mauiensis*), and 9 of the 10 animals (except for the anchialine pool shrimp *Procaris hawaiana*), are at risk of habitat destruction and modification by ungulates including pigs, goats, axis deer, black-tailed deer, sheep, mouflon, and cattle (see Table 2). The effects of these nonnative animals include the destruction of vegetative cover, trampling of plants and seedlings, direct consumption of native vegetation, soil disturbance and sedimentation (erosion and landslides), dispersal of nonnative plant seeds by animals, alteration of soil nitrogen availability, and creation of open, disturbed areas conducive to further invasion by nonnative pest plant species. All of these impacts also can lead to the conversion of a native plant community to one dominated by nonnative species (see ''Habitat Destruction and Modification by Nonnative Plants,'' below). In addition, because these animals inhabit terrain that is often steep and remote, foraging and trampling contributes to severe erosion of watersheds and degradation of streams and wetlands (Cuddihy and Stone 1990, p. 59; Dunkell *et al.* 2011, pp. 175–194).

Habitat Destruction and Modification by Nonnative Plants

Ten of the 11 ecosystems (excluding anchialine pool ecosystem) and the species in this rule that are associated with them are currently at risk of habitat destruction and modification by nonnative plants. Native vegetation on all of the main Hawaiian Islands has undergone extreme alteration because of past and present land management practices, including ranching, deliberate introduction of nonnative plants and animals, and agriculture (Cuddihy and Stone 1990, pp. 27, 58). The original native flora of Hawaii (present before human arrival) consisted of about 1,000 taxa, 89 percent of which are endemic (Wagner *et al.* 1999, pp. 3–6). Over 800 plant taxa have been introduced to the Hawaiian Islands. These were brought to Hawaii for food or for cultural reasons, to reforest areas destroyed by grazing feral and domestic animals, or for horticultural or agricultural purposes; some were introduced unintentionally (Scott *et al.* 1986, pp. 361–363; Cuddihy and Stone 1990, p. 73). Individual descriptions of 114 nonnative plant species that negatively affect the 49 species are provided in our proposed rule (80 FR 58820, September 30, 2015; see pp. 58869–58881). Fourteen of these nonnative plants are included in the Hawaii Noxious Weed List (Hawaii Department of Agriculture HAR 1981-title 4, subtitle 6, chapter 68).

Nonnative plants adversely affect native habitat in Hawaii by (1) modifying the availability of light, (2) altering soil-water regimes, (3) modifying nutrient cycling, and (4) altering fire regimes of native plant communities (*i.e.,* the ''grass/fire cycle'' that converts native-dominated plant communities to nonnative plant communities; see below) (Smith 1985, pp. 180–181; Cuddihy and Stone 1990, p. 74; D'Antonio and Vitousek 1992, p. 73; Vitousek *et al.* 1997, p. 6). The contribution of nonnative plants to the extinction of native species in the lowland and upland habitats of Hawaii is well-documented (Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74). The most commonly observed effect of nonnative plants on native species is displacement through competition. Competition occurs for water or nutrients, or it may involve allelopathy (chemical inhibition of growth of other plants), shading, or precluding sites for seedling establishment (Vitousek *et al.* 1987 *in* Cuddihy and Stone 1990, p. 74).

Alteration of fire regimes represents an ecosystem-level change caused by the invasion of nonnative plants, primarily grasses (D'Antonio and Vitousek 1992, p. 73). Grasses generate standing dead material that burns readily, and grass tissues with large surface-to-volume ratios dry out quickly, contributing to flammability (D'Antonio and Vitousek 1992, p. 73). The finest size classes of grass material ignite and spread fires under a broader range of conditions than do woody fuels or even surface litter (D'Antonio and Vitousek 1992, p. 73). The grass life form allows rapid recovery following fire because there is little above-ground vegetative structure. Grasslands also support a microclimate in which surface temperatures are hotter, contributing to drier vegetative conditions that favor fire (D'Antonio and Vitousek 1992, p. 73). In summary, nonnative plants directly and indirectly affect the 39 plants and 9 of the 10 animals in this rule (except the anchialine pool shrimp) by destroying and modifying their habitat, by removing their native host plants, or by direct competition.

Habitat Destruction and Modification by Fire

Seven of the 11 ecosystems (coastal, lowland dry, lowland mesic, montane mesic, montane dry, subalpine, and dry cliff) and the species in this rule that are associated with them are at risk of destruction and modification by fire. Fire is an increasing, human-exacerbated threat to native species and ecosystems in Hawaii. The pre-settlement fire regime in Hawaii was characterized by infrequent, low-severity events, as few natural ignition sources existed (Cuddihy and Stone 1990, p. 91; Smith and Tunison 1992, pp. 395–397). It is believed that prior to human colonization fuel was sparse in wet plant communities and only seasonally flammable in mesic and dry plant communities. The only ignition sources were volcanism and lightning (Baker *et al.* 2009, p. 43). Although Vogl (1969, *in* Cuddihy and Stone 1990, p. 91) proposed that naturally occurring fires may have been important in the development of some of the original Hawaiian flora, Mueller-Dombois (1981, *in* Cuddihy and Stone 1990, p. 91) asserts that most natural vegetation types of Hawaii would not carry fire before the introduction of alien grasses. Smith and Tunison (*in* Cuddihy and Stone 1990, p. 91) state that native plant fuels typically have low flammability. Existing fuel loads were often discontinuous, and rainfall in many areas on most islands was moderate to high. Fires inadvertently or intentionally set by the Polynesian settlers probably contributed to the initial decline of native vegetation in the drier plains and foothills. These early settlers practiced slash-and-burn agriculture that created open lowland areas suitable for the opportunistic invasion and colonization of nonnative, fire-adapted grasses (Kirch 1982, pp. 5–6, 8; Cuddihy and Stone 1990, pp. 30–31). Beginning in the late 18th century, Europeans and Americans introduced plants and animals that further degraded native Hawaiian ecosystems. Ranching and the creation of pasturelands in particular created highly fire-prone areas of nonnative grasses and shrubs (D'Antonio and Vitousek 1992, p. 67). Although fires were infrequent in mountainous regions, extensive fires have recently occurred in lowland dry and lowland mesic areas, leading to grass/fire cycles that convert native dry forest and native wet forest to nonnative grassland (D'Antonio and Vitousek 1992, p. 77).

Because of the greater frequency, intensity, and duration of fires that have resulted from the human alteration of landscapes and the introduction of nonnative plants, especially grasses, fires are now more destructive to native Hawaiian ecosystems (Brown and Smith 2000, p. 172), and a single grass-fueled fire often kills most native trees and shrubs in the area (D'Antonio and Vitousek 1992, p. 74). Fire destroys dormant seeds of native plants, as well as individual plants and animals themselves, even in steep, inaccessible areas or near streams and ponds. Successive fires remove habitat for native species by altering microclimate conditions, creating conditions more favorable to nonnative plants. Nonnative grasses (*e.g., Cenchrus setaceus;* fountain grass), many of which may be fire-adapted, produce a high fuel load that allow fire to burn areas that would not otherwise burn easily, regenerate quickly after fire, and establish rapidly in burned areas (Fujioka and Fujii 1980 *in* Cuddihy and Stone 1990, p. 93; D'Antonio and Vitousek 1992, pp. 70, 73–74; Tunison *et al.* 2002, p. 122). Native woody plants may recover to some degree, but fire tips the competitive balance toward nonnative species (National Park Service 1989 *in* Cuddihy and Stone 1990, p. 93). During a post-burn survey on Hawaii Island, in an area of native *Diospyros* forest with undergrowth of the nonnative grass *Pennisetum setaceum* [*Cenchrus setaceus*], Takeuchi (1991, p. 2) noted that ''no regeneration of native canopy is occurring within the Puuwaawaa burn area.'' Takeuchi also stated that ''burn events served to accelerate a decline process already in place, compressing into days a sequence which would ordinarily have taken decades'' (Takeuchi 1991, p. 4), and concluded that, in addition to increasing the number of fires, the nonnative *Pennisetum* acted to suppress establishment of native plants after a fire (Takeuchi 1991, p. 6).

For many decades, fires have affected rare or endangered species and their habitats on Molokai, Lanai, and Maui (Gima 1998, in litt.; Hamilton 2009, in litt.; Honolulu Advertiser 2010, in litt.; Pacific Disaster Center 2011, in litt.). These three islands experienced approximately 1,290 brush fires between 1972 and 1999 that burned a total of 64,250 ac (26,000 ha) (County of Maui 2009, ch. 3, p. 3; Pacific Disaster Center 2011, in litt.). Between 2000 and 2003, the annual number of wildfires on these islands jumped from 118 to 271; of these, several burned more than 5,000 ac (2,023 ha) each (Pacific Disaster Center 2011, in litt.). On Molokai, between 2003 and 2004, three wildfires each burned 10,000 ac (4,050 ha) (Pacific Disaster Center 2011, in litt.). From August through early September 2009, a wildfire burned approximately 8,000 ac (3,237 ha), including 600 ac (243 ha) of the remote Makakupaia section of the Molokai Forest Reserve, a small portion of The Nature Conservancy's (TNC's) Kamakou Preserve, and encroached on Onini Gulch, Kalamaula, and Kawela (Hamilton 2009, in litt.). Species at risk because of wildfire on Molokai include the plants *Joinvillea ascendens* ssp. *ascendens, Nothocestrum latifolium, Portulaca villosa, Ranunculus mauiensis, Schiedea pubescens,* and *Solanum nelsonii,* and the yellow-faced bees *Hylaeus anthracinus, H. facilis, H. hilaris,* and *H. longiceps.*

Several wildfires have occurred on Lanai in the last decade. In 2006, a wildfire burned 600 ac (243 ha) between Manele Road and the Palawai Basin, about 3 mi (4 km) south of Lanai City (The Maui News 2006, in litt.). In 2007, a brush fire at Mahana burned about 30 ac (12 ha), and in 2008, another 1,000 ac (405 ha) were burned by wildfire in the Palawai Basin (The Maui News 2007, in litt.; KITV Honolulu 2008, in litt.). Species at risk because of wildfire on Lanai include *Exocarpos menziesii, Nothocestrum latifolium, Portulaca villosa, Schidea pubescens;* and the yellow-faced bees *Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris,* and *H. longiceps.*

On west Maui, wildfires burned more than 8,650 ac (3,501 ha) between 2007 and 2010 (Honolulu Advertiser 2010, in litt.; Shimogawa 2010, in litt.). These fires encroached into the West Maui Forest Reserve, on the ridges of Olowalu and Kealaloloa, which is habitat for several endangered plants. In 2007, on east Maui, a fire consumed over 600 ac (240 ha), increasing invasion of the area by nonnative plants (*Pinus* spp.) (Pacific Disaster Center 2007, in litt.; The Maui News 2011, in litt.). Species at risk because of wildfire on west and east Maui include the plants *Festuca hawaiiensis, Joinvillea ascendens* ssp. *ascendens, Nothocestrum latifolium, Ochrosia haleakalae, Portulaca villosa, Ranunculus mauiensis, Sanicula sandwicensis, Schiedea pubescens, Sicyos macrophyllus,* and *Solanum nelsonii,* and the yellow-faced bees *Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris,* and *H. longiceps.*

Several recent fires on Oahu in the Waianae Mountain range have affected rare and endangered species. Between 2004 and 2005, wildfires burned more than 360 ac (146 ha) in Honouliuli Preserve, habitat of more than 90 rare and endangered plants and animals (TNC 2005). In 2006, a fire at Kaena Point State Park burned 60 ac (24 ha), and encroached on endangered plants in Makua Military Training Area. In 2007, there was a significant fire at Kaukonahua that crossed 12 gulches, eventually encompassing 5,655 ac (2,289 ha) that negatively affected eight endangered plant species and their habitat (*Abutilon sandwicense, Bonamia menziesii, Colubrina oppositifolia, Eugenia koolauensis, Euphorbia haeleeleana, Hibiscus brackenridgei* ssp. *mokuleianus, Nototrichium humile,* and *Schiedea hookeri*) (U.S. Army Garrison 2007b, Appendices pp. 1–5). This fire provided ingress for nonnative ungulates (cattle, goats, and pigs) into previously undisturbed areas, and opened dense native vegetation to the invasive grass *Urochloa maxima* (*Panicum maximum,* guinea grass), also a food source for cattle and goats. The grass was observed to generate blades over 2 ft (0.6 m) in length only 2 weeks following the fire (U.S. Army Garrison 2007b, Appendices pp. 1–5). In 2009, two smaller fires burned 200 ac (81 ha) at Manini Pali (Kaena Point State Park) and almost 4 ac (1.5 ha) at Makua Cave. Both of these fires burned into area designated as critical habitat, although no individual plants were directly affected (U.S. Army Natural Resource Program 2009, Appendix 2, 17 pp.). Most recently, in 2014, two fires affected native forest, one in the Oahu Forest National Wildlife Refuge (350 ac, 140 ha), on the leeward side of the Koolau Mountains (DLNR 2014, in litt.), and one above Makakilo, in the Waianae Mountains, just below Honouliuli FR, that burned more than 1,000 ac (400 ha) (KHON 2014, in litt.). The Makakilo fire took over 2 weeks to contain. Species at risk because of wildfire on Oahu include the plants *Joinvillea ascendens* ssp. *ascendens, Nothocestrum latifolium, Portulaca villosa, Ranunculus mauiensis,* and *Sicyos lanceoloideus,* and the yellow-faced bees *Hylaeus anthracinus, H. assimulans, H. facilis, H. kuakea, H. longiceps,* and *H. mana.*

In 2012, on Kauai, a wildfire that was possibly started by an unauthorized camping fire burned 40 ac (16 ha) in the Na Pali-Kona Forest Reserve on Milolii Ridge, forcing closure of a hiking trail. Fortunately, several endangered and threatened plants in the adjacent Kula NAR were not impacted (KITV 2012, in litt.). The same year, another wildfire burned over 650 ac (260 ha) on Hikimoe Ridge, and threatened the Puu Ka Pele section of Waimea Canyon State Park (Hawaii News Now 2012, in litt.; Star Advertiser 2012, in litt.). Species at risk of because wildfire on Kauai include the plants *Joinvillea ascendens* ssp. *ascendens, Labordia lorenciana, Nothocestrum latifolium, Ranunculus mauiensis, Santalum involutum,* and *Sicyos lanceoloideus.*

In the driest areas on the island of Hawaii, wildfires are exacerbated by the uncontrolled growth of nonnative grasses such as *Cenchrus setaceus* (Fire Science Brief 2009, in litt.). Since its introduction to the island in 1917, this grass now covers more than 200 square mi (500 square km) of the leeward areas of the island (Joint Fire Science Brief (JFSB) 2009, in litt.). In the past 50 years, three wildfires on the leeward side encompassed a total of 30,000 ac (12,140 ha) (JFSB 2009, in litt.). These wildfires traveled great distances at rates of 4 to 8 miles per hour (mph) (7 to 12 kilometers per hour (kph)), burning 2.5 ac (1 ha) to 6 ac (2.5 ha) per minute (the equivalent of 6 to 8 football fields per minute) (Burn Institute 2009, p. 4). Between 2002 and 2003, three successive lava-ignited wildfires in the east rift zone of Hawaii Volcanoes National Park affected native forests in lowland dry, lowland mesic, and lowland wet ecosystems (JFSB 2009, p. 3), cumulatively burning an estimated 11,225 ac (4,543 ha) (Wildfire News, June 9, 2003; JFSP 2009, p. 3). These fires destroyed over 95 percent of the canopy cover and encroached upon forest areas that were previously thought to have low susceptibility to wildfires. After the fires, nonnative ferns were observed in higher elevation rainforest where they had not previously been seen, and were believed to inhibit the recovery of the native *Metrosideros polymorpha* (ohia) trees (JFSP 2003, pp. 1–2). Nonnative grasses invaded the burn area, increasing the risk of fire encroaching into the surrounding native forest (Ainsworth 2011, in litt.). Extreme drought conditions also contributed to the number and intensity of wildfires on Hawaii Island (Armstrong and Media 2010, in litt.; Loh 2010, in litt.). This ‘‘extreme’’ drought classification for Hawaii was recently lifted to ‘‘moderate’’; however, drier than average conditions persist, and another extreme drought event may occur (NOAA 2015, in litt.). In addition, El Niño conditions in the Pacific (see ‘‘Climate Change’’ under Factor E, below), a half-century of decline in annual rainfall, and intermittent dry spells have contributed to the conditions favoring wildfires in all the main Hawaiian Islands (Marcus 2010, in litt.). Species at risk because of wildfire on Hawaii Island include the plants *Exocarpos menziesii, Festuca hawaiiensis, Joinvillea ascendens* ssp. *ascendens, Ochrosia haleakalae, Portulaca villosa, Ranunculus mauiensis, Sanicula sandwicensis, Sicyos macrophyllus,* and *Solanum nelsonii,* and the yellow-faced bee *Hylaeus anthracinus.*

In summary, fire is a threat to 14 plant species and their habitat (*Exocarpos menziesii, Festuca hawaiiensis, Joinvillea ascendens* ssp. *ascendens, Labordia lorenciana, Nothocestrum latifolium, Ochrosia haleakalae, Portulaca villosa, Ranunculus mauiensis, Sanicula sandwicensis, Santalum involutum, Schiedea pubescens, Sicyos lanceoloideus, S. macrophyllus,* and *Solanum nelsonii*), and all seven yellow-faced bees because these species and their habitat are located in or near areas that were burned previously, or in areas considered at risk because of fire due to the cumulative and compounding effects of drought and the presence of highly flammable nonnative grasses.

Habitat Destruction and Modification by Hurricanes

Ten of the 11 ecosystems (all except the anchialine pool ecosystem) where these species occur are at risk of habitat destruction and modification by hurricanes. Hurricanes exacerbate the impacts of other threats such as habitat destruction and modification by ungulates and competition with nonnative plants. By destroying native vegetation, hurricanes open the forest canopy, modify the availability of light, and create disturbed areas conducive to invasion by nonnative pest species (see ‘‘Habitat Destruction and Modification by Nonnative Plants’’, above) (Asner and Goldstein 1997, p. 148; Harrington *et al.* 1997, pp. 539–540). In addition, hurricanes adversely affect native Hawaiian stream habitat by defoliating and toppling vegetation, thus loosening the surrounding soil and increasing erosion. Along with catastrophic flooding, this soil and vegetative debris can be washed into streambeds (by hurricane-induced rain or subsequent rain storms), resulting in the scouring of stream bottoms and channels (Polhemus 1993a, 88 pp.). Natural disasters such as hurricanes can be particularly devastating to Hawaiian plant and animal species that persist in low numbers and in restricted ranges (Mitchell *et al.* 2005, p. 4–3).

Hurricanes affecting Hawaii were only rarely reported from ships in the area from the 1800s until 1949. Between 1950 and 1997, 22 hurricanes passed near or over the Hawaiian Islands, 5 of which caused serious damage (Businger 1998, pp. 1–2). In November 1982, Hurricane Iwa struck the Hawaiian Islands with wind gusts exceeding 100 miles per hour (mph) (160 kilometers per hour (kmh)), causing extensive damage, especially on the islands of Kauai, Niihau, and Oahu (Businger 1998, pp. 2, 6). Many forest trees were destroyed (Perlman 1992, pp. 1–9), which opened the canopy and facilitated the invasion of native forest by nonnative plants (Kitayama and Mueller-Dombois 1995, p. 671). Hurricanes therefore exacerbate the threats posed by nonnative plants, as described in ‘‘Habitat Destruction and Modification by Nonnative Plants,’’ above. In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained winds of 130 mph (209 kmh, 113 knots), passed directly over the island of Kauai and close to the island of Oahu, causing significant damage to Kauai and along Oahu's southwestern coast (Blake *et al.* 2007, pp. 20, 24). Biologists documented damage to the habitat of six endangered plant species on Kauai, and one plant on Oahu. Polhemus (1993a, pp. 86–87) documented the extirpation of the scarlet Kauai damselfly (*Megalagrion vagabundum*) (a species related to *M. xanthomelas*), from the entire Hanakapiai Stream system on the island of Kauai as a result of the impacts of Hurricane Iniki. Damage by future hurricanes will further alter the remaining native-plant dominated habitat for rare plants and animals in native ecosystems of Kauai, Oahu, and other Hawaiian Islands (Bellingham *et al.* 2005, p. 681) (see ‘‘Climate Change’’ under *Factor E. Other Natural or Manmade Factors Affecting Their Continued Existence,* below).

In summary, hurricanes exacerbate other habitat threats, such as competition with nonnative plants, as well as result in direct habitat destruction. This is a particular problem for the plant *Pritchardia bakeri,* the band-rumped storm-petrel, the orangeblack Hawaiian damselfly, and all seven yellow-faced bees.

Habitat Modification and Destruction Due to Landslides, Rockfalls, Treefall, Flooding, Erosion, Drought, and Tsunamis

Habitat destruction and modification by landslides, rockfalls, treefall, flooding, erosion, and drought (singly or in combination) is a threat to all 11 ecosystems in which these species occur. Landslides, rockfalls, treefall, flooding, and erosion change native plant and animal communities by destabilizing substrates, damaging or destroying individual plants, and altering hydrological patterns. In the open sea near Hawaii, rainfall averages 25 to 30 inches (in) (630 to 760 millimeters (mm)) per year, yet the islands may receive up to 15 times this amount in some places, caused by orographic features (topography) (Wagner *et al.* 1999, adapted from Price (1983) and Carlquist (1980), pp. 38–39). During storms, rain may fall at rates of 3 in (76 mm) per hour or more, and sometimes may reach nearly 40 in (1,000 mm) in 24 hours, resulting in destructive flash-flooding in streams and narrow gulches (Wagner *et al.* 1999, adapted from Price (1983) and Carlquist (1980), pp. 38–39). Due to the steep topography in many mountainous areas on the Hawaiian Islands, disturbance caused by introduced ungulates exacerbates erosion and increases the potential for landslides, rockfalls, or flooding, which in turn damages or destroys native plants and disturbs habitat of the band-rumped storm-petrel (see Table 2). These events could eliminate one or more isolated occurrences of species that persist in low numbers and a limited geographic range, resulting in reduced redundancy and resilience of the species.

Landslides, rockfalls, treefall, flooding, and erosion are threats to 20 plant species (*Cyanea kauaulaensis, Cyclosorus boydiae, Deparia kaalaana, Dryopteris glabra* var. *pusilla, Gardenia remyi, Joinvillea ascendens* ssp. *ascendens, Kadua fluviatilis, K. haupuensis, Labordia lorenciana, Lepidium orbiculare, Phyllostegia brevidens, P. helleri, P. stachyoides, Portulaca villosa, Pseudognaphalium sandwicensium* var. *molokaiense, Ranunculus hawaiensis, R. mauiensis, Sanicula sandwicensis, Schiedea pubescens,* and *Solanum nelsonii*) and to the band-rumped storm-petrel and the orangeblack Hawaiian damselfly. Landslides, rockfalls, and erosion can directly affect nests and nesting habitat of the band-rumped storm-petrel. Destabilization of cliff habitat leads to additional landslides and alteration of hydrological patterns, affecting the availability of soil moisture. Landslides also destroy and modify riparian and stream habitat by direct physical damage, and create disturbed areas leading to invasion by nonnative plants, as well as damaging or destroying plants directly. *Kadua haupuensis, Labordia lorenciana, Lepidium orbiculare, Phyllostegia brevidens,* and *P. helleri* are known only from a few individuals in single occurrences on cliffs or steep-walled stream valleys, and one landslide could extirpate a species by direct destruction. Monitoring data presented by the Plant Extinction Prevention Program (PEPP) and botanical surveys suggest that flooding is a likely threat to eight plant species, *Cyanea kauaulaensis, Cyclosorus boydiae, Deparia kaalaana, Labordia lorenciana, Phyllostegia stachyoides, Sanicula sandwicensis, Schiedea pubescens,* and *Solanum nelsonii,* as some individuals occur on stream banks (Wood *et al.* 2007, p. 198; PEPP 2011, pp. 162–164; Oppenheimer and Lorence 2012, pp. 20–21; PEPP 2013, p. 54; PEPP 2014, pp. 95, 142). The naiad life stage of the orangeblack Hawaiian damselfly would be destroyed by flooding if an individual is carried out of suitable habitat or into areas occupied by nonnative fish.

Drought is reported to be a threat to 10 plants (*Cyclosorus boydiae, Deparia kaalaana, Huperzia stemmermanniae, Phyllostegia stachyoides, Ranunculus hawaiensis, R. mauiensis, Sanicula sandwicensis, Schiedea pubescens, Sicyos lanceoloideus,* and *Solanum nelsonii*), the orangeblack Hawaiian damselfly (directly or by desiccation of streams and ponds), and all seven yellow-faced bees (Magnacca 2007, pp. 181, 183; Polhemus 2008, p. 26; Chu *et al.* 2010, pp. 4887, 4891, 4898; PEPP 2011, pp. 162–164; Fortini *et al.* 2013, p. 2; PEPP 2013, p. 177; PEPP 2014, pp. 140–142, 154–156, 162, 166–167). Between 1860 and 2002, there were 49 periods of drought on Oahu, 30 periods of drought on Molokai, Lanai, and Maui, and at least 18 serious or severe drought events on Hawaii Island (Giambelluca *et al.* 1991, pp. 3–4; Hawaii Commission on Water Resource Management (CWRM) 2009, in litt.; Hawaii Civil Defense 2011, pp. 14–1–14–12). The most severe drought events over the past 15 years were associated with the El Niño phenomenon (Hawaii Civil Defense 2011, p. 14–3). In 1998, the city of Hilo had the lowest January total rainfall (0.014 in) ever observed for any month since records have been kept, with average rainfall being almost 10 in for January (Hawaii Civil Defense 2011, p. 14–3). Currently, the State remains under abnormally dry to moderate drought conditions, with the onset of another El Niño event (U.S. Drought Monitor 2015, in litt., National Weather Service 2015, in litt.). Drought events dry up streams, irrigation ditches, and reservoirs, and deplete groundwater supplies (Hawaii CWRM 2009, in litt.). Recent episodes of drought have driven axis deer farther into forested areas in search of food, increasing their negative impacts on native vegetation from herbivory, bark stripping, and trampling (see *Factor C. Disease or Predation,* below) (Waring 1996, in litt; Nishibayashi 2001, in litt.). Drought events could eliminate one or more isolated populations of a species that currently persists in low numbers and a limited geographic range, resulting in reduced redundancy and resilience of the species or extinction.

Tsunamis destroy and modify habitat for species in Northwestern Hawaiian Islands and in low-lying coastal areas of the main Hawaiian Islands. Tsunamis in Hawaii are caused by earthquakes, submarine landslides, and volcanic eruptions that may occur within the archipelago or in distant parts of the Pacific. These events disturb the ocean's surface, and gravity combined with the water's motion produces a series of long-period waves that travel quickly and can reach heights of 32 ft (10 m) or more when reaching land. Major tsunamis occur worldwide about once every 10 years, on average, and almost 60 percent of those occur in the Pacific Ocean (Pacific Tsunami Warning Center, *http://ptwc.weather.gov/ptwc/faq.php#8,* accessed June 2016). In 2011, a tsunami caused by an earthquake in Japan reached Hawaii and the Northwestern Hawaiian Islands. This tsunami swept over Midway Atoll's Eastern Island and Kure Atoll's Green Island, where it inundated plants, spread plastic debris, killed thousands of seabirds, and destroyed seabird nesting areas as it traveled about 500 ft (150 m) inland (DOFAW 2011, in litt.; Starr 2011, in litt.; USFWS 2011, in litt.). This threat could occur at any time and negatively affect occurrences and habitat of the plant *Solanum nelsonii* and the yellow-faced bees *Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris,* and *H. longiceps.*

Habitat Destruction and Modification by Water Extraction

Freshwater habitats on all the main Hawaiian Islands have been severely altered and degraded because of past and present land and water management practices, including agriculture, urban development, and development of ground water, perched aquifer, and surface water resources (Harris *et al.* 1993, p. 11; Meier *et al.* 1993, p. 181). Extensive modification of lentic (standing water) habitat in the Hawaiian Islands began about 1100 A.D. with a rapid increase in the human population (Harris *et al.* 1993, p. 9; Kirch 1982, pp. 5–6). Hawaiians cultivated *Colocasia esculenta* (kalo, taro) by creating shallow, walled ponds, or *loi,* in marshes and riparian areas (Meier *et al.* 1993, p. 181; Handy and Handy 1972, p. 58). By 1778, virtually all valley bottoms with permanent stream flow and most basin marshes were converted to taro cultivation (Handy and Handy 1972, pp. 396, 411). Hawaiians also modified wetlands by constructing fishponds, many of which were primarily fresh water, fed by streams or springs (Meier *et al.* 1993, p. 181). Despite this habitat modification by early Hawaiians, many areas of extensive marshland remained intact and were used by the native damselflies. Over time, however, many of the wetlands formerly used for taro were drained and filled for dry-land agriculture or development (Stone 1989, p. 129; Meier *et al.* 1993, pp. 181–182). In addition, marshes are slowly filled and converted to meadow habitat due to increased sedimentation resulting from increased storm water runoff from upslope development and blockage of downslope drainage (Wilson Okamoto and Associates, Inc. 1993, p. 3–5). Presently the most significant threat to the remaining natural ponds and marshes in Hawaii, habitat for the orangeblack Hawaiian damselfly, is the nonnative grass species *Urochloa mutica.* This sprawling, perennial grass was first observed on Oahu in 1924, and now occurs on all the main islands (O'Connor 1999, p. 1504). This species forms dense, monotypic stands that can completely eliminate any open water by layering of its trailing stems (Smith 1985, p. 186).

Similar to the loss of wetlands in Hawaii, the loss of streams has been significant and began with the early Hawaiians who modified stream systems by diverting water to irrigate taro. However, these Hawaiian-made diversions were closely regulated and were not permitted to take more than half the stream flow, and were typically used to flood taro *loi* only periodically (Handy and Handy 1972, pp. 58–59). The advent of sugarcane plantations in 1835 led to more extensive stream diversions. These systems were typically designed to tap water at upper elevation sources (above 980 ft (300 m)) by means of concrete weirs. All or most of the stream flow was diverted into fields or reservoirs (Takasaki *et al.* 1969, p. 65; Harris *et al.* 1993, p. 10). By the 1930s, major water diversions had been developed on all the main islands, and currently one-third of Hawaii's perennial streams are diverted (Harris *et al.* 1993, p. 10). In addition to diverting water for agriculture and domestic water supply, streams have been diverted for use in producing hydroelectric power (Hawaii Stream Assessment 1990, p. 96). Surface flow has also been diverted into channels, and the perched aquifers which fed the streams have been tapped by means of tunnels (Stearns and Vaksvik 1935, pp. 365, 378–434; Stearns 1985, p. 291, 301–303). Many of these aquifers are the sources of springs, which contribute flow to streams. The draining of these aquifers causes springs to become dry (Stearns and Vaksvik 1935, pp. 380, 388; USGS 2000, in litt.). Most remaining streams that are not already diverted have been, and continue to be, seriously degraded by the activities of feral ungulates and by nonnative plants. Channelization has not been restricted to lower reaches, and it results in the loss of riparian vegetation, increasing flow velocity, illumination, and water temperature (Parrish *et al.* 1984, pp. 83–84). These conditions make the channels unsuitable as habitat for the orangeblack Hawaiian damselfly.

Water extraction (*e.g.,* withdrawal of subsurface fresh water for development and human use) from underground fresh water sources increases salinity levels of anchialine pools and negatively affect the anchialine pool shrimp, *Procaris hawaiana,* which relies on the delicate balance of mixohaline (brackish water) habitats (Conry 2012, in litt.; National Park Service 2016, in litt.). Water extraction also negatively affects the plant *Cyclosorus boydiae* and the orangeblack Hawaiian damselfly by degrading or destroying habitat for these species (Harris *et al.* 1993, pp. 9–13; Medeiros *et al.* 1993, p. 88; Meier *et al.* 1993, pp. 181–183; Palmer 2003, p. 88).

Habitat Destruction and Modification by Climate Change

Climate change affects the habitat of the 49 species. Discussion of climate change impacts is included in our complete discussion of climate change under *Factor E. Other Natural or Manmade Factors Affecting Their Continued Existence,* below.

Summary of Factor A

Destruction and modification of the habitat of each of the 49 species addressed in this rule is occurring throughout the entire range of each of the species. These impacts include the effects of agriculture and urban development, introduced ungulates, nonnative plants, fire, hurricanes, landslides, rockfalls, treefall, flooding, erosion, drought, tsunamis, and water extraction.

Habitat destruction and modification by agriculture and urban development is an ongoing and serious threat to the plant *Cyclosorus boydiae,* the orangeblack Hawaiian damselfly, the anchialine pool shrimp *Procaris hawaiana,* and the yellow-faced bees *Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris,* and *H. longiceps.* Conversion of wetland and other aquatic habitat (*i.e.,* water extraction) for agriculture and urban development is ongoing, is expected to continue into the future, and affects the orangeblack Hawaiian damselfly by removing habitat required for hunting and breeding. Water extraction affects the orangeblack Hawaiian damselfly because it (1) Reduces the amount and distribution of stream habitat; (2) reduces stream flow and habitat; and (3) leads to an increase in water temperature, which causes physiological stress to the damselfly naiads. Water extraction affects the delicate balance of the anchialine pool ecosystem, including salinity and biota, negatively affecting the anchialine pool shrimp, *Procaris hawaiana.* Loss of stream-course habitat affects *Cyclosorus boydiae* because this is the only habitat where this riparian species occurs.

The threat of habitat destruction and modification by ungulates is ongoing as ungulates currently occur in all ecosystems on which these species depend except the anchialine pool system. Introduced ungulates pose a threat to 37 of the 39 plants (except for *Cyanea kauaulaensis* and *Hypolepis hawaiiensis* var. *mauiensis*), and 9 of the 10 animal species (all except for the anchialine pool shrimp) in this rule that occur in these 10 ecosystems because ungulates: (1) Directly affect the species by trampling and grazing (see Factor C discussion, below); (2) increase soil disturbance and erosion; (3) create open, disturbed areas conducive to nonnative plant invasion by dispersing fruits and seeds, which results in conversion of a native-dominated plant community to a nonnative-dominated plant community; and (4) increase marsh and stream disturbance and sedimentation, which negatively affects these aquatic habitats.

Habitat destruction and modification by nonnative plants is a serious and ongoing current threat to all 39 plant species because nonnative plants: (1) Adversely affect microhabitat by modifying the availability of light; (2) alter soil-water regimes; (3) modify nutrient cycling processes; (4) alter fire ecology, leading to incursions of fire-tolerant nonnative plant species into native habitat; (5) outcompete, and possibly directly inhibit (through allelopathy) the growth of native plant species; and (6) alter habitat and substrate such that erosion leading to rockfalls and landslides may increase. Each of these processes can convert native-dominated plant communities to nonnative plant communities (Cuddihy and Stone 1990, p. 74; Vitousek 1992, pp. 33–35).

The threat of habitat destruction and modification by fire to 14 plant species (*Exocarpos menziesii, Festuca hawaiiensis, Joinvillea ascendens* ssp. *ascendens, Labordia lorenciana, Nothocestrum latifolium, Ochrosia haleakalae, Portulaca villosa, Ranunculus mauiensis, Sanicula* *sandwicensis, Santalum involutum, Schiedea pubescens, Sicyos lanceoloideus, S. macrophyllus,* and *Solanum nelsonii*) and all seven yellow-faced bee species is serious and ongoing because fires occur frequently and damage and destroy native vegetation, including dormant seeds, seedlings, and juvenile and adult plants, including host plants for the bees. Many nonnative, invasive plants, particularly fire-tolerant grasses, create more destructive fires, invade burned areas, and can out-compete native plants and inhibit their regeneration (D'Antonio and Vitousek 1992, pp. 70, 73–74; Tunison *et al.* 2002, p. 122). Successive fires that burn farther and farther into native habitat destroy the ecosystem and its components upon which these species depend.

Habitat destruction and modification by natural disasters such as hurricanes represent a serious threat to the plant *Pritchardia bakeri,* the band-rumped storm-petrel, the orangeblack Hawaiian damselfly, and all seven yellow-faced bee species. Hurricanes open the forest canopy, modifying available light and creating disturbed areas that are conducive to invasion by nonnative plants (Asner and Goldstein 1997, p. 148; Harrington *et al.* 1997, pp. 346–347). The discussion under ''Habitat Destruction and Modification by Nonnative Plants'' provides additional information related to canopy gaps, light availability, and the establishment of nonnative plant species. In addition, hurricanes cause mortality of birds, including adults and chicks drowned when nest sites are flooded (Schreiber 2002, p. 186; Hass *et al.* 2012, pp. 252–253). Hurricanes also destroy nesting habitat, a particular problem for species like storm-petrels that return to the same nest site each year (Schreiber 2002, p. 186). These hurricane impacts are likely for the band-rumped storm-petrel. Finally, hurricanes can alter and directly damage streams and wetlands used by the orangeblack Hawaiian damselfly (Polhemus 1993a, pp. 86–87). The impacts from hurricanes can be particularly devastating to these species because they persist in low numbers in restricted ranges and are therefore less resilient to such disturbances. A single destructive hurricane holds the potential of driving to extinction species that persist as one or several small, isolated populations.

Landslides, rockfalls, treefalls, flooding, and erosion (singly or combined) are a threat to 20 plant species (*Cyanea kauaulaensis, Cyclosorus boydiae, Deparia kaalaana, Dryopteris glabra* var. *pusilla, Gardenia remyi, Joinvillea ascendens* ssp. *ascendens, Kadua fluviatilis, K. haupuensis, Labordia lorenciana, Lepidium orbiculare, Phyllostegia brevidens, P. helleri, P. stachyoides, Portulaca villosa, Pseudognaphalium sandwicensium* var. *molokaiense, Ranunculus hawaiensis, R. mauiensis, Sanicula sandwicensis, Schiedea pubescens,* and *Solanum nelsonii*), the band-rumped storm-petrel, and the orangeblack Hawaiian damselfly by destabilizing substrates, damaging and killing individuals, altering hydrological patterns, and destroying or modifying habitat—all resulting in changes to native plant and animal communities. Drought is a threat to 10 plant species (*Cyclosorus boydiae, Deparia kaalaana, Huperzia stemmermanniae, Phyllostegia stachyoides, Ranunculus hawaiensis, R. mauiensis, Sanicula sandwicensis, Schiedea pubescens, Sicyos lanceoloideus,* and *Solanum nelsonii*), the orangeblack Hawaiian damselfly (directly or by desiccation of streams and ponds), and all seven yellow-faced bee species (and the host plants upon which all seven yellow-faced bees depend).

Habitat destruction and modification by over-washing of low-lying areas by tsunamis is a threat to coastal species, including *Solanum nelsonii, Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris,* and *H. longiceps.*

Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Plants

We are not aware of any threats to the 39 plant species that would be attributed to overutilization for commercial, recreational, scientific, or educational purposes.

Animals

Anchialine Pool Shrimp

Illegal collection is a threat to the anchialine pool shrimp *Procaris hawaiana* because of inadequate monitoring and enforcement at the pools where this species occurs. All terrestrial and aquatic invertebrates (including anchialine pool shrimp) are protected under (1) the State of Hawaii Revised Statutes (1993) chapter 195D–4-f license; and (2) DLNR chapter 124: Indigenous Wildlife, Endangered and Threatened Wildlife, and Introduced Wild Birds. Collection of plants and animals is prohibited in the State Natural Area Reserves (NARs) Ahihi-Kinau (Maui) and Manuka (Hawaii Island), but enforcement of prohibitions is insufficient to prevent illegal collecting at these remote sites. Collection is not prohibited in State Parks or City and County property where some anchialine pools occur, and is not expressly prohibited at Lua O Palahemo (Hawaii Island), and thus no regulatory protection of these shrimp exists at the remaining five anchialine pools outside of Manuka NAR that are known to contain *P. hawaiana.* A Native Invertebrate Research and Collecting permit issued by DLNR's Division of Forestry and Wildlife is required to collect anchialine pool shrimp for research or commercial purposes, and the commercial market is supported by legal, permitted collection. We expect that permit holders, whether they are collecting for scientific or commercial purposes, adhere to the conditions of their permit and do not pose a threat to *P. hawaiana.* However, we consider illegal collection of this anchialine pool shrimp, *P. hawaiana,* to be an ongoing threat because, despite the prohibition on collecting within the NARs and the permitting process for collection elsewhere, collection can occur at any time owing to insufficient patrolling or other monitoring or enforcement at the pools where *P. hawaiana* occurs.

Factor C. Disease or Predation

Disease

We are not aware of any current threats to the 49 species that would be attributable to disease. Disease may be a potential threat to the yellow-faced bee *Hylaeus anthracinus,* as pathogens carried by nonnative bees, wasps, and ants could be transmitted through shared food sources (Graham 2015, in litt.); however, we have no evidence of this type of disease transmission at this time.

Predation

Hawaii's plants and animals evolved in nearly complete isolation from continental influence. Successful, natural colonization of these remote volcanic islands is infrequent, and many organisms never succeeded in establishing populations. As an example, Hawaii lacks native ants and conifers, has very few families of birds, and has only had two native species of land mammal, both insectivorous bats (Loope 1998, p. 748; Ziegler 2002, pp. 244–245). In the absence of grazing or browsing mammals, plants that became established did not need mechanical or chemical defenses against mammalian herbivory such as thorns, prickles, and toxins. Because the evolutionary pressure to either produce or maintain such defenses was lacking, Hawaiian plants either lost or never developed these adaptations (Carlquist 1980, p. 173). Likewise, native Hawaiian birds and insects experienced no evolutionary pressure to develop defense mechanisms against mammalian or invertebrate predators that were not historically present on the islands. The native flora and fauna are thus particularly vulnerable to the impacts of introduced nonnative species, as discussed below.

Introduced Ungulates

In addition to the habitat impacts discussed above (see ''Habitat Destruction and Modification by Introduced Ungulates'' under *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Their Habitat or Range*), grazing and browsing (predation) by introduced ungulates are a threat to the following 27 plant species in this proposal (see Table 2, above): *Asplenium diellaciniatum* (black-tailed deer); *Calamagrostis expansa* (pigs), *Cyclosorus boydiae* (pigs), *Deparia kaalaana* (pigs), *Exocarpos menziesii* (goats, mouflon, sheep), *Festuca hawaiiensis* (goats, sheep), *Gardenia remyi* (pigs, goats, axis deer), *Huperzia stemmermanniae* (goats, axis deer, cattle), *Joinvillea ascendens* ssp. *ascendens* (pigs, goats, axis deer, black-tailed deer), *Kadua fluviatilis* (pigs, goats), *Labordia lorenciana* (goats, black-tailed deer), *Microlepia strigosa* var. *mauiensis* (pigs), *Myrsine fosbergii* (pigs, goats), *Nothocestrum latifolium* (pigs, goats, axis deer, black-tailed deer, mouflon, cattle), *Ochrosia haleakalae* (goats, cattle), *Phyllostegia brevidens* (pigs), *P. stachyoides* (pigs, goats), *Portulaca villosa* (goats, axis deer, mouflon), *Pseudognaphalium sandwicensium* var. *molokaiense* (axis deer), *Ranunculus hawaiensis* (pigs, mouflon, cattle), *R. mauiensis* (pigs, goats, axis deer, black-tailed deer, cattle), *Sanicula sandwicensis* (goats), *Santalum involutum* (goats), *Schiedea pubescens* (axis deer, cattle), *Sicyos lanceoloideus* (goats, black-tailed deer), *S. macrophyllus* (mouflon, cattle), and *Solanum nelsonii* (axis deer, cattle).

Feral Pigs

We have direct evidence of ungulate damage to some of the 39 plant species, but for many, due to their remote locations or lack of study, ungulate damage is presumed based on the known presence of these introduced ungulates in the areas where these species occur and the results of studies involving similar species or ecosystems conducted in Hawaii and elsewhere (Diong 1982, p. 160; Mueller-Dombois and Spatz, 1975, pp. 1–29; Hess 2008, 4 pp.; Weller *et al.* 2011, p. 8). For example, in a study conducted by Diong (1982, p. 160) on Maui, feral pigs were observed browsing on young shoots, leaves, and fronds of a wide variety of plants, of which over 75 percent were endemic species. A stomach-content analysis in this study showed that most of the pigs' food source consisted of the endemic *Cibotium* (hapuu, tree fern). Pigs were observed to fell native plants and remove the bark from standing plants of species in the genera *Cibotium, Clermontia, Coprosma, Hedyotis* [*Kadua*], *Psychotria,* and *Scaevola,* resulting in larger trees and shrubs dying after a few months of repeated feeding (Diong 1982, p. 144). Beach (1997, pp. 3–4) found that feral pigs in Texas spread disease and parasites, and their rooting and wallowing behavior led to spoilage of watering holes and loss of soil through leaching and erosion. Rooting activity by pigs also decreased the survivability of some plant species through disruption at root level of mature plants and seedlings (Beach 1997, pp. 3–4; Anderson *et al.* 2007, in litt.). In Hawaii, pigs dig up forest ground cover consisting of delicate and rare species of orchids, ferns, mints, lobeliads, and other taxa, including their roots, tubers, and rhizomes (Stone and Anderson 1988, p. 137). The following plants are particularly at risk of herbivory by feral pigs: *Calamagrostis expansa* on Maui and Hawaii Island (HBMP 2010); *Cyclosorus boydiae* on Oahu (HBMP 2010); *Deparia kaalaana* on Maui (HBMP 2010); *Gardenia remyi* on Hawaii Island (PEPP 2011, pp. 113–114; PEPP 2012, p. 102), west Maui (HBMP 2010), Molokai (HBMP 2010) and Kauai (HBMP 2010); *Joinvillea ascendens* ssp. *ascendens* on Hawaii Island (PEPP 2011, pp. 120–121; PEPP 2012, p. 113; HBMP 2010), Kauai (PEPP 2014, p. 109; HBMP 2010), Maui (HBMP 2010), Molokai (HBMP 2010), and Oahu (HBMP 2010); *Kadua fluviatilis* on Kauai (HBMP 2010) and Oahu (HBMP 2010); *Microlepia strigosa* var. *mauiensis* on Maui (Bily 2009, in litt.; Oppenheimer 2007, in litt.); *Myrsine fosbergii* on Kauai (HBMP 2010); *Nothocestrum latifolium* on Maui (PEPP 2011, p. 140; HBMP 2010) and Molokai (HBMP 2010); *Phyllostegia brevidens* on Maui and Hawaii Island (PEPP 2014, p. 36); *P. stachyoides* on Molokai (PEPP 2014, pp. 140–141); *Ranunculus hawaiensis* on Hawaii Island (HBMP 2010); and *R. mauiensis* on Kauai (PEPP 2011, p. 161; PEPP 2013, p. 177; PEPP 2014, p. 156; HBMP 2010), Maui (PEPP 2011, p. 144; PEPP 2013, pp. 177–178; PEPP 2014, p. 155; HBMP 2010), and Molokai (HBMP 2010). Feral pigs occur in 10 of the 11 ecosystems (all except anchialine pool) discussed here; the results of the studies described above suggest that foraging by pigs can directly damage and destroy these plants through herbivory. Feral pigs may also consume native host plants of the yellow-faced bees *Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris, H. kuakea, H. longiceps,* and *H. mana.*

Feral Goats

Feral goats are able to forage in extremely rugged terrain and are instrumental in the decline of native vegetation in many areas of the Hawaiian Islands (Cuddihy and Stone 1990, p. 64; Clarke and Cuddihy 1980, p. C–20; van Riper and van Riper 1982, pp. 34–35; Tomich 1986, pp. 153–156). Feral goats consume a variety of plants for food and have been observed to browse on (but are not limited to) native plant species in the following genera: *Argyroxiphium, Canavalia, Chamaesyce, Erythrina, Plantago, Schiedea,* and *Stenogyne* (Cuddihy and Stone 1990, p. 64; Warren 2004, p. 462; Wood 2007, pers. comm.). A study conducted on the island of Hawaii demonstrated that native *Acacia koa* seedlings are unable to survive due to browsing and grazing by goats (Spatz and Mueller-Dombois 1973, p. 874). If goats remained in the area in high numbers, mature trees eventually died and with them the root systems that supported suckers and vegetative reproduction. When feral goats were excluded by fences for 3 years, there was a positive height-growth response of *A. koa* suckers (Spatz and Mueller-Dombois 1973, p. 873). Another study at Puuwaawaa on Hawaii Island demonstrated that prior to management actions in 1985, regeneration of endemic shrubs and trees in a goat-grazed area was almost totally lacking, contributing to the invasion of forest understory by exotic grasses and weeds. After the removal of goats, *A. koa* and native *Metrosideros* seedlings were observed germinating by the thousands (HDLNR 2002, p. 52). Based on these studies, and other comparisons of fenced and unfenced areas, it is clear that goats devastate native Hawaiian ecosystems (Loope *et al.* 1988, p. 277). Because feral goats occur in 10 of the 11 ecosystems (all except anchialine pool) discussed in this proposal, the results of the studies described above indicate that goats likely also alter these ecosystems and directly damage or destroy native plants. Browsing or grazing by feral goats poses a particular threat to the following plant species: *Exocarpos menziesii* on Hawaii Island (NTBG Herbarium Database 2014, in litt.), *Festuca hawaiiensis* on Hawaii Island (Wood 2001b, in litt.), *Gardenia remyi* on Kauai (PEPP 2011, p. 114; PEPP 2013, p. 107; Kishida 2011, in litt.), *Huperzia stemmermanniae* on Hawaii Island (HBMP 2010), *Joinvillea ascendens* ssp. *ascendens* on Kauai (PEPP 2010, p. 80), *Kadua fluviatilis* on Kauai (HBMP 2010), *Labordia lorenciana* on Kauai (PEPP 2011, p. 124; PEPP 2013, p. 126), *Myrsine fosbergii* on Kauai (HBMP 2010), *Nothocestrum latifolium* on Maui (HBMP 2010), *Ochrosia haleakalae* on Maui and Hawaii Island (HBMP 2010), *Phyllostegia stachyoides* on Molokai (HBMP 2010), *Portulaca villosa* on Hawaii Island (PEPP 2012, p. 140), *Ranunculus mauiensis* on Kauai and Maui (PEPP 2011, p. 161; PEPP 2012, p. 144; PEPP 2013, pp. 177–178; PEPP 2014, pp. 155–156; Kishida 2011, in litt.), *Sanicula sandwicensis* on Maui (PEPP 2011, p. 163), and *Sicyos lanceoloideus* on Kauai (PEPP 2012, p. 154; PEPP 2013, p. 189). In addition, browsing by feral goats may also damage or destroy native host plants of the yellow-faced bees *Hylaeus anthracinus, H. assimulans, H. facilis,* and *H. hilaris.*

Axis Deer

Axis deer are known to consume a wide range of forage items throughout their native range and in areas where they have been introduced (Anderson 1999, p. 3). Although they prefer to graze on grass, axis deer have been documented to eat over 75 species of plants, including all plant parts (Anderson 1999, p. 3). They exhibit a high degree of opportunism regarding their choice of forage, and consume progressively less palatable plants until no edible vegetation remains (Dinerstein 1987, *in* Anderson 1999, p. 5; Medeiros 2010, pers. comm.). Axis deer on Maui follow a cycle of grazing and browsing in open lowland grasslands during the rainy season (November through March) and then migrating to the lava flows of montane mesic forest during the dry summer months to graze and browse on many native plant species, for example, *Abutilon menziesii* (kooloaula, listed endangered), *Erythrina sandwicensis* (wiliwili), and *Sida fallax* (Medeiros 2010, pers. comm.). During the El Niño drought cycles from 1988 through 2001, Maui experienced an 80 to 90 percent decline in native shrub species caused by axis deer browsing on and girdling young saplings (Medeiros 2010, pers. comm.). On Lanai, grazing by axis deer has been reported as a major threat to the endangered *Gardenia brighamii* (nanu), and Swedberg and Walker (1978, *in* Anderson 2003, pp. 124–25) reported that the native plants *Osteomeles anthyllidifolia* (uulei) and *Leptecophylla tameiameiae* (pukiawe) comprised more than 30 percent of axis deer rumen volume. During the driest summer months, axis deer are observed in coastal areas in search of food (Medeiros 2010, pers. comm.). Because axis deer occur in 10 of the 11 ecosystems on Molokai, Lanai, and Maui (all except anchialine pool), the results from the studies above, in addition to direct observations from field biologists, suggest that axis deer can also alter these ecosystems and directly damage or destroy native plants. Browsing or grazing by axis deer poses a threat to the following plant species: *Gardenia remyi* on Molokai (HBMP 2010), *Huperzia stemmermanniae* on Maui (HBMP 2010), *Joinvillea ascendens* ssp. *ascendens* on Maui (PEPP 2014, pp. 108–109), *Nothocestrum latifolium* on Lanai (PEPP 2012, p. 129), *Portulaca villosa* on Lanai (HBMP 2010), *Pseudognaphalium sandwicensium* var. *molokaiense* on Molokai (Wood 2005c, in litt.; Kallstrom 2008, in litt.; MNTF 2010), *Ranunculus mauiensis* on Maui (PEPP 2013, p. 178; PEPP 2014, pp. 154–155), *Schiedea pubescens* on Molokai and Lanai (Wood 2004, in litt.; Rowland 2006, in litt.; Oppenheimer 2001, in litt.), and *Solanum nelsonii* on Molokai (PEPP 2012, p. 156; PEPP 2013, pp. 190–191; PEPP 2014, p. 167). Axis deer may also damage or destroy native host plants of the yellow-faced bees *Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris,* and *H. longiceps.*

Black-Tailed Deer

Black-tailed deer are extremely adaptable, and in their native range (U.S. Pacific coast) inhabit every principal ecosystem including open grasslands, agricultural land, shrubland, woodland, mountain forests, semi-deserts, and high mountain ecosystems (NRCS 2005, in litt.). Their home range size varies in the continental United States, but has been estimated to from 1 to 4 sq mi (2.5 to 10 km) and sometimes as large as 30 sq mi (78 sq km), with adults defending small areas when caring for fawns (NRCS 2005, in litt.). We do not know their home range size on Kauai; however, the island is only 562 sq mi (1,456 sq km) in size. Black-tailed deer are primarily browsers, but as they have a smaller rumen compared to other browsers in relation to their body size, they must select the most nutritious plants and parts of plants (Mule Deer Foundation 2011, in litt.). Their diet consist of a diversity of living, wilted, dry, or decaying vegetation, including leaves, needles, succulent stems, fruits, nuts, shrubs, herbaceous undergrowth, domestic crops, and grasses (NRCS 2005, in litt.). Black-tailed deer consume native vegetation on the island of Kauai (van Riper and van Riper 1982, pp. 42–43; Stone 1985, pp. 262–263; Tomich 1986, pp. 132–134; Cuddihy and Stone 1990, p. 67). In the 1990s, it was estimated there were about 350 animals in and near Waimea Canyon; however, in 2013, the population was estimated to be 1,000 to 1,200 animals in public hunting areas (not including private lands), and was expanding into the southern and eastern sections of the island (Mule Deer Working Group 2013, in litt.). According to State records, black-tailed deer are feeding largely on the introduced species *Psidium cattleianum* and *Rubus rosifolius,* as well as the native species *Alyxia stellata* (maile), *Dodonaea viscosa* (aalii), *Dianella sandwicensis* (ukiuki), *Coprosma* sp. (pilo), and *Acacia koa* (Cuddihy and Stone 1990, p. 67). Browsing by black-tailed deer is a threat to the Kauai plant species *Asplenium diellaciniatum, Joinvillea ascendens* ssp. a*scendens, Labordia lorenciana, Nothocestrum latifolium, Ranunculus mauiensis,* and *Sicyos lanceoloideus.*

Mouflon and Sheep

Mouflon, feral domestic sheep, and mouflon-sheep hybrids browse native vegetation on Lanai and Hawaii Island. Domestic sheep have been raised on Kauai, Lanai, Kahoolawe, and Hawaii, but today sheep farming only occurs on Hawaii Island on Mauna Kea and Hualalai (Pratt and Jacobi *in* Pratt *et al.* 2009, p. 151). Sheep browse (eating shoots, leaves, flowers, and bark) on the native *Sophora chrysophylla* (mamane), the primary food source of the endangered forest bird, the palila (*Loxioides bailleui*) (Scowcroft and Sakai 1983, p. 495). Feral sheep reductions were initiated in palila habitat; however, even after most were removed, tree bark stripping continued and some mamane populations did not recover (Pratt and Jacobi *in* Pratt *et al.* 2009, p. 151). On Hawaii Island, vegetation browsing by mouflon led to the decline of the largest population of the endangered *Argyroxiphium kauense* (kau silversword, Mauna Loa silversword, or ahinahina), reducing it from a ''magnificent population of several thousand'' (Degener *et al.* 1976, pp. 173–174) to fewer than 2,000 individuals in a period of 10 years (unpublished data *in* Powell 1992, p. 312). Mamane is also preferred browse for mouflon, and according to Scowcroft and Sakai (1983, p. 495), mouflon eat the shoots, leaves, flowers, and bark of this species. Mouflon are also reported to strip bark from native koa trees and to seek out the native plants *Geranium* *cuneatum* (hinahina) and *Silene hawaiiensis,* and Lanai occurrences of *Gardenia brighamii* (Benitez *et al.* 2008, p. 57; Mehrhoff 1993, p. 11). While mouflon were introduced to Lanai and Hawaii Island as game mammals, a private game ranch on Maui has added mouflon to its stock, and it is likely that over time some individuals may escape (Hess 2010, pers. comm.; Kessler 2010, pers. comm.). Browsing and grazing by mouflon, feral domestic sheep, and mouflon-sheep hybrids poses a threat to the plant species *Exocarpos menziesii* on Hawaii Island (Keitt and Island Conservation 2008, pp. 90, 92; NPS 2013, pp. i, 124); *Festuca hawaiiensis* on Hawaii Island (Oppenheimer 2001, in litt.; HBMP 2007, in litt.); *Nothocestrum latifolium* on Lanai (PEPP 2012, p. 129); *Portulaca villosa* on Lanai (HBMP 2010); *Ranunculus hawaiensis* on Hawaii Island (HBMP 2010); and *Sicyos macrophyllus* on Hawaii Island (HBMP 2010). Because feral sheep and mouflon occur in all of the described ecosystems except for the anchialine pool ecosystem, the data from studies above suggest that in addition to consuming the host plants of the yellow-faced bees *Hylaeus anthracinus* and *H. assimulans* on Lanai, herbivory by feral sheep and mouflon also may consume host plants of the other species on Lanai: *H. facilis, H. hilaris,* and *H. longiceps.*

Feral Cattle

Grazing by cattle is considered one of the most important factors in the destruction of Hawaiian forests (Baldwin and Fagerlund 1943, pp. 118–122). Feral cattle are currently found only on the islands of Molokai, Maui, and Hawaii (Tomich 1986, pp. 140–144; de Sa *et al.* 2013, 29 pp.). Cattle consume tree seedlings and browse saplings (Cuddihy 1984, p. 16). In Hawaii Volcanoes National Park (Hawaii Island), Cuddihy reported that there were twice as many native plant species as nonnatives in areas that had been fenced to exclude cattle (Cuddihy 1984, pp. 16, 34). Loss of the native sandalwood forest on Lanai is attributed to cattle (Skottsberg 1953 *in* Cuddihy 1984, p. 16). Browsing and grazing by feral cattle poses a threat to the following plant species: *Huperzia stemmermanniae* on Maui and Hawaii Island (Medeiros *et al.* 1996b, p. 96); *Nothocestrum latifolium* on Molokai and Maui (HBMP 2010); *Ochrosia haleakalae* on Maui (HBMP 2010); *Ranunculus hawaiensis* on Hawaii Island (HBMP 2010); *R. mauiensis* on Maui and Hawaii Island (PEPP 2012, p. 144; PEPP 2013, p. 178; PEPP 2014, pp. 154–155; HBMP 2010); *Schiedea pubescens* on Maui (Wood 2005d, in litt.; HBMP 2010); *Sicyos macrophyllus* on Hawaii Island (PEPP 2010, p. 111; HBMP 2010); and *Solanum nelsonii* on Molokai (Wood 1999, in litt.; HBMP 2010). Because feral cattle occur in 6 of the 11 ecosystems (lowland dry, lowland mesic, lowland wet, montane wet, montane mesic, and subalpine) in which these species occur on Molokai, Maui, and Hawaii Island, the results from the studies cited above, in addition to direct observations from field biologists, indicate that grazing by feral cattle can directly damage or destroy these plants.

Blackbuck

The blackbuck antelope (*Antelope cervicapra*) is an endangered species from India brought to a private game reserve on Molokai about 15 years ago from an Indian zoo (Kessler 2010, pers. comm.). According to Kessler (2010, pers. comm.), a few individuals escaped captivity and established a wild population of unknown size on the low, dry plains of western Molokai. Blackbuck primarily use grassland habitat for grazing. In India, foraging consumption and nutrient digestibility are high in the moist winter months and low in the dry summer months (Jhala 1997, pp. 1348, 1351). Although most plant species are grazed intensely when they are green, some are grazed only after they are dry (Jhala 1997, pp. 1348, 1351). Because the foraging dynamics of blackbuck antelope in Hawaii and possible habitat effects are unknown at this time, we do not currently consider this ungulate a threat to the four native plant species known from dry areas on Molokai: *Gardenia remyi, Nothocestrum latifolium, Portulaca villosa,* and *Pseudognaphalium sandwicensium* var. *molokaiense,* or to the yellow-faced bees *Hylaeus anthracinus, H. facilis, H. hilaris,* and *H. longiceps* (which rely on host plants that ungulates consume).

Other Introduced Vertebrates

Rats

Three species of introduced rats occur in the Hawaiian Islands. Studies of Polynesian rat (*Rattus exulans*) DNA suggest they first appeared in the islands along with emigrants from the Marquesas Islands (French Polynesia) in about 400 A.D., with a second introduction around 1100 A.D. (Ziegler 2002, p. 315). The black rat (*R. rattus*) and the Norway rat (*R. norvegicus*) arrived in the islands more recently, as stowaways on ships sometime in the late 19th century (Atkinson and Atkinson 2000, p. 25). The Polynesian rat and the black rat are primarily found in rural and remote areas of Hawaii, in dry to wet habitats, while the Norway rat is typically found in urban areas or agricultural fields (Tomich 1986, p. 41). The black rat is widely distributed throughout the main Hawaiian Islands and can be found in a range of ecosystems and as high as 9,000 ft (2,700 m), but it is most common at low- to mid-elevations (Tomich 1986, pp. 38–40). Sugihara (1997, p. 194) found both the black and Polynesian rats up to 7,000 ft (2,000 m) on Maui, but found the Norway rat only at lower elevations. Rats are omnivorous and eat almost any type of food (Nelson 2012, in litt.). Rats occur in 7 of the 11 ecosystems (coastal, lowland mesic, lowland wet, montane wet, montane mesic, montane dry, and wet cliff), and predation or herbivory by rats is a threat to 19 plants (*Calamagrostis expansa* (Maui and Hawaii Island; HBMP 2010), *Cyanea kauaulaensis* (Maui; PEPP 2012, pp. 71–72; PEPP 2014, p. 73), *Dryopteris glabra* var. *pusilla* (Kauai; Wood 2015, in litt.); *Gardenia remyi* (Kauai, Molokai, Maui, and Hawaii Island; Wood 2004, in litt.; HBMP 2010); *Joinvillea ascendens* ssp. *ascendens* (Kauai, Oahu, Molokai, Maui, and Hawaii Island; PEPP 2014, p. 109), *Kadua haupuensis* (Kauai; Lorence *et al.* 2010, p. 140), *Labordia lorenciana* (Kauai; Wood *et al.* 2007, p. 198), *Ochrosia haleakalae* (Maui; Oppenheimer 2015, in litt.), *Phyllostegia helleri* (Kauai; HBMP 2010), *P. stachyoides* (Molokai, Maui, and Hawaii Island; PEPP 2012, p. 133; PEPP 2013, pp. 158–159; PEPP 2014, pp. 140–142), *Pritchardia bakeri* (Oahu; Hodel 2012, pp. 42, 73), *Ranunculus mauiensis* (Kauai, Oahu, Molokai, Maui, and Hawaii Island; HBMP 2010), *Sanicula sandwicensis* (Maui and Hawaii Island; PEPP 2012, p. 148), *Santalum involutum* (Kauai; Harbaugh *et al.* 2010, pp. 835–836), *Schiedea diffusa* ssp. *diffusa* (Molokai, Maui; HBMP 2010), *S. pubescens* (Molokai, Lanai, and Maui; Wood 2005d, in litt.; HBMP 2010), *Sicyos macrophyllus* (Maui and Hawaii Island; Pratt 2008, in litt.), *Solanum nelsonii* (NWHI, Niihau, Molokai, Maui, and Hawaii Island; PEPP 2012, p. 156; PEPP 2014, p. 167), and *Wikstroemia skottsbergiana* (Kauai; Mitchell *et al.* 2005, in litt.)) and to the band-rumped storm-petrel (Lehua, Kauai, Maui, Kahoolawe, Lanai, and Hawaii Island; Pyle and Pyle 2009, in litt.).

Rat Impacts on Plants: Rats affect native plants by eating fleshy fruits, seeds, flowers, stems, leaves, roots, and other plant parts (Atkinson and Atkinson 2000, p. 23), and by stripping bark and cutting small branches (twig cutting) in search of moisture and nutrients, with detrimental impacts to plants' vigor and regeneration (Abe and Umeno 2011, pp. 27–39; Nelson 2012, pp. 1–4, 8–9). Studies in New Zealand have demonstrated that differential regeneration as a consequence of rat predation alters species composition of forested areas (Cuddihy and Stone 1990, pp. 68–69). Rats have caused declines or even the total elimination of island plant species (Campbell and Atkinson 1999 *in* Atkinson and Atkinson 2000, p. 24). In the Hawaiian Islands, rats may consume as much at 90 percent of the seeds produced by some native plants, and in some cases prevent regeneration of forest species completely (Cuddihy and Stone 1990, pp. 68–69). Hawaiian plants with fleshy fruit, such as *Cyanea* and *Pritchardia,* are particularly susceptible to rat predation (Cuddihy and Stone 1990, pp. 67–69). Predation of seeds by rats poses a serious and ongoing threat to all the Hawaiian *Pritchardia* palms, including *P. bakeri,* because rats are able to consume every seed in a fruiting stalk, preventing successful reproduction (Hodel 2012, pp. 42, 73). Fossil pollen records indicate that *Pritchardia* palms were once among the dominant species of coastal, lowland, and interior forests of Hawaii (Burney *et al.* 2001, pp. 630–631; Chapin *et al.* 2007, p. 21); today, complete coverage by all age classes of *Pritchardia* occurs only on small islets currently unoccupied by rats (Athens 2009, p. 1498). Because rats occur in seven of the ecosystems in which these species occur, the results from these studies, in addition to direct observations by field biologists, suggest that predation by rats can directly damage or destroy native plants.

Rat Impacts on the Band-Rumped Storm-Petrel: Introduced predators are the most serious threat facing the band-rumped storm-petrel. Rats occur on all the main Hawaiian Islands, and populations are also high on Lehua; however, attempts to control rats on Lehua are ongoing (Parkes and Fisher 2011, 48 pp.). Ground-, crevice-, and burrow-nesting seabirds, as well as their eggs and young, are highly susceptible to predation by rats; storm-petrels are the most susceptible of seabirds to rat predation and have experienced population-level impacts and extirpation as a result (Simons 1984, p. 1073; Jones *et al.* 2008, pp. 20–21). Evidence from the islands of Hawaii and Maui show that the Hawaiian petrel, a much larger seabird that nests in some of the same areas as the band-rumped storm-petrel, suffers huge losses to introduced predators (Johnston 1992, in litt.; Hodges and Nagata 2001, pp. 308–310; Hu *et al.* 2001, p. 234). The effects of introduced predators on the breeding success of the band-rumped storm-petrel are probably similar to the documented effects on the breeding success of Hawaiian petrels because these birds are similarly vulnerable. Population modeling showed that consistent predation of Hawaiian petrels, where reproductive success was reduced to 35 percent and adult survival was 80 percent, could drive a population to extinction in 20 to 30 years (Simons 1984, pp. 1071–1073). Rat bones were collected from a band-rumped storm-petrel nest on a sheer cliff on Kauai, and two live rats were observed moving along small rock ledges in the same area (Wood *et al.* 2002, p. 8), demonstrating that even remote and otherwise inaccessible nest sites are not safe from these predators. Because rats are present in all three ecosystems in which the band-rumped storm-petrel occurs (coastal, dry cliff, and wet cliff), predation by rats likely results in decreases in the numbers and populations of the band-rumped storm-petrel. We do not anticipate a reduction of this threat in the near future.

Barn Owl Impacts on the Band-Rumped Storm-Petrel

Two species of owls, the native pueo (*Asio flammeus sandwichensis*) and the introduced barn owl (*Tyto alba*), are known to prey on native Hawaiian birds. For example, between 1996 and 1998, 10 percent of nest failures of the puaiohi (small Kauai thrush, *Myadestes palmeri*), an endangered forest bird, on Kauai were attributed to owls (Snetsinger *et al.* 1994, p. 47; Snetsinger *et al.* 2005, pp. 72, 79). The band-rumped storm petrel only comes to land after dark, and likely avoids predation by the pueo, which hunts in daylight (Hawaii DOFAW 2005). The nonnative barn owl, however, is a nocturnal hunter and may prey on the storm-petrel. Barn owls were introduced to Kauai, Oahu, Molokai, and Hawaii Island between 1958 and 1963, to control rats and mice in sugar cane plantations, and now they occur on all of the main islands (USFWS 2013, p. 9). Barn owls are well-known predators of storm-petrels and other seabirds on islands (LeCorre and Jouventin 1997, p. 215; Velarde et al. 2007, p. 286; Guerra *et al.* 2014, p. 182; Ringler *et al.* 2015, p. 79). Direct impacts of barn owls on band-rumped storm-petrels in Hawaii are not well documented, but evidence and numerous anecdotal reports exist of barn owls preying on seabirds in the main Hawaiian islands, including the threatened Newell's shearwater and endangered Hawaiian petrel, and including on Kauai and Lehua, where band-rumped storm-petrels are known to nest (summarized in USFWS 2013, pp. 11–12). Because barn owls occur throughout the range of the band-rumped storm-petrel in Hawaii, they are likely to be predators of these seabirds.

Cat Impacts on the Band-Rumped Storm-Petrel

Cats (*Felis catus*) were introduced to Hawaii in the early 1800s, and are present on all the main Hawaiian Islands (Tomich 1986, p. 101). Cats are notorious for their predation on birds (Tomich 1986, p. 102). Native mammalian carnivores are absent from oceanic islands because of their low dispersal ability, but once introduced, are significant predators on seabird colonies and terrestrial birds that have no innate defenses against predation by these animals (Scott *et al.* 1986, p. 363; Ainley *et al.* 1997, p. 24; Ziegler 2002, p. 243; Hess and Banko 2006, in litt.; Nogales *et al.* 2013, p. 804). Cats may have contributed to the extinction of the Hawaiian rail (*Porzana sandwichensis*) (Stone 1985 *in* Stone and Scott 1985, p. 266). Although cats are more common at lower elevations, there are populations in areas completely isolated from human presence, including montane forests and alpine areas of Maui and Hawaii Island (Lindsey *et al. in* Pratt *et al.* 2009, p. 277; Scott *et al.* 1986, p. 363). Examination of the stomach contents of feral cats at Hakalau Forest NWR (Hawaii Island) found native and introduced birds to be the most common prey item (Banko *et al.* 2004, p. 162). Cats are believed to prey on roosting or incubating adult band-rumped storm-petrels and young, as evidenced by carcasses found in Hawaii Volcanoes National Park depredated by cats (Hu, pers. comm. *in* Slotterback 2002, in litt.; Hess *et al.* 2008, pp. 11, 14). Predation by cats is well known for the endangered Hawaiian petrel, which has some accessible and well-studied nesting areas; this species shares life-history and evolutionary traits with the band-rumped storm-petrel that make both vulnerable to nonnative mammalian predators. We expect the band-rumped storm-petrel to experience impacts of cat predation similar to those documented in the Hawaiian petrel. On Mauna Loa (Hawaii Island), feral cats were major predators of Hawaiian petrels (Hu *et al.* 2001, p. 234), and on Haleakala (Maui), almost half of the known mortalities of Hawaiian petrels between 1964 and 1996 were attributed to cats (Natividad Hodges and Nagata 2001, p. 312; Hu *et al.* 2001, p. 234). Population modeling of the Hawaiian petrel indicated that the petrel population would be unable to withstand any level of predation for long, and even with seemingly low levels of predation, the petrel population would be reduced by half in fewer than 30 years (Simons 1984, p. 1073). The band-rumped storm petrel is smaller in size than the petrel, but also nests in burrows and rock-crevices, lacks co-evolved predator avoidance behavior, and has a lengthy incubation and fledgling period, making this species highly vulnerable to predation by introduced mammals. Because feral cats occur in all four ecosystems in which the band-rumped storm petrel occurs, they are likely to be significant predators of these birds.

Mongoose Impacts on the Band-Rumped Storm-Petrel

The small Indian mongoose (*Herpestes auropunctatus*) was introduced to Hawaii in 1883, to control rodents in sugar cane plantations (Tomich 1986, pp. 95–96). This species quickly became widespread on Oahu, Molokai, Maui, and Hawaii Island, from sea level to elevations as high as 7,000 ft (2,130 m) (Tomich 1986, pp. 93–94). Mongooses have been sighted, and two captured, on Kauai, but it is still uncertain if the species is established there or how large populations might be (Kauai Invasive Species Committee 2013, in litt.; The Garden Island 2012, in litt.; Hess *et al.* in Pratt *et al.* 2009, p. 429). Mongooses are omnivorous, are known to prey on Hawaiian birds and their eggs, and are considered a likely factor in the decline of the endangered Hawaiian goose (nene, *Branta sandvicensis*) (Tomich 1986, p. 97). They are known or suspected predators on other Hawaiian birds, including the Hawaiian crow (alala, *Corvus hawaiiensis*), Hawaiian duck (koloa, *Anas wyvilliana*), Hawaiian coot (alae keokeo, *Fulica alai*), Hawaiian stilt (aeo, *Himantopus mexicanus knudseni*), Hawaiian gallinule (ula, *Gallinula chloropus sandvicensis*), Hawaiian petrel, and Newell's shearwater. Bird extinctions in other areas are attributed to mongooses, such as the loss of the barred-wing rail (*Nesoclopeus poecilopterus*) in Fiji, and the Jamaica petrel (*Pterodroma caribbaea*) (Hays and Conant 2007, p. 6). Birds extirpated from islands occupied by mongooses retain their populations on islands known to be mongoose-free (Hays and Conant 2007, p. 7). In Hawaii, mongooses occur in habitat types where they are not found within their natural range, and they have no predators and few communicable diseases or parasites. Because mongooses occur in all four ecosystems in which the band-rumped storm petrel occurs, they are likely to be significant predators of the band-rumped storm-petrel.

Nonnative Fish Impacts on the Orangeblack Hawaiian Damselfly

Predation by nonnative fishes is a threat to the orangeblack Hawaiian damselfly. Similar to the aquatic insects, Hawaii has a low diversity of freshwater fishes, with only five native species in two families (gobies (Gobiidae) and sleepers (Eleotridae)) that occur on all the main islands (Devick 1991, p. 196). Information on these five species indicates that the Hawaiian damselflies probably experienced limited natural predation pressure from these native fishes (Kido 1997, p. 493; Englund 1999, p. 236). Conversely, fish predation has been an important factor in the evolution of behavior in damselfly naiads in continental systems (Johnson 1991, p. 13). Some species of damselflies, including the native Hawaiian species, are not adapted to coexist with some fish species, and are found only in bodies of water without fish (Henrikson 1988, pp. 179–180; McPeek 1990a, pp. 92–93). The naiads of these species tend to occupy more exposed positions and engage in conspicuous foraging behavior that makes them susceptible to predation by fishes (Macan 1977, p. 47; McPeek 1990b, p. 1722). The introduction of nonnative fishes has been implicated in the extirpation of a species related to the orangeblack Hawaiian damselfly, the endangered Pacific Hawaiian damselfly (*Megalagrion pacificum*), from Oahu, Kauai, and Lanai, and from many streams on the remaining islands where it occurs (Moore and Gagne 1982, pp. 1–4). More than 70 species of fish have been introduced into Hawaiian freshwater habitats (Devick 1991, p. 189; Englund and Eldredge *in* Staples and Cowie 2001, p. 32; Englund 2004, in litt., p.27). The impact of fish introductions prior to 1900 cannot be assessed because this predates the initial collection of damselflies in Hawaii (Perkins 1913, p. clxxvi). In 1905, two species, the mosquito fish (*Gambusia affinis*) and the sailfin molly (*Poecilia latipinna*), were introduced for biological control of mosquitoes (Van Dine 1907, pp. 6–9). In 1922, three additional species were established for mosquito control, the green swordtail (*Xiphophorus helleri*), the moonfish (*Xiphophorus maculatus*), and the guppy (*Poecilia reticulata*). By 1935, the orangeblack Hawaiian damselfly was found only in waters without introduced fishes (Williams 1936, p. 289; Zimmerman 1948b, p. 341; Polhemus 1993b, p. 591; Englund 1998, p. 235). Beginning about 1980, a large number of new fish introductions began in Hawaii, originating primarily from the aquarium fish trade (Devick 1991, p. 189). This recent wave of fish introductions on Oahu corresponded with the drastic decline and range reduction of other Hawaiian damselfly species: The endangered oceanic Hawaiian damselfly (*Megalagrion oceanicum*), the endangered crimson Hawaiian damselfly (*M. leptodemas*), and the endangered blackline Hawaiian damselfly (*M. nigrohamatum nigrolineatum*). Currently, these damselflies are found only in drainages or higher parts of stream systems where nonnative fish are not yet established (Englund and Polhemus 1994, pp. 8–9; Englund 2004, in litt., p. 27). In summary, Hawaiian damselflies evolved with few, if any, predatory fishes and the lack of defensive behavior makes the orangeblack Hawaiian damselfly particularly vulnerable to, and are threatened by, predation by nonnative fish.

Nonnative Fish Impacts on the Anchialine Pool Shrimp

In Hawaii, the introduction of nonnative fishes into anchialine pools and the ensuing predation by nonnative fishes is considered the greatest threat to native shrimp within anchialine pool systems (Bailey-Brock and Brock 1993, p. 354). These impacts are discussed further under *Factor E. Other Natural or Manmade Factors Affecting Their Continued Existence,* below.

Bullfrog Impacts on the Orangeblack Hawaiian Damselfly

Native to the eastern United States and the Great Plains region, the bullfrog (*Rana catesbeiana, Lithobates catesbeiana*), was first introduced to Hawaii in 1899, to help control insects, and has become established on all the main Hawaiian Islands (Bryan 1931, pp. 62–63; Bury and Whelan 1985, p. 1; Lever 2003, p. 203). The bullfrog is flexible in both habitat and food requirements (McKeown 1996, pp. 24–27; Bury and Whelan 1984, pp. 3–7; Lever 2003, pp. 203–204), and can utilize any water source within a temperature range of 60 to 75 degrees Fahrenheit (°F) (16 to 24 degrees Celsius (°C)) (DesertUSA 2008). Englund *et al.* (2007, pp. 215, 219) found a strong correlation between the presence of bullfrogs and the absence of Hawaiian damselflies in their study of streams on all the main Hawaiian Islands. Because bullfrogs are omnivorous feeders and occur in the same habitat as the orangeblack Hawaiian damselfly, we consider predation by bullfrogs a threat to the orangeblack Hawaiian damselfly.

Introduced Invertebrates

Slugs

Herbivory by nonnative slugs is a threat to 10 of the 39 plant species (*Cyanea kauaulaensis* (Maui); *Deparia kaalaana* (Maui), *Dryopteris glabra* var. *pusilla* (Kauai), *Hypolepis hawaiiensis* var. *mauiensis* (Maui), *Ochrosia haleakalae* (Maui, Hawaii Island), *Phyllostegia brevidens* (Maui), *P. stachyoides* (Molokai, Maui), *Ranunculus mauiensis* (Kauai, Maui), *Schiedea diffusa* ssp. *diffusa* (Maui), and *S. pubescens* (Molokai, Maui)) through mechanical damage, destruction of plant parts, and mortality (see Table 2) (Joe 2006, p. 10; HBMP 2010; PEPP 2011, pp. 149, 170; PEPP 2012, pp. 71–72, 117–118, 133, 144–145, 153; PEPP 2013, pp. 54, 67, 91, 125–126, 158–159, 177–178, 185; Oppenheimer and Bustamente 2014, p. 106; PEPP 2014, pp. 73, 112–114, 136, 141–142, 154–156, 159, 162–163). Slugs are known to damage individuals of *Cyanea* and *Cyrtandra* species in the wild (Wood 2001, in litt.; Sailer and Kier 2002, in litt.; PEPP 2007, p. 38; PEPP 2008, pp. 23, 29, 52–53, 57). Information in the U.S. Army's 2005 ''Status Report for the Makua Implementation Plan'' indicates that herbivory by slugs can be a threat to all species of *Cyanea,* and can result in up to 80 percent seedling mortality (U.S. Army Garrison 2005, p. 3–51). Slug damage has also been reported on other Hawaiian plants including *Argyroxiphium grayanum* (greensword), *Alsinidendron* sp., *Hibiscus* sp., *Schiedea kaalae* (maolioli), *Solanum sandwicense* (popolo aiakeakua), and *Urera* sp. (Gagne 1983, pp. 190–191; Sailer 2006, pers. comm. *in* Joe 2006, pp. 28–34). Joe and Daehler (2008, p. 252) found that native Hawaiian plants are more vulnerable to slug damage than nonnative plants. In particular, they found that individuals of the endangered plants *Cyanea superba* and *Schiedea obovata* had 50 percent higher mortality when exposed to slugs as compared to individuals that were within exclosures without slugs. Because slugs are reported in five ecosystems (lowland mesic, lowland wet, montane wet, montane mesic, and wet cliff) on all the main Hawaiian Islands, the data from the studies cited above, in addition to direct observations by field biologists, indicate that slugs can directly damage or destroy native plants.

Black Twig Borers

The black twig borer (*Xylosandrus compactus*) is known to infest a wide variety of common plant taxa, including rare native plant species (Davis 1970, p. 39; Extension Entomology and US–CTAHR Integrated Pest Management Program 2006, p. 1). This insect pest burrows into branches, introduces a pathogenic fungus as food for its larvae, and lays its eggs (Davis 1970, p. 39). Twigs, branches, and entire plants can be damaged or killed from an infestation (Extension Entomology and UH–CTAHR Integrated Pest Management Program 2006, in litt.). On the Hawaiian Islands, the black twig borer has many hosts, disperses easily, and is probably present at most elevations up to 2,500 ft (762 m) (Howarth 1985, pp. 152–153). The black twig borer is reported as a threat to *Labordia lorenciana* and *Nothocestrum latifolium* (Ching-Harbin 2015, in litt.; Kishida 2015, in litt.).

Backswimmers

Backswimmers are aquatic true bugs (Heteroptera) in the family Notonectidae, so called because they swim upside down. Backswimmers are voracious predators and frequently feed on prey much larger than themselves, such as tadpoles, small fish, and other aquatic invertebrates including damselfly naiads (Borror *et al.* 1989, p. 296; Zalom 1978, p. 617). Backswimmers (several species) were introduced in recent times. *Buenoa pallipes* (NCN) has been recorded from Hawaii Island, Oahu, Maui, and Kauai (Zimmerman 1948, pp. 232–233; Larsen 1996, p. 40). This species is found in streams and can be abundant in lowland ponds and reservoirs. It feeds on any suitably sized insect, including damselfly naiads (Zalom 1978, p. 617). Two additional species of backswimmers have become established in Hawaii, *Anisops kuroiwae* (NCN) on Maui and Lanai, and *Notonecta indica* (NCN) on Hawaii Island, Oahu, and Maui (Larsen 1996, pp. 39–40). Predation by backswimmers is a threat to the orangeblack Hawaiian damselfly (Haines 2015, in litt.).

Ants

At least 47 species of ants are known to be established in the Hawaiian Islands (Hawaii Ants 2008, 11 pp.). No native ant species occur in Hawaii, and the native yellow-faced bee species in Hawaii evolved in the absence of predation pressure from ants. Ants are known to prey upon Hawaiian yellow-faced bee (*Hylaeus*) species, with observations of drastic reductions in yellow-faced bee populations in ant-infested areas (Medeiros *et al.* 1986, pp. 45–46; Reimer 1994, p. 17; Stone and Loope 1987, p. 251; Cole *et al.* 1992, pp. 1313, 1317, 1320). The presence of ants in nearly all of the low-elevation habitat sites currently and historically occupied by yellow-faced bee species may preclude these species' recovery in some of these areas (Reimer 1994, pp. 17–18; Daly and Magnacca 2003, pp. 9–10). Although the primary impact of ants on Hawaii's native invertebrate fauna is via predation, they also compete for nectar (Reimer 1994, p. 17; Howarth 1985, p. 155; Hopper *et al.* 1996, p. 9; Holway *et al.* 2002, pp. 188, 209; Daly and Magnacca 2003, p. 9; Lach 2008, p. 155) and nest sites (Krushelnycky *et al.* 2005, pp. 6–7). Some ant species may affect yellow-faced bee species indirectly as well, by consuming seeds of native host plants, thereby reducing the plants' recruitment and fecundity (Bond and Slingsby 1984, p. 1031). The threat of ant predation on the yellow-faced bees is amplified by the fact that most ant species have winged reproductive adults and can quickly expand their range by establishing new colonies in suitable habitat (Staples and Cowie 2001, p. 55). In addition, these attributes allow some ants to destroy otherwise geographically isolated populations of native arthropods (Nafus 1993, pp. 19, 22–23). Several studies suggest a serious ecosystem-level effect of invasive ants on plant pollination (Krushelnycky *et al.* 2005, p. 9; Lach 2008, p. 155). Where ranges overlap, ants compete with native pollinators such as yellow-faced bees and preclude them from pollinating native plants (Howarth 1985, p. 157), potentially leading to a decrease in availability of the bees' native plant food sources. Lach (2008, p. 155) found that yellow-faced bees that regularly consume pollen from flowers of *Metrosideros polymorpha* (ohia) were entirely absent from trees with flowers visited by the ant *Pheidole megacephala.*

The four most aggressive ant species in Hawaii are the big-headed ant (*Pheidole megacephala*), the yellow crazy ant (*Anoplolepis gracilipes*), the tropical fire ant (*Solenopsis geminata*), and *S. papuana* (NCN). The big-headed ant is native to central Africa and was first reported in Hawaii in 1879 (Krushelnycky *et al.* 2005, p. 24). This species occurs from coastal to mesic habitat up to 4,000 ft (1,220 m) in elevation. With few exceptions, native insects have been eliminated in habitats where the big-headed ant is present (Perkins 1913, p. xxxix; Gagne 1979, p. 81; Gillespie and Reimer 1993, p. 22). Native habitat of the yellow crazy ant is not known, but it is speculated the species originated in West Africa (MacGown 2015, in litt.). It occurs in low to mid elevations (less than 2,000 ft (600 m)) in rocky areas of moderate annual rainfall (less than 100 in (250 cm)) (Reimer *et al.* 1990, p. 42). Although surveys have not been conducted to ascertain this species' presence in each of the known habitats occupied by the seven yellow-faced bees, we know that the yellow crazy ant occurs adjacent to some of the identified populations sites based upon observations of their expanding range and their preference for coastal and dry forest habitat (as indicated where the species is most commonly collected) (Antweb 2015, in litt.; Magnacca and King 2013, pp. 13–14). Direct observations indicate that Hawaiian arthropods are susceptible to predation by this ant species. Gillespie and Reimer (1993, pp. 21, 26) and Hardy (1979, pp. 37–38) documented the complete elimination of native spiders from mesic and dry forests after they were invaded by the big-headed ant and the yellow crazy ant. Lester and Tavite (2004, p. 291) found that the yellow crazy ant in the atolls of Tokelau (Central Polynesia) form very high densities in a relatively short period of time with locally serious consequences for invertebrate diversity. Densities of 3,600 individuals collected in pitfall traps within a 24-hour period were observed, as well as predation on invertebrates ranging from crabs to other ant species. Results from these and other studies (Reimer *et al.* 1990, p. 47) indicate that yellow crazy ants have the potential as predators to profoundly affect endemic insect fauna in areas they occupy. We believe that the yellow crazy ant is a threat to populations of the Hawaiian yellow-faced bees in areas within their range.

Solenopsis papuana, native to the Pacific region but not to Hawaii, is the only abundant, aggressive ant that has invaded intact mesic and wet forest, as well as coastal and lowland dry ecosystems. First detected in 1967, this species occurs from sea level to over 3,600 ft (1,100 m) on all of the main Hawaiian Islands, and is still expanding its range (Reimer *et al.* 1990, p. 42; Reimer 1993, p. 14). Studies have been conducted that suggest a negative effect of this ant species on indigenous invertebrates (Gillespie and Reimer 1993, p. 21). Although surveys have not been conducted to ascertain the presence of *S. papuana* in each of the known ecosystems occupied by the seven yellow-faced bees, because of the expanding range of this introduced ant species, and its widespread occurrence in coastal to wet habitats, it is a possible threat to all known populations of the seven yellow-faced bees.

Solenopsis geminata is also considered a significant threat to native invertebrates in Hawaii (Wong and Wong 1988, p. 171). Found in drier areas of all the main Hawaiian Islands, it displaced *Pheidole megacephala* as the dominant ant in some localities more than 20 years ago (Wong and Wong 1988, p. 175). Known to be a voracious predator, this ant species was documented to significantly increase native fruit fly mortality in field studies in Hawaii (Wong and Wong 1988, p. 175). *Solenopsis geminata* is included among the eight species ranked as having the highest potential risk to New Zealand species in a detailed pest risk assessment for the country (GISD 2011, in litt.), and is included as one of the five ant species listed among the ''100 of the World's Worst Invaders'' (Manaaki Landcare Research 2015, in litt.). In addition to predation, *S. geminata* workers tend honeydew-producing members of the Homoptera suborder, especially mealybugs, which can affect plants directly and indirectly through the spread of disease (Manaaki Landcare Research 2015, in litt.). Although surveys have not been conducted to ascertain the presence of *S. geminata* in each of the known seven yellow-faced bees' habitat sites, because of its expanding range and widespread presence, *S. geminata* is a threat to all known populations of the seven yellow-faced bees.

Although we have no direct information that correlates the decrease in populations of the seven yellow-faced bees in this final rule due to the establishment of nonnative ants, predation of and competition with other yellow-faced bee species by ants has been documented, resulting in clear reductions in or absence of populations (Magnacca and King 2013, p. 24). We expect similar predation impacts to the seven yellow-faced bees to continue as a result of the widespread presence of ants throughout the Hawaiian Islands, their highly efficient and non-specific predatory behavior, and their ability to quickly disperse and establish new colonies. Therefore, we conclude that predation by nonnative ants represents a serious threat to the continued existence of the seven yellow-faced bees, now and into the future.

Wasps

Predation by the western yellow jacket wasp (*Vespula pensylvanica*) is a serious and ongoing threat to the seven yellow-faced bees (Gambino *et al.* 1987, p. 170; Wilson *et al.* 2009, pp. 1–5). The western yellow jacket is a social wasp species native to mainland North America. It was first reported on Oahu in the 1930s (Sherley 2000, p. 121), and an aggressive race became established in 1977 (Gambino *et al.* 1987, p. 170). In temperate climates, the western yellow jacket wasp has an annual life cycle, but in Hawaii's tropical climate, colonies of this species persist year round, allowing growth of large populations (Gambino *et al.* 1987, p. 170) and thus a greater impact on prey populations. Most colonies occur between 2,000 and 3,500 ft (600 and 1050 m) in elevation (Gambino *et al.* 1990, p. 1088), although they can also occur at sea level. The western yellow jacket wasp is known to be an aggressive, generalist predator and has been documented preying upon Hawaiian yellow-faced bee species (Gambino *et al.* 1987, p. 170; Wilson *et al.* 2009, p. 2). It has been suggested that the western yellow jacket wasp may compete for nectar with native Hawaiian invertebrates, but we have no information to suggest this represents a threat to the seven yellow-faced bees. Predation by the western yellow jacket wasp is a significant threat to the seven yellow-faced bee species because of the wasps' presence in habitat combined with the small number of occurrences and small population sizes of the Hawaiian yellow-faced bees.

Summary of Factor C

We are unaware of any information that indicates that disease is a threat to the 39 plant species. We are also unaware of any information that indicates that disease is a threat to the band-rumped storm-petrel, the orangeblack Hawaiian damselfly, or the anchialine pool shrimp, *Procaris hawaiana.* It has been suggested that transmission of disease from alien invertebrates by mutual flower visitation is a threat to the seven yellow-faced bees (*Hylaeus* spp.), but we currently have no evidence that this is occurring.

We consider predation and herbivory by one or more of the nonnative animal species (pigs, goats, axis deer, black-tailed deer, sheep, mouflon, cattle, rats, barn owls, cats, mongooses, fish, slugs, ants, black twig borers, and wasps) to pose an ongoing threat to 35 of the 39 plant species and to all 10 animal species throughout their ranges for the following reasons:

(1) Observations and reports have documented that pigs, goats, axis deer, black-tailed deer, sheep, mouflon, and cattle browse 27 of the 39 plant species, in addition to other studies demonstrating the negative impacts of ungulate browsing on native plant species of the islands. If the numbers and range of blackbuck antelope increase, their browsing will be a threat to native plants that occur on Molokai,

including host plants for the yellow-faced bees.

(2) Nonnative rats and slugs (either singly or combined) cause mechanical damage to plants and destruction of plant parts (branches, flowers, fruits, and seeds), and are considered a threat to 22 of the 39 plant species.

(3) Rats also prey upon adults, juveniles, and eggs of the band-rumped storm-petrel, and are linked with the dramatic decline of many closely related bird species. Because rats are found in all of the ecosystems in which the band-rumped storm-petrel occurs, we consider predation by rats to be a serious and ongoing threat.

(4) Barn owls and cats have established populations in the wild on all the main islands, and mongooses have established populations on all the main islands except for Kauai. All of these nonnative animals are known to prey on ground- and burrow-nesting seabirds. Predation by these animals is a serious and ongoing threat to the band-rumped storm-petrel.

(5) The absence of Hawaiian damselflies (including the orangeblack Hawaiian damselfly) from ponds, pools, and other aquatic habitat on the main Hawaiian Islands is strongly correlated with the presence of predatory nonnative fish; numerous observations and reports suggest nonnative predatory fishes eliminate native damselflies from these habitats. Accordingly, predation by nonnative fishes is a serious and ongoing threat to the orangeblack Hawaiian damselfly. Predation by bullfrogs, backswimmers, and Jackson's chameleons, and competition with caddisflies are threats to the orangeblack Hawaiian damselfly.

(6) Once introduced to anchialine pools, nonnative fish, through predation and competition for food sources, directly affect anchialine pool shrimp, including *Procaris hawaiana,* and also disrupt anchialine pool ecology.

(7) Damage and destruction by the black twig borer is a threat to two plant species, *Labordia lorenciana* and *Nothocestrum latifolium.*

(8) Predation by nonnative ants and wasps poses a threat to all seven yellow-faced bees.

These threats are serious and ongoing, act in concert with other threats to the species, and are expected to continue or increase in magnitude and intensity into the future without effective management actions to control or eradicate them. The effects of the combined threats suggest the need for immediate implementation of recovery and conservation methods.

Factor D. The Inadequacy of Existing Regulatory Mechanisms

Overview

Currently, no existing Federal, State, or local laws, treaties, or regulations specifically conserve or protect 48 of the 49 species (except the band-rumped storm-petrel by the Migratory Bird Treaty Act (MBTA; 16 U.S.C. 703–712)), or adequately address the threats to any of the 49 species (see Table 2). There are a few small programs and organizations that conduct vegetation monitoring and nonnative species and predator control, but these activities are nonregulatory, and neither continuation of these conservation efforts nor funding for them is guaranteed.

Federal laws pertaining to the 49 species addressed here include Executive Order (E.O.) 13112, the MBTA, the Lacey Act (16 U.S.C. 3371–3378; 18 U.S.C. 42–43), the Federal Noxious Weed List (7 CFR 360.200), and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The U.S. Department of Agriculture (USDA) inspects propagative and restricted plant materials and animals, and implements ''Special Local Needs'' rules for pesticide use, but only on a species-by-species basis. The Department of Homeland Security-Customs and Border Protection (CBP) is responsible for inspecting commercial, private, and military vessels and aircraft, and related cargo and passengers arriving from foreign locations. However, CBP focuses on quarantine issues involving non-propagative plant materials; wooden packing materials, timber, and products; internationally regulated commercial species under CITES; and federally listed noxious plants, seeds, soils, and pests of concern to the continental United States, such as pests to mainland U.S. forests and agriculture.

Hawaii State law regarding natural resource protections include those under Hawaii revised statutes (HRS): Plant and nondomestic animal quarantine and microorganism import (HRS 11–3–150A) and noxious weed control (HRS 11–3–152); flood control (HRS 12–2), water and land development (HRS 12–174), and State water code (HRS 12–2–174D); wildlife (general wildlife, hunting, game birds, game mammals, and wild birds and other wildlife) (HRS 12–4–183D); aquatic resources and wildlife-alien aquatic organisms (HRS 12–5–187A); general and miscellaneous, invasive species council (HRS 12–6–194); conservation of aquatic life, wildlife, and land plants (HRS 12–6–195D); and Natural Area Reserves (NARs) (HRS 12–6–195). These laws are interpreted and implemented under Hawaii administrative rules (HAR). Applicable HARs include: Noxious weed rules (HAR 4–6–68); plant and nondomestic animal quarantine, microorganism import rules (HAR 4–6-ch 71A, 71C), and plant intrastate rules (HAR4–6–72); rules regulating game mammal hunting (HAR 13–5–2-ch 123; indigenous wildlife, endangered and threatened wildlife, and introduced wild birds (HAR 13–5–2-ch 124); protection of instream uses of water (HAR 13–7-ch 169), and NARs system (HAR 13–9-ch 208–210).

Private and local programs that provide protections, and that help to implement Federal and State environmental regulations, laws, and rules for one or more of the 49 species, include the Hawaii Invasive Species Committee (HISC), the Coordinating Group on Alien Pest Species (CGAPS), and the Hawaii Association of Watershed Partnerships (HAWP). In addition, the Plant Extinction Protection Program (PEPP) was created to protect Hawaii's rare plant species in need of immediate conservation efforts, by monitoring, propagating, outplanting, and providing some protection from threats.

We discuss Federal and State regulatory mechanisms, along with agencies and groups authorized to implement them, and the coordination between them, below.

Federal Regulatory Mechanisms

On February 3, 1999, Executive Order (E.O.) 13112 was signed establishing the National Invasive Species Council (NISC). This E.O. requires that a Council of Departments dealing with invasive species be created to prevent the introduction of invasive species; provide for their control; and minimize the economic, ecological, and human health impacts that invasive species cause. Invasive species include aquatic plant and animal species, terrestrial plants and animal species, and plant and animal pathogens. This E.O. was reviewed in 2005 (NISC 2005). NISC uses a cooperative approach to enhance the Federal Government's response to the threat of invasive species, and emphasizes prevention, early detection and rapid response, and sharing of information. See our discussion below concerning the Hawaii Invasive Species Committee (HISC) regarding the effectiveness of this law.

The MBTA is the domestic law that implements the United States' commitment to four international conventions (with Canada, Japan, Mexico, and Russia) for the protection of shared migratory bird resources. The MBTA regulates most aspects of take, possession, transport, sale, purchase, barter, export, and import of migratory birds and prohibits the killing, capturing, and collecting of individuals, eggs, and nests, unless such action is authorized by permit. While the MBTA does prohibit actions that directly kill a covered species, unlike the Endangered Species Act (Act), it does not prohibit habitat modification that indirectly kills or injures a covered species, affords no habitat protection when the birds are not present, and provides only very limited mechanisms for addressing chronic threats to covered species, such as nonnative predators.

The Lacey Act authorizes the Secretary of the Interior to list as ''injurious'' any wildlife deemed to be harmful to human beings, to the interests of agriculture, horticulture, forestry, or to wildlife or the wildlife resources of the United States. The Service inspects arriving wildlife products, and enforces the injurious wildlife provisions of the Lacey Act. Among other provisions, the Lacey Act prohibits importation of injurious mammals, birds, fish, amphibians and reptiles listed in the Lacey Act or which are declared by the Secretary of the Interior through regulation to be injurious to human beings, agriculture, horticulture, forestry or wildlife; however, these prohibitions do not apply to plants and organisms other than those listed or designated by regulations as injurious wildlife (USFWS 2016, in litt.). The current list of animals considered as ''injurious wildlife'' is provided at 50 CFR part 16. The list includes fruit bats, mongoose, European rabbits and hares, wild dogs, rats or mice, raccoon dogs, brushtail possum (the species introduced to New Zealand), starlings, house sparrows, mynas, dioch, Java sparrows, red whiskered bulbuls, walking catfish, mitten crabs, zebra mussels, fish in the snakehead family, four species of carp, salmonids, brown tree snakes, and pythons (USFWS 2012, 50 CFR part 16). The Lacey Act requires declarations of importation only for formal entries (*i.e.,* commercial shipments), but not for informal entries (*i.e.,* personal shipments) (USDA–APHIS 2015, in litt.). Additionally, a species may still be imported or transported across State lines while it is being considered for addition to the list of ''injurious wildlife'' (Fowler *et al.* 2007, pp. 357–358). Mongoose, rabbits, rats, mice, house sparrows, mynas, Java sparrows, and red whiskered bulbuls are already established in Hawaii, are difficult and costly to control, or are not controlled at all. None of the aquatic species on the injurious species list is present in Hawaii.

The continued spread of injurious species indicates the limited effectiveness of the Lacey Act in preventing introductions of such species to the State (Fowler *et al.* 2007, p. 357). As an example of continued introduction of nonnative species in Hawaii, opossums (*Didelphis virginiana*) have been found in shipping containers on Oahu in 2005, 2011, and most recently in 2015 (Star Advertiser 2015b, in litt). This species is not included on the Lacey Act's list of injurious wildlife. Opossums are omnivorous scavengers, consuming a wide variety of food items including insects, small vertebrates, bird eggs, slugs and snails, and fruits and berries (Oregon Department of Fish and Wildlife 2015, in litt.; Clermont College 2015, in litt.). If opossums were to establish wild populations in Hawaii, their predation on ground-nesting seabirds, insects, and snails could negatively affect the band-rumped storm petrel, the orangeblack Hawaiian damselfly, one or more of the 39 plants, and endangered snail species.

The Department of Agriculture-Animal and Plant Health Inspection Service-Plant Protection and Quarantine (USDA–APHIS–PPQ) inspects propagative plant material, provides identification services for arriving plants and animals, conducts pest risk assessments, and other related matters, but focuses on pests of wide concern across the United States (HDOA 2009, in litt.). The USDA–APHIS–PPQ's Restricted Plants List restricts the import of a limited number of noxious weeds. If not specifically prohibited, current Federal regulations allow plants to be imported from international ports with some restrictions. The Federal Noxious Weed List (see 7 CFR 360.200; USDA 2012) includes more than 100 of the many globally known invasive plants, 21 of which are already established in Hawaii. Plants on the list do not require a weed risk assessment prior to importation from international ports.

A local organization (under the Institute of Pacific Islands Forestry-USFS), Pacific Island Ecosystems at Risk (PIER) has compiled a complete list of those plant species that are a threat to ecosystems in the Pacific Islands, and those that are potentially invasive and are present in the Pacific Region, along with a weed-risk assessment for most of them (*http://www.hear.org/pier/,* last updated May 15, 2013). There are over 1,000 plant species on the PIER list, and, in our proposed rule (80 FR 58820, September 30, 2015; see pp. 58869–58881), we discuss 114 of these invasive plants that currently have the greatest impacts on the 49 species. In addition, the USDA–APHIS–PPQ is in the process of finalizing rules to include a weed risk assessment for plants newly imported to Hawaii (and that may not yet appear on the PIER list).

Water extraction is a threat to the plant species (*Cyclosorus boydiae*), the orangeblack Hawaiian damselfly, and the anchialine pool shrimp *Procaris hawaiana.* The U.S. Army Corps of Engineers (COE) has regulatory jurisdiction under section 404 of the Clean Water Act (33 U.S.C. 1251 *et seq.*) for activities that would result in a discharge of dredged or fill material into waters of the United States; however, in issuing permits for such activities, the COE does not typically establish minimal instream flow standards (IFS) as a matter of policy (U.S. Army 1985, RGL 85–6).

State Regulatory Mechanisms

The Hawaii Endangered Species law (HRS 195D) prohibits take, possession, sale, transport or commerce in designated species. This includes aquatic as well as terrestrial animal species, and terrestrial plants (not freshwater or marine plants). This State law also recognizes as endangered or threatened those species determined to be endangered or threatened pursuant to the Act. This Hawaii law states that a threatened species (under the Act) or an indigenous species may be determined to be an endangered species under State law. Protection of these species is under the authority of Hawaii's Department of Land and Natural Resources, and under administrative rule (HAR 13–5–2-Ch 124). Although this State law can address threats such as habitat modification, light attraction, and line collision through HCPs that address the effects of individual projects or programs, it does not address the pervasive threats to the 49 species posed by nonnative predators and feral ungulates.

The importation of nondomestic animals, including aquatic species and microorganisms, is regulated by a permit system (HAR 4–71) managed through the Hawaii Department of Agriculture (HDOA). In addition, transport of plants and plant parts between Hawaiian Islands is managed through the HDOA (HAR 4–6–72), but only for those species that have already been determined to be pest species. The objective of these administrative rules is to implement the requirements of HRS 11–3–150A. The list of nondomestic animals (HAR 4–71) is defined by providing a list of those animals considered domestic: dog, cat, horse, ass (burro or donkey), cattle and beefalo, sheep, goat, swine, pot-bellied pig, alpaca, llama, rabbit, chicken, turkeys, pigeons, ducks, geese, and their hybrids. Examples of regulated pests are listed at HAR 4–72, including nonnative insects, slugs, insects, plants, and plant viruses that can damage or harm commercial crops. The HDOA's Board of Agriculture maintains lists of nondomestic animals that are prohibited from entry, animals without entry restrictions, or those that require a permit for import and possession. The HDOA requires a permit to import animals, and conditionally approves entry for individual possession, businesses (*e.g.,* pets and resale trade, retail sales, and food consumption), or institutions. However, habitat destruction and modification, and predation, by feral domestic animals (such as goat and cats, respectively) are two primary threats to the 49 species not addressed by the HDOA prohibitions and permitting process.

The State of Hawaii allows importation of most plant taxa, with limited exceptions, if shipped from domestic ports (HLRB 2002; USDA–APHIS–PPQ 2010; CGAPS 2009). Hawaii's plant import rules (HAR 4–70) regulate the importation of 13 plant taxa of economic interest, including pineapple, sugarcane, palms, and pines. Certain horticultural crops (*e.g.,* orchids) may require import permits and have pre-entry requirements that include treatment or quarantine or both either prior to or following entry into the State.

Critical biosecurity gaps include inadequate staffing, facilities, and equipment for Federal and State inspectors devoted to invasive species interdiction (HLRB 2002; USDA–APHIS–PPQ 2010; CGAPS 2009). In recognition of these gaps, a State law has been passed that allows the HDOA to collect fees for quarantine inspection of freight entering Hawaii (Act 36 (2011) HRS 150A–5.3). Legislation enacted in 2011 (H.B. 1568) requires commercial harbors and airports to provide biosecurity and inspection facilities to facilitate the movement of cargo through ports. This bill is a significant step toward optimizing biosecurity capacity in the State, but only time will determine its effectiveness (Act 2011 (11)). We believe there is a need for all civilian and military port and airport operations and construction to make biosecurity concerns a core objective.

As an example, the threat of introduction of nonnative species is evidenced by the 2013 discovery of presence of the nonnative coconut rhinoceros beetle (CRB, *Oryctes rhinoceros*), which quickly spread from its known point of introduction across the island of Oahu in a few months (HISC 2014, in litt. + maps; HDOA 2014, in litt.). The CRB is considered one of the most damaging insects to coconut and African oil palm trees in southern and southeast Asia, as well as the western Pacific Islands, and could devastate populations of native and nonnative palm trees in Hawaii (Giblin-Davis 2001 *in* HISC 2014, in litt.). A rapid response team headed by HDOA (with USDA, University of Hawaii, U.S. Navy, and other partners) has set up pheromone traps island-wide, and capture and range delineation efforts are ongoing, along with funding for support services to control the CRB (HISC 2014, in litt.). However, existing regulatory mechanisms did not prevent the introduction of this pest species into Hawaii. These regulatory mechanisms, such as HAR 71A and HAR 71C (regarding release of nonnative species) and H.B. 1568 (pertaining to State law to enforce biosecurity measures), therefore, are inadequate to prevent introduction of nonnative species. Efforts to control the CRB continue, but whether those efforts will be effective is unknown at this time.

Hawaii's noxious weed law was enacted to prevent the introduction and transport of noxious weeds or their seeds or vegetative reproductive parts into any area that is reasonably free of those noxious weeds (HRS 11–3–152), and it states that the Hawaii Department of Agriculture shall take necessary measures to restrict the introduction and establishment of specific noxious weeds in such areas. Hawaii administrative rule (HAR 4–6–68) further defines the term ''noxious weed'' and the criteria for designation of plants as such and criteria for designation of a noxious weed ''free area.'' The list of noxious weeds, compiled in 1992, consists of 79 plant species, 49 of which were not yet established in Hawaii. Since that time, 20 species on the list have become established in Hawaii: *Bocconia frutescens* (plume poppy), *Cereus uruguayanus* (spiny tree cactus), *Chromolaena odorata* (siamweed), *Cortaderia jubata* (Andean pampas grass), *Cytisus scoparius* (Scotch broom), *Hyptis suaveolens* (wild spikenard), *Malachra alceifolia* (malachra), *Melastoma* spp. (melastoma; two species now established, *M. candidum* and *M. sanguineum*), *Miconia* spp. (miconia; *M. calvescens* now on four islands), *Passiflora pulchella* (wingleaf passionfruit), *Piper aduncum* (spiked pepper), *Prosopis juliflora* (algarroba), *Pueraria phaseoloides* (tropical kudzu), *Rubus sieboldii* (Molucca raspberry), *Senecio madagascariensis* (fireweed), *Solanum elaeagnifolium* (silverleaf nightshade), *Solanum robustum* (shrubby nightshade), *Solanum torvum* (turkeyberry), and *Spartium junceum* (Spanish broom). Thus, despite State legislation and regulations addressing invasive and noxious species, their entry into the State continues.

The State manages the use of surface and ground water resources through the Commission on Water Resource Management (CWRM), as mandated by the State Water Code (HRS 174, HAR 13–168–196). The State considers all natural flowing surface water (streams, springs, seeps) as State property (HRS 174C), and the DLNR has management responsibility for the aquatic organisms in these waters (HRS Annotated 1988, Title 12 1992 Cumulative Supplement). In Hawaii, instream flow is regulated by establishing standards on a stream-by-stream basis. The standards currently in effect represent flow conditions in 1987 (status quo), the year the administrative rules (State Water Code) were adopted (HRS 174C–71, HAR title 13, ch 169–44–49). Because of the complexity of establishing instream flow standards (IFS) for 376 perennial streams, the Commission retains interim IFS at status quo levels as set in 1987 (CWRM 2009, in litt.; CRWM 2014, in litt). In the Waiahole Ditch Combined Contested Hearing on Oahu (1991–2006), the Hawaii Supreme Court determined that status quo interim IFS were not adequate, and required the Commission to reassess the IFS for Waiahole Ditch and other streams Statewide (Cast No. CCH–OA95–1; Maui Now.com, in litt.). The Commission has been gathering information to fulfill this requirement since 2006, but no IFS recommendations have been made to date (CWRM 2008, p. 3–153; CRWM 2014, in litt.).

In addition, in the Hawaii Stream Assessment Report (HDLNR 1990; prepared in coordination with the National Park Service (NPS)), the Commission identified high-quality rivers and streams (and portions thereof) that may be placed within a Wild and Scenic River System. This report ranked 70 out of 176 analyzed rivers and streams as outstanding high-quality habitat, and recommended that streams meeting certain criteria be protected from further development (HDLNR 1990, pp. xxi–xxiv). However, there is no mechanism within the State's Water Code to designate and set aside these streams, or to identify and protect stream habitat. Accordingly, damselfly populations (including the orangeblack Hawaiian damselfly) are at risk of continued loss of habitat.

Hawaii's DLNR Division of Aquatic Resources (DAR) is responsible for conserving, protecting, and enhancing the State's renewable resources of aquatic life and habitat (HDAR 2015, in litt.; DLNR–DAR 2003, p. 3–13). The release of live nonnative fish or other nonnative aquatic life into any waters of the State is prohibited (HRS 187A–6.5), and DAR has the authority to seize, confiscate, or destroy as a public nuisance any of these prohibited species (HRS 187A–2; HRS 187A–6.5). However, the DAR recognizes that nonnative species continue to enter the State and move between islands (DLNR–DAR 2003, p. 2–12).

There are no existing regulatory mechanisms that specifically protect Hawaii's anchialine pools (habitat for the anchialine pool shrimp *Procaris hawaiana* and the orangeblack Hawaiian damselfly); however 2 anchialine pools on Maui and 12 anchialine pool on Hawaii Island are located within State NARs. State NARs were created to preserve and protect samples of Hawaii's ecosystems and geological formations, and are monitored. Designation as a State NAR prohibits the removal of any native organism and the disturbance of pools (HAR 13–209–4). Though signs are posted at NARs to notify the public that anchialine pools are off-limits to bathers, off-road vehicle use around the pools, and other activities, the anchialine pools are in remote areas and the State does not have sufficient funding to effectively enforce those restrictions.

Nonnative ungulates pose threats of habitat destruction and modification and predation (herbivory) to 37 of the 39 plants species, and of habitat destruction and modification to 9 of the 10 animals in this rule (see Table 2). The State provides opportunities to the public to hunt game mammals (ungulates including feral pigs and goats, axis deer, black-tailed deer, and mouflon, sheep and mouflon-sheep hybrids) on 91 State-designated public hunting areas (within 45 units) on all the main Hawaiian Islands except Kahoolawe and Niihau (HAR–DLNR 2010, 13–123; HDLNR 2009b, pp. 25–30). On Niihau, public hunting opportunities are managed by a private business (Niihau Safaris Inc. 2015, in litt.). The State's management objectives for game mammals range from maximizing public hunting opportunities (*i.e.,* ''sustained yield'') in some areas to removal by State staff or their designees from other areas (HAR–DLNR 2010, p. 12–123; HDLNR 2009b, pp. 25–30). Thirty of the 39 plant species, the band-rumped storm-petrel, the orangeblack Hawaiian damselfly, and three yellow-faced bees have populations in areas where habitat is used for game enhancement and game populations are maintained at levels for public hunting (Holmes and Joyce 2009, 4 pp.; HAR–DLNR 2010, p. 12–123; HBMP 2010). Public hunting areas are defined, but not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land-use designation. While fences are sometimes built to protect areas from game mammals, the current number and locations of fences are not adequate to prevent habitat destruction and modification for 46 of the 49 species. One additional State regulation (HRS 12–183D) was enacted recently to prevent intra-island transport of axis deer only. There are no other State regulations than those described above that address protection of the species and their habitat from feral ungulates.

Under statutory authorities provided by HRS title 12, subtitle 4, 183D Wildlife, the DLNR maintains HAR ch 124 (2014), which defines ''injurious wildlife'' as ''any species or subspecies of animal except game birds and game mammals which is known to be harmful to agriculture, aquaculture, indigenous wildlife or plants, or constitute a nuisance or health hazard and is listed in the exhibit entitled Exhibit 5, Chapter 13–124, List of Species of Injurious Wildlife in Hawaii.'' Under HAR 13–124–3(d), ''no person shall, or attempt to: (1) Release injurious wildlife into the wild; (2) Transport them to island or locations within the State where they are not already established and living in a wild state; and (3) Export any such species or the dead body or parts thereof, from the State. Permits for these actions may be considered on a case-by-case basis.'' This law was enacted after an incident in 2012 of interisland transport of axis deer (for hunting purposes) to Hawaii Island, which was without axis deer previously.

Local Mechanisms

Local biologists and botanists recognize the urgent need to address the importation of nonnative, invasive species, and are working to implement actions required; however, their funding is not guaranteed. We discuss the four primary groups below.

In 1995, the Coordinating Group on Alien Pest Species (CGAPS), a partnership of managers from Federal, State, County, and private agencies and organizations involved in invasive species work in Hawaii, was formed in an effort to coordinate policy and funding decisions, improve communication, increase collaboration, and promote public awareness (CGAPS 2009). This group facilitated the formation of the Hawaii Invasive Species Council (HISC), which was created by gubernatorial executive order in 2002, to coordinate local initiatives for the prevention of introduction and for control of invasive species by providing policy-level direction and planning for the State departments responsible for invasive species issues (CGAPS 2009). In 2003, the Governor signed into law Act 85, which conveys statutory authority to the HISC to continue to coordinate approaches among the various State and Federal agencies, and international and local initiatives, for the prevention and control of invasive species (HDLNR 2003, p. 3–15; HISC 2009, in litt.; HRS 194–2). Some of the recent priorities for the HISC include interagency efforts to control nonnative species such as the plants *Miconia calvescens* (miconia) and *Cortaderia* spp. (pampas grass), coqui frogs (*Eleutherodactylus coqui*), the CRB, and ants (HISC 2009, 2013, and 2015, in litt.; OISC 2015, in litt.; *http://dlnr.hawaii.gov/hisc*). Budget cuts beginning in 2009 restricted State funding support of HISC, resulting in a serious setback of conservation efforts (HISC 2009; HISC 2015).

The Hawaii Association of Watershed Partnerships comprises 11 separate partnerships on six Hawaiian Islands. These partnerships are voluntary alliances of public and private landowners, ''committed to the common value of protecting forested watersheds for water recharge, conservation, and other ecosystem services through collaborative management'' (*http://hawp.org/partnerships*). Funding for the partnerships is provided through a variety of State and Federal sources, public and private grants, and in-kind services provided by the partners and volunteers. However, budget cuts of 40 to 60 percent have occurred since 2009, with serious impacts to the positive contributions of these groups to implementing the laws and rules that can protect and control threats to one or more of the 49 species.

Another group was established to coordinate State and Federal agency efforts in the protection of rare endemic plant species in the State and Guam and the Commonwealth of the Northern Mariana Islands (CNMI), Hawaii's Plant Extinction Prevention Program (PEPP). This program identifies and supports the ''rarest of the rare'' plant species in need of immediate conservation efforts. The goal of PEPP is to prevent the extinction of plant species that have fewer than 50 individuals remaining in the wild.

These four partnerships, CGAPS, HISC, HAWP, and PEPP, are stop-gap measures that attempt to address issues that are not resolved by individual State and Federal agencies. The capacity of State and Federal agencies and their nongovernmental partners in Hawaii to provide sufficient inspection services, enforce regulations, and mitigate or monitor the effects of nonnative species is limited due to the large number of taxa currently causing damage (CGAPS 2009). Many invasive, nonnative species established in Hawaii currently have limited but expanding ranges, and they cause considerable concern. Resources available to reduce the spread of these species and counter their negative effects are limited. Control efforts are focused on a few invasive species that cause significant economic or environmental damage to commercial crops and public and private lands. Comprehensive control of an array of nonnative species and management to reduce disturbance regimes that favor them remain limited in scope. If current levels of funding and regulatory support for control of nonnative species are maintained, the Service expects existing programs to continue to exclude, or, on a very limited basis, control these species only in the highest priority areas. Threats from established nonnative species are ongoing and are expected to continue into the future.

As an example of current and future challenges for biosecurity in Hawaii, a strain of the plant rust *Puccinia psidii* (ohia rust) was first noticed affecting stands of the nonnative rose apple (*Syzygium jambos*) and the native *Metrosideros* (ohia) seedlings (both in the plant family Myrtaceae) in nurseries in 2005. *Metrosideros* spp. are a dominant component of native forest in Hawaii, providing watershed protection and habitat for native wildlife. The Hawaii Board of Agriculture recommended a quarantine rule be passed against the introduction of all new strains of ohia rust (through transmission on Myrtaceae species used in the horticulture trade), to prevent destruction of ohia forests and the risk to agriculture and horticulture industries (Environment Hawaii 2015, pp. 1,8–9). However, the rule remains in draft form and under review (HDOA 2015, in litt.), accessed August 1, 2016). An example of the failure of biosecurity in Hawaii and the speed with which a new invader can cause widespread destruction is the introduction of the gall wasp *Quadrastichus erythrinae.* This highly destructive wasp was detected in Taiwan in 2003. Despite evidence of its rapid advance across the Pacific Basin with concomitant loss of populations of native and ornamental trees in the genus *Erythrina,* this wasp arrived and naturalized in Hawaii in 2005 (Gramling 2005, p. 1). The wasp dispersed throughout the main Hawaiian Islands within weeks, and as a result, the endemic wiliwili, *Erythrina sandwicensis,* was quickly devastated (Rubinoff *et al.* 2010, p. 24).

On the basis of the information provided above, existing State and Federal regulatory mechanisms are not preventing the introduction of nonnative species and pathogens into Hawaii via interstate and international pathways, or via intrastate movement of nonnative species between islands and watersheds. Nor do these mechanisms address the current threats posed to the 49 species by established nonnative species. Therefore, State and Federal regulatory mechanisms do not adequately protect the 49 species, or their habitats, from the threat of new introductions of nonnative species or the continued expansion of nonnative species populations on and between islands and watersheds. The impacts from these threats are ongoing and are expected to continue into the future.

Summary of Factor D

Existing State and Federal regulatory mechanisms are not preventing the introduction into Hawaii of nonnative species or controlling the spread of nonnative species between islands and watersheds, or establishing or maintaining instream flow standards. Water extraction is a threat to one plant, *Cyclosorus boydiae,* to the orangeblack Hawaiian damselfly, and the anchialine pool shrimp (Factor A). Habitat-altering ungulates and nonnative plants (Factor A) pose major ongoing threats to all 49 species addressed in this rule. Thirty-five of the 39 plants and all 10 animals experience the threat of predation or herbivory by nonnative animals (Factor C). The seven yellow-faced bees and the orangeblack Hawaiian damselfly experience competition with nonnative insect species (Factor E). The intentional or inadvertent introduction of nonnative species and their spread within Hawaii, and the damage caused by existing populations of nonnative species, continues despite existing regulatory mechanisms designed to address this threat (in all its manifestations described above) to all 49 species. No existing regulatory mechanisms effectively address maintenance of instream flow, springs, seeps, and anchialine pools or address the threats of water extraction and stream modification for the anchialine pool shrimp and orangeblack Hawaiian damselfly. All of these threats are ongoing and are expected to continue into the future; therefore, we conclude the existing regulatory mechanisms are inadequate to reduce or eliminate these threats to the 49 species.

Factor E. Other Natural or Manmade Factors Affecting Their Continued Existence

Other factors that pose a threat to some or all of the 49 species include artificial lighting and structures, ingestion of marine debris and plastics, dumping of trash and the introduction of nonnative fish into anchialine pools, recreational use of and sedimentation of anchialine pools, low numbers of individuals and populations, hybridization, lack of or declining regeneration, competition with nonnative invertebrates, and loss of host plants. Each threat is discussed in detail below, along with identification of which species are affected by these threats. The impacts of climate change to these species and their ecosystems have the potential to exacerbate all of the threats described below.

Artificial Lighting and Structures Effects on the Band-Rumped Storm-Petrel

Artificial lights are a well-documented threat to night-flying seabirds such as petrels, shearwaters, and storm-petrels (Croxall *et al.* 2012, p. 28). A significant impact to the band-rumped storm-petrel results from the effects of artificial (night) lighting on fledglings and, to a lesser degree, on adults. Lighting of roadways, resorts, ballparks, residences, and other development, as well as on cruise ships out at sea, both attracts and confuses night-flying storm-petrels and other seabirds (Harrison *et al.* 1990, p. 49; Reed *et al.* 1985, p. 377; Telfer *et al.* 1987, pp. 412–413; Banko *et al.* 1991, p. 651). Storm-petrels use the night sky to navigate and possibly to search for bioluminescent marine prey (Telfer *et al.* 1987, p. 412). Artificial lights can attract night-flying seabirds and result in ''fallout'' (birds becoming grounded) when birds become confused and exhaust themselves circling around lights or collide with buildings, powerlines, or other structures. Once grounded, these birds are at risk of predation or being run over by cars (Reed *et al.* 1985, p. 377; Telfer *et al.* 1987, p. 410). Vulnerability to artificial lighting varies among species and age classes and is influenced by season, lunar phase, and weather conditions.

Young birds are more likely than adults to become disoriented by manmade light sources (Montevecchi 2006, pp. 101–102). Over a 12-year period (1978 to 1990), Harrison *et al.* (1990, p. 49) reported that 15 band-rumped storm-petrels, 13 of which were fledglings, were recovered on Kauai as a result of fallout. Between 1991 and 2008, another 21 band-rumped storm-petrels were collected on Kauai (Holmes and Joyce 2009, p. 2). Currently, fallout due to light pollution is recorded almost annually on Kauai (Kauai Island Utility Cooperative 2015, in litt.). In addition, band-rumped storm-petrels may be attracted to lights at sea and collide with boats; this source of injury and mortality has been documented for other storm-petrel species (*e.g.,* Black 2005, p. 67). The actual extent of such loss and its overall impact on the band-rumped storm-petrel population in Hawaii is not known because scavengers often prevent the detection or recovery of the dead or injured birds, and the scattered and remote nesting areas of this species preclude demographic monitoring to quantify the impacts of this source of mortality. However, given the probable small total number of band-rumped storm-petrels nesting in Hawaii and the threats they face from nonnative predators such as rats and cats, any additional mortalities are likely to have negative impacts on the population.

A related threat to seabirds in Hawaii, including the band-rumped storm-petrel, is collision with structures such as communication towers and utility lines (Cooper and Day 1998, pp. 16–18; Podolsky *et al.* 1998, pp. 23–33). Several seabird species that nest in the Hawaiian Islands, including the Newell's Townsend's shearwater (federally listed as threatened), the Hawaiian petrel (federally listed as endangered), and the band-rumped storm-petrel, regularly commute between inland nest sites and the ocean. These birds commute at night, when manmade obstacles such as communication towers and utility lines are difficult to see. They strike these unseen obstacles, and often die or are injured as a result. An early study estimated that 340 Newell's Townsend's shearwater fledglings die annually on the eastern and southern shores of Kauai as a result of collisions (Podolsky *et al.* 1998, p. 30); however, current analyses for all seabirds on Kauai indicate the number of collisions with utility lines is much higher, over 2,000 strikes per year (using site-specific strike rates), but numbers of birds that hit utility lines is site-dependent (Travers *et al.* 2014, pp. 19, 29–37; Service 2015, in litt., Slide 21). Absent preventative measures, the impact to the band-rumped storm-petrel from artificial lighting and collisions with structures is expected to increase as the human population grows and development continues on the Hawaiian Islands.

Other Human Effects on the Band-Rumped Storm-Petrel

Other factors that may negatively affect the band-rumped storm-petrel include commercial fisheries interactions and alteration of prey base upon which the band-rumped storm-petrel depends. Commercial fisheries are known to adversely affect certain species of seabirds (Furness 2003, pp. 33–35). Seabirds are caught in fishing gear and suffer mortality by drowning. Seabirds also come into contact with and consume deep-water fish to which they would not normally have access, and can become contaminated by high levels of heavy metals in these fish (Furness 2003, p. 34). Commercial fisheries also cause depletion of small pelagic schooling fish, a significant food source for seabirds (Furness 2003, p. 34). The potential effects of these activities have not been assessed for the band-rumped storm-petrel; however, storm-petrels have been observed to attend fishing vessels (*e.g.,* Yorio and Caille 1999, p. 21; Yeh *et al.* 2013, p. 146), and the effects of fishery interactions on this species are likely to be similar to those documented for other seabird species in the same order (Procellariiformes or tubenoses; albatrosses and petrels). In addition, plastics and other debris in the open ocean can be ingested accidentally by band-rumped storm-petrels and pose a threat to this species (Ryan 1989, p. 629). Although a study by Moser and Lee (1992, p. 85) found no evidence of plastic ingestion by band-rumped storm-petrels, the sample size was very small (4 individuals) and inadequate to conclusively determine whether this species suffers from ingestion of plastics. Other species of storm-petrels have been documented to ingest plastics (Bond and Lavers 2013, p. 3; Ryan 2015, p. 20; Wilcox *et al.* 2015, p. 3), and band-rumped storm-petrels are likely to do so also. Many closely related seabirds do suffer ill effects from ingestion of plastics, including physical damage to the digestive tract, effects of toxins carried on the plastics, and resulting mortality (Ryan 1989, pp. 623–629; Tanaka *et al.* 2013, pp. 2–3).

Effects of Recreational Use, and Dumping of Trash and Nonnative Fish Into Anchialine Pools

On Hawaii Island, it is estimated that up to 90 percent of the anchialine pools have been destroyed or altered by human activities (Brock 2004, p. i). The more recent human modification of anchialine pools includes bulldozing and filling of pools (Bailey-Brock and Brock 1993, p. 354). Trampling damage from use of anchialine pools for swimming and bathing has been documented (Brock 2004, pp. 13–17). Historically, pools were sometimes modified with stone walls and steps by Hawaiians who used them for bathing. There are no documented negative impacts to pond biota as a result of this activity; however, introduction of soaps and shampoos is of concern (Brock 2004, p. 15).

The depressional features of anchialine pools make them susceptible to dumping. Refuse found in degraded pools and pools that have been filled with rubble have been dated to about 100 years old, and the practice of dumping trash into pools continues today (Brock 2004, p. 15). For example, Lua O Palahemo (Hawaii Island) is located approximately 560 ft (170 m) from a sandy beach frequented by visitors who fish and swim. There are multiple dirt roads that surround the pool making it highly accessible. Plastic bags, paper, fishing line, water bottles, soda cans, radios, barbed wire, and a bicycle have been documented within the pool (Kensley and Williams 1986, pp. 417–418; Bozanic 2004, p. 1; Wada 2010, in litt.). Introduction of trash involving chemical contamination into anchialine pools, as has been observed elsewhere on Hawaii Island (Brock 2004, pp. 15–16), drastically affects water quality and results in local extirpation of anchialine pool shrimp species.

Anchialine pool habitats can gradually disappear when wind-blown materials accumulate through a process known as senescence (Maciolek and Brock 1974, p. 3; Brock 2004, pp. 11, 35–36). Conditions promoting rapid senescence include an increased amount of sediment deposition, good exposure to light, shallowness, and a weak connection with the water table, resulting in sediment and detritus accumulating within the pool instead of being flushed away with tidal exchanges and ground water flow (Maciolek and Brock 1974, p. 3; Brock 2004, pp. 11, 35–36). Sedimentation degrades the health of Hawaiian anchialine pool systems in which the anchialine pool shrimp, *Procaris hawaiana,* and the orangeblack Hawaiian damselfly occur.

In general, the accidental or intentional introduction and spread of nonnative fishes (bait and aquarium fish) is considered the greatest threat to anchialine pools in Hawaii (Brock 2004, p. 16). Maciolek (1983, p. 612) found that the abundance of shrimp in a given population is indirectly related to predation by fish. Lua O Palahemo is vulnerable to the intentional dumping of nonnative bait and aquarium fishes because the area is accessible to vehicles and human traffic, although due to its remote location, it is not monitored regularly by State agency staff. The release of mosquito fish and tilapia into the Waikoloa Anchialine Pond Preserve (WAAPA) at Waikoloa, North Kona, Hawaii, resulted in the infestation of all ponds within an approximately 3-ha (8-ac) area, which represented about two-thirds of the WAAPA. Within 6 months, all native hypogeal (subterranean) shrimp species disappeared (Brock 2004, p. iii). Nonnative fish drive anchialine species out of the lighted, higher productivity portion of the pools, into the surrounding water table bed rock, subsequently leading to the decimation of the benthic community structure of the pool (Brock 2004, p. iii). In addition, nonnative fish prey on and exclude native hypogeal shrimp that are usually a dominant and essential faunal component of anchialine pool ecosystems (Brock 2004, p. 16; Bailey-Brock and Brock 1993, pp. 338–355). The loss of the shrimp changes ecological succession by reducing herbivory of macroalgae, allowing an overgrowth and change of pool flora. This overgrowth changes the system from clear, well-flushed basins to a system characterized by heavy sedimentation and poor water exchange, which increases the rate of pool senescence (Brock 2004, p. 16). Nonnative fishes, unlike native fishes, are able to complete their life cycles within anchialine pool habitats, and remain a permanent detrimental presence in all pools in which they are introduced (Brock 2004, p. 16). In Hawaii, the most frequently introduced fishes are those in the Poeciliidae family (freshwater fish which bear live young) and include mosquito fish, various mollies (*Poecilia* spp.), and tilapia, that prey on and exclude the herbivorous aquatic animals upon which *Procaris hawaiana* feeds. More than 90 percent of the 600 to 700 anchialine habitats in the State of Hawaii were degraded between 1974 and 2004, due to the introduction of nonnative fishes (Brock 2004, p. 24). According to Brock (2012, pers. comm.), sometime in the 1980s, nonnative fishes were introduced into Lua O Palahemo. It is our understanding that the fish were subsequently removed by illegal use of a fish poison (EPA 2007. pp. 22–23; Finlayson *et al.* 2010, p. 2), and to our knowledge the pool is currently free of nonnative fish; however, nonnative fish could be introduced into the pool at any time.

Low Numbers of Individuals and Populations

Species that undergo significant habitat loss and degradation, and other threats resulting in population decline, range reduction, and fragmentation, are inherently highly vulnerable to extinction because of localized catastrophes such as hurricanes, floods, rockfalls, landslides, treefalls, and drought; climate change impacts; demographic stochasticity; and the increased risk of genetic bottlenecks and inbreeding depression (Gilpin and Soulé 1986, pp. 24–34). These conditions are easily reached by island species and especially species endemic to single islands that face numerous threats such as those described above (Pimm *et al.* 1988, p. 757; Mangel and Tier 1994, p. 607). Populations that have been diminished and isolated by habitat loss, predation, and other threats exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Very small, isolated plant populations are also more susceptible to reduced reproductive vigor due to ineffective pollination, inbreeding depression, and hybridization. This is particularly true for functionally unisexual plants like *Myrsine fosbergii* of which some individuals are functionally dioecious (male and female flowers occur on separate individuals). Isolated individuals have difficulty in achieving natural pollen exchange, which decreases the production of viable seed. Populations are also affected by demographic stochasticity, through which populations are skewed toward either male or female individuals by chance. The problems associated with small occurrence size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by interactions with other threats, such as those discussed above (see Factor A and Factor C, above).

Plants

The effects resulting from having a reduced number of individuals and occurrences poses a threat to all 39 plant species addressed in this proposal. We consider the following 19 species to be especially vulnerable to extinction due to threats associated with small occurrence size or small number of occurrences because:

- The only known occurrences of *Cyanea kauaulaensis, Labordia lorenciana, Lepidium orbiculare,* and *Phyllostegia helleri* are threatened either by landslides, rockfalls, treefalls, drought, or erosion, or a combination of these factors.
- *Cyanea kauaulaensis, Cyrtandra hematos, Gardenia remyi, Joinvillea ascendens* ssp. *ascendens, Labordia lorenciana, Nothocestrum latifolium,* and *Ochrosia haleakalae* numbers are declining, and they have not been observed regenerating in the wild.
- The only known wild individuals of *Cyperus neokunthianus, Kadua haupuensis,* and *Stenogyne kaalae* ssp. *sherffii* are extirpated; there is one remaining individual of *Deparia kaalaana,* and only three individuals of *Phyllostegia brevidens. Kadua haupuensis* and *Stenogyne kaalae* ssp. *sherffii* only exist in propagation.
- The following single-island endemic species are known from fewer than 250 individuals: *Asplenium diellaciniatum, Cyanea kauaulaensis, Cyperus neokunthianus, Cyrtandra hematos, Dryopteris glabra* var. *pusilla, Hypolepis hawaiiensis* var. *mauiensis, Kadua haupuensis, Labordia lorenciana, Lepidium orbiculare, Phyllostegia helleri, Pritchardia bakeri, Santalum involutum, Stenogyne kaalae* ssp. *sherffii,* and *Wikstroemia skottsbergiana.*

Animals

Like most native island biota, the Hawaiian population of band-rumped storm-petrel, the orangeblack Hawaiian damselfly, the anchialine pool shrimp (*Procaris hawaiana*), and the seven yellow-faced bees are particularly sensitive to disturbances due to their diminished numbers of individuals and populations, and small geographic ranges.

The band-rumped storm-petrel is represented in Hawaii by very small numbers of populations, and perhaps not more than a few hundred individuals (Harrison *et al.* 1990, p. 49). A single human-caused action such as establishment of mongoose on Kauai, or a hurricane during the breeding season, could cause reproductive failure and the mortality of a significant percentage of the remaining individuals. Threats to this species include habitat destruction and modification, landslides and erosion, hurricanes, predation, injury and mortality from lights and structures, and other human factors (such as commercial fisheries). The effects of these threats are compounded by the current low number of individuals and populations of band-rumped storm-petrel.

We consider the orangeblack Hawaiian damselfly vulnerable to extinction due to impacts associated with low numbers of individuals and low numbers of populations because this species is known from only five of eight Hawaiian Islands (Hawaii Island, Maui, Lanai, Molokai, and Oahu) where it occurred historically, and because of the current reduction in numbers on each of those five islands. Jordan *et al.* (2007, p. 247) conducted a genetic and comparative phylogeography analysis (a study of historical processes responsible for genetic divergence within a species) of four Hawaiian *Megalagrion* species, including the orangeblack Hawaiian damselfly. This analysis demonstrated *Megalagrion* populations with low genetic diversity are at greater risk of decline and extinction than those with high genetic diversity. The authors found that low genetic diversity was observed in populations known to be bottlenecked or relictual (groups of animals or plants that exist as a remnant of a formerly widely distributed group), including populations of the orangeblack Hawaiian damselfly. The following threats to this species have all been documented: habitat destruction and modification by agriculture and urban development, droughts, floods, and hurricanes; predation by nonnative fish, backswimmers, bullfrogs, and Jackson's chameleons; competition with caddisflies; and water extraction from streams and ponds. The effects of these threats are compounded by the current low number of individuals and populations of the orangeblack Hawaiian damselfly.

We consider the anchialine pool shrimp, *Procaris hawaiana,* vulnerable to extinction due to impacts associated with low numbers of individuals and populations because this species is known from only 25 of over 500 assessed anchialine pools on Hawaii Island, and from only 2 anchialine pools on Maui. Threats to *P. hawaiana* include: Habitat destruction and modification; agriculture and urban development; commercial trade; dumping of nonnative fish and trash into anchialine pools; recreation; and water extraction. The effects of these threats are compounded by the low number of individuals and populations of *P. hawaiana.*

We consider the seven Hawaiian yellow-faced bees vulnerable to extinction due to impacts associated with low numbers of individuals and populations. The seven yellow-faced bee species currently occur in only 22 locations (with some overlap) on six main Hawaiian Islands, and are vulnerable to habitat change and stochastic events due to low numbers and occurrences (Daly and Magnacca 2003, p. 3; Magnacca 2007, p. 173). *Hylaeus anthracinus* occurs in 15 total locations from Hawaii Island, Maui, Kahoolawe, Molokai, and Oahu, but has not been recently observed in its last known location on Lanai; *H. assimulans* is found in 5 total locations on Maui, Lanai, and Kahoolawe, but has not been observed recently on Oahu or Molokai; *H. facilis* is found in 2 total locations on Oahu and Molokai, but has not been observed recently from Lanai and Maui; *H. hilaris* is known from one population on Molokai and has not been observed recently from Lanai and Maui; *H. kuakea* is known from one small area on Oahu; *H. longiceps* is known from 6 total locations on Maui, Lanai, Molokai, and Oahu, but has not been collected from several historical locations on those islands; and *H. mana* is known from 3 locations on Oahu. Threats to these species include agriculture and urban development; habitat destruction and modification by nonnative ungulates, nonnative plants, tsunamis, fire, drought, and hurricanes; the effects of climate change on habitat; loss of host plants; and predation or competition by nonnative ants, wasps, and bees. The effects of these threats are compounded by the low numbers of individuals and populations of the seven yellow-faced bees.

Hybridization

Natural hybridization is a frequent phenomenon in plants and can lead to the creation of new species (Orians 2000, p. 1949), or sometimes to the decline of species through genetic assimilation or ''introgression'' (Ellstrand 1992, pp. 77, 81; Levin *et al.* 1996, pp. 10–16; Rhymer and Simberloff 1996, p. 85). Hybridization, however, is especially problematic for rare species that come into contact with species that are abundant or more common (Rhymer and Simberloff 1996, p. 83). We consider hybridization to be a threat to *Cyrtandra hematos, Microlepia strigosa* var. *mauiensis,* and *Myrsine fosbergii* because it will lead to extinction of the original genotypically distinct species and varieties, as noted by biologists' observations of occurrences (Kawelo 2009, in litt.; Ching Harbin 2015, in litt.; Oppenheimer 2015, in litt.;).

No Regeneration

Lack of, or low levels of, regeneration (reproduction and recruitment) in the wild has been observed, and is a threat to seven plants: *Cyanea kauaulaensis, Cyrtandra hematos, Gardenia remyi, Joinvillea ascendens* ssp. *ascendens, Labordia lorenciana, Nothocestrum latifolium,* and *Ochrosia haleakalae* (see *Plants* under ''Low Numbers of Individuals and Populations,'' above). The reasons for this are not well understood; however, seed predation by rats and ungulates, inbreeding depression, and lack of pollinators are thought to play a role (Wagner *et al.* 1999, p. 1451; Wood *et al.* 2007, p. 198; HBMP 2010; Oppenheimer and Lorence 2012, pp. 20–21; PEPP 2010, p. 73; PEPP 2014, p. 34).

Competition With Nonnative Invertebrates

There are 15 known species of nonnative bees in Hawaii (Snelling 2003, p. 342), including two nonnative *Hylaeus* species (Magnacca 2007, p. 188). Most nonnative bees inhabit areas dominated by nonnative vegetation and do not compete with Hawaiian bees for foraging resources (Daly and Magnacca 2003, p. 13); however, the European honey bee (*Apis mellifera*) is an exception. This social species is often very abundant in areas with native vegetation and aggressively competes with *Hylaeus* for nectar and pollen (Hopper *et al.* 1996, p. 9; Daly and Magnacca 2003, p. 13; Snelling 2003, p. 345). The European honey bee was first introduced to the Hawaiian Islands in 1875, and currently inhabits areas from sea level to the upper tree line boundary (Howarth 1985, p. 156). Individuals of the European honey bee have been observed foraging on *Hylaeus* host plants such as *Scaevola* spp. and *Sesbania tomentosa* (ohai) (Hopper *et al.* 1996, p. 9; Daly and Magnacca 2003, p. 13; Snelling 2003, p. 345). Although we lack information indicating Hawaiian *Hylaeus* populations have declined because of competition with the European honey bee for nectar and pollen, it does forage in *Hylaeus* habitat and excludes *Hylaeus* species (Magnacca 2007b, p. 188; Lach 2008, p. 155). *Hylaeus* species do not occur in native habitat where there are large numbers of European honey bee individuals, but the impact of smaller, more moderate populations is not known (Magnacca 2007, p. 188). Nonnative, invasive bees are widely documented to decrease nectar volumes and usurp native pollinators (Lach 2008, p. 155). There are also indications that populations of the European honey bee are not as vulnerable as *Hylaeus* species to predation by nonnative ant species (see *Factor C. Disease or Predation,* above). As described above, *Hylaeus* bees that collect pollen from flowers of the native tree *Metrosideros polymorpha* were absent from trees with flowers visited by the big-headed ant, while visits by the European honey bee were not affected (Lach 2008, p. 155). As a result, Lach (2008, p. 155) concluded that the European honey bee may have a competitive advantage over *Hylaeus* species because it is not excluded by the big-headed ant. Other nonnative bees found in areas of native vegetation and overlapping with native *Hylaeus* population sites include *Ceratina* species (carpenter bees), *Hylaeus albonitens* (Australian colletid bees), *H. strenuus* (NCN), and *Lasioglossum impavidum* (NCN) (Magnacca 2007, p. 188; Magnacca and King 2013, pp. 19–22).

Loss of Host Plants Through Competition

The seven yellow-faced bees are dependent upon native flowering plants for their food resources, pollen and nectar, and for nesting sites. Introduced invertebrates outcompete native *Hylaeus* for use of host plants for pollen, nectar, and nesting sites. This effect is compounded by the impacts of nonnative ungulates on native host plants for *Hylaeus* (see discussion under Factors A and C, above). Nonnative plants are a threat to the seven yellow-faced bees and their host plants because they (1) Degrade habitat and outcompete native plants; (2) increase the intensity, extent, and frequency of fire, converting native shrubland and forest to land dominated by nonnative grasses; and (3) as a result of fire, cause the loss of the native host plants upon which the yellow-faced bees depend (Factor A). Drought, fire, and water extraction lead to loss of host plants within the known ranges of populations of yellow-faced bees, and are discussed under *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Their Habitat or Range,* above.

Competition With Caddisflies

Caddisflies (Order Trichoptera), a nonnative aquatic insect, were first observed and identified in Hawaii in the 1940s (Flint *et al.* 2003, p. 31); several species are established on all the main Hawaiian Islands. They may have been introduced inadvertently with aquarium plants released into streams (Flint *et al.* 2003, p. 37). Stream sampling showed that caddisflies accounted for 57 percent of the stream benthos (flora and fauna in stream sediment) in upper elevation Kauai streams (Englund *et al.* 2000, p. 23; Flint *et al.* 2003, p. 38), and caddisflies now inhabit every Oahu stream. Caddisflies compete with native aquatic invertebrate for resources and space (Haines 2015, in litt.), which may reduce prey abundance for naiads of the orangeblack Hawaiian damselfly. In addition, caddisflies provide a food source for introduced fish species, contributing to successful establishment of nonnative fish (Flint *et al.* 2003, p. 38), an additional threat to the orangeblack Hawaiian damselfly.

Climate Change

Our analyses under the Act include consideration of ongoing and projected changes in climate, and the impacts of global climate change and increasing temperatures on Hawaii ecosystems are the subjects of active research. Global temperature has increased over the past century, and particularly since the mid-20th century (IPCC 2014, p. 5), and this increase in temperature is correlated to emissions of carbon dioxide and other greenhouse gasses, which have increased more since 1970 than in prior periods (IPCC 2014, pp. 13–14). Analysis of the historical record indicates surface temperature in Hawaii has been increasing since the early 1900s, with relatively rapid warming over the past 30 years. The average increase since 1975 has been 0.48 °F (0.27 °C) per decade for annual mean temperature at elevations above 2,600 ft (800 m) and 0.16 °F (0.09 °C) per decade for elevations below 800 m (Giambelluca *et al.* 2008, pp. 3–4). Relative to average global temperature from 1986 to 2005, the average ambient air temperature is likely to increase globally by at least 0.5 to 4.7 °F (0.3 to 2.6 °C) by the year 2100 (IPCC 2013, p. 20). Based on models using climate data downscaled for Hawaii, the ambient temperature is projected to increase by 3.8 to 7.7 °F (2.1 to 4.3 °C), depending upon elevation and the emission scenario (Liao *et al.* 2015, p. 4344). On the main Hawaiian Islands, predicted changes associated with increases in temperature include a shift in vegetation zones upslope, a similar shift in animal species' ranges, changes in mean precipitation with unpredictable effects on local environments, increased occurrence of drought cycles, and increases in intensity and numbers of hurricanes (Loope and Giambelluca 1998, pp. 514–515; U.S. Global Change Research Program (US–GCRP) 2009, pp. 10, 12, 17–18, 32–33; Giambelluca 2013, p. 6). Additionally, sea level is rising as a result of thermal expansion of warming ocean water; the melting of ice sheets, glaciers, and ice caps; and the addition of water from terrestrial systems (Climate Institute 2011, in litt.), and sea-level rise negatively affects species occurring in low-lying coastal areas including *Solanum nelsonii* (Starr 2011, in litt.) and affects the stability of anchialine pools systems that are habitat for *Procaris hawaiana* (Sakihara 2015, in litt.).

The forecast of changes in precipitation is highly uncertain because it depends, in part, on how the El Niño–La Niña weather cycle (an episodic feature of the ocean-atmosphere system in the tropical Pacific having important global consequences for weather and climate) might change (State of Hawaii 1998, pp. 2–10). The historical record indicates that Hawaii tends to be dry (relative to a running average) during El Niño phases and wet during La Niña phases (Chen and Chu 2005, pp. 4809–4810). However, over the past century, the Hawaiian Islands have experienced a decrease in precipitation of just over 9 percent (US National Science and Technology Council 2008, p. 61) and a trend of decrease (from the long-term mean) is evident in recent decades (Chu and Chen 2005, pp. 4802–4803; Diaz *et al.* 2005, pp. 1–3). Stream-gauge data provide corroborating evidence of a long-term decrease in precipitation and stream flow on the Hawaiian Islands (Oki 2004, p. 4). This long-term drying trend, coupled with existing ditch diversions and periodic El Niño-caused drying events, has created a pattern of severe and persistent stream dewatering events (Polhemus 2008, in litt., p. 26). Models of future rainfall downscaled for Hawaii generally project increasingly wet windward slopes and mild to extreme drying of leeward areas in particular by the middle and end of the 21st century (Timm and Diaz 2009, p. 4262; Elison Timm *et al.* 2015, pp. 95, 103–105). Altered seasonal moisture regimes can have negative impacts on plant growth cycles and overall negative impacts on native ecosystems (US–GCRP 2009, pp. 32–33). Long periods of decline in annual precipitation result in a reduction of moisture availability, an increase in drought frequency and intensity, and a self-perpetuating cycle of nonnative plant invasion, fire, and erosion (US–GCRP 2009, pp. 32–33; Warren 2011, pp. 221–226) (see ''Habitat Destruction and Modification by Fire,'' above). Overall, the documented and projected increase in variance of precipitation events will change patterns of water availability for the species (Parmesan and Matthews 2006, p. 340), changes that point to changes in plant communities as a consequence over the coming decades.

Tropical cyclone frequency and intensity are projected to change as a result of increasing temperature and changing circulation associated with climate change over the next 100 to 200 years (Vecchi and Soden 2007, pp. 1068–1069, Figures 2 and 3; Emanuel *et al.* 2008, p. 360, Figure 8; Yu *et al.* 2010, p. 1371, Figure 14). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami *et al.* 2013, p. 2, Figure 1d). In general, tropical cyclones with the intensities of hurricanes have been an uncommon occurrence in the Hawaiian Islands. From the 1800s until 1949, hurricanes were only rarely reported from ships in the area. Between 1950 and 1997, 22 hurricanes passed near or over the Hawaiian Islands, and 5 of these caused serious damage (Businger 1998, in litt.). A recent study shows that, with a possible shift in the path of the subtropical jet stream northward, away from Hawaii, more storms will be able to approach and reach the Hawaiian Islands from an easterly direction, with Hurricane Iselle in 2014 being an example (Murakami *et al.* 2015, p. 751).

As described above (see *Climate Change Vulnerability Assessment for the Hawaiian Plants,* above, and Table 2), 27 of the 39 plant species in this proposal were included in the recent analysis of the vulnerability of Hawaiian plants to climate changes conducted by Fortini *et al.* (2013, 134 pp.). All 27 species scored as moderately to extremely vulnerable, as did most other species in the analysis that already are considered to be of conservation concern (because they face multiple non-climate threats) (Fortini *et al.* 2013, pp. 25, 37). The specific impacts of climate change effects on the habitat, biology, and ecology of individual species are largely unknown and remain a subject of study. However, in the assessment of more than 1,000 Hawaiian plants, including 319 already listed as endangered or threatened, a strong relationship emerged between climate vulnerability scores and current threats and conservation status (Fortini *et al.* 2013, p. 5). Therefore, we anticipate that the 13 plant species not analyzed are likely to be similarly vulnerable to climate change effects. The projected landscape- or island-scale changes in temperature and precipitation, as well as the potentially catastrophic impacts of projected increases in storm frequency and severity, also point to likely adverse impacts of climate change on all 10 of the animal species considered in this proposal because they rely on abiotic conditions, such as water temperature, or habitat elements, such as host plants and prey species, likely to be substantively altered by climate change.

Although we lack information about the specific effects of current and projected climate change on these species, we anticipate that increased ambient temperature and hurricane intensity, changing precipitation patterns, and sea-level rise and inundation will create additional stresses on these species because they are vulnerable to these disturbances. For example, projected warmer temperatures and increased storm severity resulting from climate change are likely to exacerbate other threats to the species, such as by enhancing the spread of nonnative invasive plants into these species' native ecosystems in Hawaii. The drying trend, especially on leeward sides of islands, creates suitable conditions for increased invasion by nonnative grasses and enhances the risk of wildfire. Sea-level rise threatens ecosystems and species nearest the coast, including the anchialine pool ecosystem.

The risk of extinction as a result of the effects of climate change increases when a species' range and habitat requirements are restricted, its habitat decreases, and its numbers and number of populations decline (IPCC 2014, pp. 14–15). The fragmented range, diminished number of populations, and low total number of individuals have compromised the rangewide redundancy and resilience of these 49 species. Therefore, we would expect them to be particularly vulnerable to the habitat impacts of the effects of climate change (Loope and Giambelluca 1998, pp. 504–505; Pounds *et al.* 1999, pp. 611–612; Still *et al.* 1999, p. 610; Benning *et al.* 2002, pp. 14,246–14,248; Giambelluca and Luke 2007, pp. 13–15). Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the current threats to these species, such as habitat loss and degradation.

In summary, based on the best available information, we conclude that climate change effects, including increased inter-annual variability of ambient temperature, precipitation, and hurricanes, are likely to impose additional stresses on all 11 ecosystems and all of the 49 species we are listing in this rule, thus exacerbating current threats to these species. These 49 species all persist with small population sizes and highly restricted or fragmented ranges. They thus face increased immediate risk from stochastic events such as hurricanes, which can extinguish an important proportion of the remaining individuals, and from long-term, landscape-scale environmental changes because reduced populations often lack ecological or genetic adaptive capacity (Fortini *et al.* 2013, pp. 3–5).

In addition to impacts resulting from changes in terrestrial habitat and disturbance regimes, climate change affects aquatic habitat. For example, physiological stress in the orangeblack Hawaiian damselfly is caused by increased water temperatures to which the species is not adapted (Pounds *et al.* 1999, pp. 611–612; Still *et al.* 1999, p. 610; Benning *et al.* 2002, pp. 14246, 14248). All of these aspects of climate change and their impacts on native species and ecosystems will be exacerbated by human demands on Hawaii's natural resources; for example, decreased availability of fresh water will magnify the impact of human water consumption on Hawaii's natural streams and reservoirs (Giambelluca *et al.* 1991, p. v). Climate change impacts contribute to the multiple threats affecting the status of all of these species, and the effects of climate change are projected to increase in the future.

Summary of Factor E

We consider the threat from artificial lighting and structures to be a serious and ongoing threat to the band-rumped storm-petrel in Hawaii because these threats cause injury and mortality, resulting in a loss of breeding individuals and juveniles, and are expected to continue into the future. Injury or mortality or loss of food sources caused by the activities of commercial fisheries, and injury or mortality resulting from ingestion of plastics and marine debris, are likely to contribute to further decline in the Hawaiian population of the band-rumped storm-petrel.

We consider the threats from recreational use of, and dumping of trash and introduction of nonnative fish into, the pools that support the anchialine pool shrimp *Procaris hawaiana* to be serious threats that have the potential to occur at any time, although their occurrence is not predictable. The use of anchialine pools for dumping of trash leads to accelerated sedimentation in the pool, exacerbating conditions leading to its senescence. Changing the anchialine pool system by dumping of trash, introduction of nonnative fish, and sedimentation also affects habitat for the orangeblack Hawaiian damselfly. In addition, recreational use of off-road vehicles contributes to increased sedimentation in anchialine pools, and has been noted to affect the habitat of the orangeblack Hawaiian damselfly on Lanai.

We consider the impacts from limited numbers of individuals and populations to be a serious and ongoing threat to all 39 plant species, and especially for the following 19 plants: *Asplenium diellaciniatum Cyanea kauaulaensis, Cyperus neokunthianus, Cyrtandra hematos, Deparia kaalaana, Dryopteris glabra* var. *pusilla, Gardenia remyi, Hypolepis hawaiiensis* var. *mauiensis, Joinvillea ascendens* ssp. *ascendens, Kadua haupuensis, Labordia lorenciana, Lepidium orbiculare, Myrsine fosbergii, Phyllostegia brevidens, P. helleri, Pritchardia bakeri, Santalum involutum, Stenogyne kaalae* ssp. *sherffii,* and *Wikstroemia skottsbergiana,* as low numbers and small occurrences of these plants result in greater vulnerability to stochastic events and can result in reduced levels of genetic variability leading to diminished capacity to adapt to environmental changes. Under these circumstances, the likelihood of long-term persistence is diminished, and the likelihood of extirpation or extinction is increased. This threat applies to the entire range of each of these species.

We also consider the impacts from limited numbers of individuals and populations to be a serious and ongoing threat to the band-rumped storm-petrel, the orangeblack Hawaiian damselfly, the anchialine pool shrimp *Procaris hawaiana,* and to the yellow-faced bees (*Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris, H. kuakea, H. longiceps,* and *H. mana*). The threat from limited numbers of individuals and populations is ongoing and is expected to continue into the future because (1) A single catastrophic event may result in extirpation of remaining populations and extinction of these species; (2) species with few known occurrences are less resilient to threats that might otherwise have a relatively minor impact (on widely distributed species); (3) these species experience reduced reproductive vigor due to inbreeding depression; and (4) they experience reduced levels of genetic variability leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of its long-term persistence.

The threat from hybridization is an unpredictable but ongoing threat to *Cyrtandra hematos, Microlepia strigosa* var. *mauiensis,* and *Myrsine fosbergii,* as has been observed at current occurrences.

We consider the threat to *Cyanea kauaulaensis, Cyrtandra hematos, Gardenia remyi, Joinvillea ascendens* ssp. *ascendens, Labordia lorenciana, Nothocestrum latifolium,* and *Ochrosia haleakalae* from lack of regeneration to be ongoing and to continue into the future because the reasons for the lack of recruitment in the wild are unknown and uncontrolled, and any competition from nonnative plants or habitat modification by ungulates or fire, or other threats could lead to the extirpation of these species.

We consider the threat of competition with nonnative invertebrates a serious and ongoing threat to the yellow-faced bees, *Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris, H. kuakea, H. longiceps,* and *H. mana.* Nonnative wasps and bees are aggressive and can prevent use of the native host plants required for food and nesting by all seven yellow-faced bees. Competition with caddisflies is a threat to the orangeblack Hawaiian damselfly.

Based on current and projected changes in climate, increasing temperature, changing precipitation regimes, increases in storm severity, and sea-level rise will likely exacerbate the threats to these 49 species. The effects of climate change on these species include, but are not limited to, physiological stress caused by increased water or air temperature or lack of moisture, the long-term destruction and modification of habitat, increased competition by nonnative species, and changes in disturbance regimes that lead to changes in habitat and direct mortality of individuals (*e.g.,* fire, drought, flooding, and hurricanes).

Determination for 49 Species

Section 4 of the Act (16 U.S.C. 1533), and its implementing 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 each of the 49 species. We find that all of these species face threats that are ongoing and are expected to continue into the future throughout their ranges. Habitat destruction and modification by agriculture and urban development, and conversion of wetland habitat or water extraction resulting from such activity, is a threat to one plant, *Cyclosorus boydiae,* and seven animals (the orangeblack Hawaiian damselfly, the anchialine pool shrimp (*Procaris hawaiana*), *Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris,* and *H. longiceps*) (Factor A). Habitat destruction and modification by nonnative feral ungulates poses a threat to 46 of the 49 species (except for *Cyanea kauaulaensis, Hypolepis hawaiiensis* var. *mauiensis,* and the anchialine pool shrimp) (Factor A). Habitat destruction and modification by nonnative plants poses a threat to all 39 plant species and 9 of the 10 animals (except for *Procaris hawaiana*) (Factor A). Fourteen of the plant species (*Exocarpos menziesii, Festuca hawaiiensis, Joinvillea ascendens* ssp. *ascendens, Labordia lorenciana, Nothocestrum latifolium, Ochrosia haleakalae, Portulaca villosa, Ranunculus mauiensis, Sanicula sandwicensis, Santalum involutum, Schiedea pubescens, Sicyos lanceoloideus, S. macrophyllus,* and *Solanum nelsonii*) and all seven yellow-faced bees, are at risk of habitat destruction and modification by fire. Habitat loss and mortality resulting from hurricanes is a threat to the plant *Pritchardia bakeri,* the band-rumped storm-petrel, the orangeblack Hawaiian damselfly, and all seven yellow-faced bees (Factor A). Twenty of the plant species (*Cyanea kauaulaensis, Cyclosorus boydiae, Deparia kaalaana, Dryopteris glabra* var. *pusilla, Gardenia remyi, Joinvillea ascendens* ssp. *ascendens, Kadua fluviatilis, K. haupuensis, Labordia lorenciana, Lepidium orbiculare, Phyllostegia brevidens, P. helleri, P. stachyoides, Portulaca villosa, Pseudognaphalium sandwicensium* var. *molokaiense, Ranunculus hawaiensis, R. mauiensis, Sanicula sandwicensis, Schiedea pubescens,* and *Solanum nelsonii*), the band-rumped storm-petrel, and the orangeblack Hawaiian damselfly are threatened by the destruction and modification of their habitats from, either singly or in combination, landslides, rockfalls, treefalls, flooding, or tsunamis (Factor A). Habitat loss or degradation and loss of host plants, mortality, and water extraction due to drought is a threat to the plants *Cyclosorus boydiae, Deparia kaalaana, Huperzia stemmermanniae, Phyllostegia* *stachyoides, Ranunculus hawaiensis, R. mauiensis, Sanicula sandwicensis, Schiedea pubescens, Sicyos lanceoloideus,* and *Solanum nelsonii;* the orangeblack Hawaiian damselfly; and all seven yellow-faced bees (Factor A and Factor E). Unpermitted collection for commercial purposes poses a serious threat to the anchialine pool shrimp *Procaris hawaiana* (Factor B). Predation or herbivory is a serious and ongoing threat to 35 of the 39 plant species (by feral pigs, goats, axis deer, black-tailed deer, cattle, sheep, mouflon, rats, slugs, and the black twig borer), to the band-rumped storm petrel (by barn owls, cats, rats, and mongoose), and to the seven yellow-faced bees (by ants and wasps) (Factor C). Predation by bullfrogs, backswimmers, nonnative fish, and Jackson's chameleons is a threat to the orangeblack Hawaiian damselfly (Factor C). Predation by nonnative fish is a threat to the anchialine pool shrimp (Factor C). The existing regulatory mechanisms do not adequately address these threats to the 49 species (Factor D). Injury and mortality caused by artificial lighting and structures are serious and ongoing threats to the band-rumped storm-petrel (Factor E). The threats of injury or mortality, or loss of food sources, caused by the activities of commercial fisheries, and injury or mortality resulting from ingestion of plastics and marine debris, can contribute to further decline of the Hawaiian population of the band-rumped storm-petrel (Factor E). Recreational use of, and dumping of trash and nonnative fish into, anchialine pools is a threat to the anchialine pool shrimp and also to the orangeblack Hawaiian damselfly that uses that habitat (Factor E). Competition by ants, wasps, and bees for the food and nesting resources, including loss of native host plants, is a threat to all seven yellow-faced bees. Competition with caddisflies is a threat to the orangeblack Hawaiian damselfly (Factor E). These threats are exacerbated by these species' inherent vulnerability to extinction from stochastic events at any time because of their endemism, low numbers of individuals and populations, and restricted habitats. There are serious and ongoing threats to all 49 species due to factors associated with low numbers of individuals and populations (Factor E). The threat of low numbers to seven plants (*Cyanea kauaulaensis, Cyrtandra hematos, Gardenia remyi, Joinvillea ascendens* ssp. *ascendens, Labordia lorenciana, Nothocestrum latifolium,* and *Ochrosia haleakalae*) is exacerbated by lack of regeneration in the wild (Factor E). Hybridization is a threat to three plant species, *Cyrtandra hematos, Microlepia strigosa* var. *mauiensis,* and *Myrsine fosbergii* (Factor E). The effects of rising temperature and other aspects of climate change are likely to exacerbate many of these threats and likely to pose threats to the 49 species (Factor E).

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 ''that is likely to become endangered throughout all or a significant portion of its range within the foreseeable future.'' We find that each of the endemic Hawaiian species and the Hawaii DPS of the band-rumped storm-petrel are presently in danger of extinction throughout their entire ranges. Based on the immediacy, severity, scope, and interaction of the threats described above, such as the pervasive threats of predation and habitat loss and degradation posed by nonnative plants and animals, a determination of threatened status for any of these species is not appropriate. Therefore, on the basis of the best available scientific and commercial information, we are listing the following 49 species as endangered in accordance with sections 3(6) and 4(a)(1) of the Act: the plants *Asplenium diellaciniatum, Calamagrostis expansa, Cyanea kauaulaensis, Cyclosorus boydiae, Cyperus neokunthianus, Cyrtandra hematos, Deparia kaalaana, Dryopteris glabra* var. *pusilla, Exocarpos menziesii, Festuca hawaiiensis, Gardenia remyi, Huperzia stemmermanniae, Hypolepis hawaiiensis* var. *mauiensis, Joinvillea ascendens* ssp. *ascendens, Kadua fluviatilis, Kadua haupuensis, Labordia lorenciana, Lepidium orbiculare, Microlepia strigosa* var. *mauiensis, Myrsine fosbergii, Nothocestrum latifolium, Ochrosia haleakalae, Phyllostegia brevidens, Phyllostegia helleri, Phyllostegia stachyoides, Portulaca villosa, Pritchardia bakeri, Pseudognaphalium sandwicensium* var. *molokaiense, Ranunculus hawaiensis, Ranunculus mauiensis, Sanicula sandwicensis, Santalum involutum, Schiedea diffusa* ssp. *diffusa, Schiedea pubescens, Sicyos lanceoloideus, Sicyos macrophyllus, Solanum nelsonii, Stenogyne kaalae* ssp. *sherffii,* and *Wikstroemia skottsbergiana;* and the following animals: the Hawaii DPS of the band-rumped storm-petrel (*Oceanodroma castro*), the orangeblack Hawaiian damselfly (*Megalagrion xanthomelas*), the anchialine pool shrimp (*Procaris hawaiana*), and the yellow-faced bees *Hylaeus anthracinus, Hylaeus assimulans, Hylaeus facilis, Hylaeus hilaris, Hylaeus kuakea, Hylaeus longiceps,* and *Hylaeus mana.*

Under the Act and our implementing regulations, a species may warrant listing if it is in danger of extinction or likely to become so throughout all or a significant portion of its range (SPR). Under our SPR policy (79 FR 37578, July 1, 2014), if a species is endangered or threatened throughout a significant portion of its range and the population in that significant portion is a valid DPS, we will list the DPS rather than the entire taxonomic species or subspecies. We have determined that the Hawaii population of the band-rumped storm-petrel is a valid DPS, and we are listing that DPS. Each of the other 48 species endemic to the Hawaiian Islands that we are listing in this rule is highly restricted in its range, and the threats occur throughout its range. Therefore, we assessed the status of each species throughout its entire range. In each case, the threats to the survival of these species occur throughout the species' range and are not restricted to any particular portion of that range. Accordingly, our assessment and determination applies to each species throughout its entire range. Likewise, we assessed the status of the Hawaii DPS of the band-rumped storm-petrel throughout the range of the DPS and have determined that the threats occur throughout the DPS and are not restricted to any particular portion of the DPS. Because we have determined that these 48 species and one DPS are endangered throughout all of their ranges, no portion of their ranges can be ''significant'' for purposes of the definitions of ''endangered species'' and ''threatened species.'' See the Final Policy of Interpretation of the Phrase ''Significant Portion of Its Range'' in the Endangered Species Act's Definitions of ''Endangered Species'' and ''Threatened Species'' (79 FR 37578, July 1, 2014).

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 through listing results in public awareness and conservation by Federal, State, and local agencies; private organizations; and individuals. The Act encourages cooperation with the States and requires that recovery actions be carried out for all 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 identifies site-specific management actions that set a trigger for review of the five factors that control whether a species remains endangered or may be downlisted or delisted, 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 stakeholders) are often established to develop recovery plans. When completed, the recovery outline, draft recovery plan, and the final recovery plan 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**).

Implementation of recovery actions generally requires the participation of a broad range of partners, including other Federal agencies, States, 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 all lands.

Following publication of this final listing rule, 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 will be eligible for Federal funds to implement management actions that promote the protection or recovery of the 49 species. 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 one or more of these 49 species. Additionally, we invite you to submit any new information on these 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, as amended, requires Federal agencies to evaluate their actions with respect to any species that is proposed or listed as endangered or threatened 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 a listed 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 species' habitat that may require conference or consultation or both as described in the preceding paragraph include, but are not limited to, actions within the jurisdiction of the Natural Resources Conservation Service (NRCS), the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, and branches of the Department of Defense (DOD). Examples of these types of actions include activities funded or authorized under the Farm Bill Program, Environmental Quality Incentives Program, Ground and Surface Water Conservation Program, Clean Water Act (33 U.S.C. 1251 *et seq.*), Partners for Fish and Wildlife Program, and DOD construction activities related to training or other military missions.

The Act and its implementing regulations set forth a series of general prohibitions and exceptions that apply to endangered wildlife. The prohibitions of section 9(a)(1) of the Act, codified at 50 CFR 17.21, 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) endangered wildlife within the United States or 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 endangered wildlife under certain circumstances. Regulations governing permits are codified at 50 CFR 17.22. With regard to endangered wildlife, a permit may be issued 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.

With respect to endangered plants, prohibitions outlined at 50 CFR 17.61 make it illegal for any person subject to the jurisdiction of the United States to import or export, transport in interstate or foreign commerce in the course of a commercial activity, sell or offer for sale in interstate or foreign commerce, or to remove and reduce to possession any such plant species from areas under Federal jurisdiction. In addition, for endangered plants, the Act prohibits malicious damage or destruction of any such species on any area under Federal jurisdiction, and the removal, cutting, digging up, or damaging or destroying of any such species on any other area in knowing violation of any State law or regulation, or in the course of any violation of a State criminal trespass law. Exceptions to these prohibitions are outlined at 50 CFR 17.62.

We may issue permits to carry out otherwise prohibited activities involving endangered plants under certain circumstances. Regulations governing permits are codified at 50 CFR 17.62. With regard to endangered plants, the Service may issue a permit authorizing any activity otherwise prohibited by 50 CFR 17.61 for scientific purposes or for enhancing the propagation or survival of endangered plants.

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 listing on proposed and ongoing activities within the range of a listed species. Based on the best available information, activities that may potentially result in a violation of section 9 of the Act include but are not limited to:

(1) 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 these taxa at least 100 years old, as defined by section 100(h)(1) of the Act;

(2) Activities that take or harm the band-rumped storm-petrel, the orangeblack Hawaiian damselfly, the anchialine pool shrimp (*Procaris hawaiana*), and the seven yellow-faced bees by causing significant habitat modification or degradation such that it causes actual injury by significantly impairing essential behavior patterns. This may include introduction of nonnative species that compete with or prey upon the 10 animal species or the unauthorized release of biological control agents that attack the life stage of any of these 10 species; and

(3) Damaging or destroying any of the 39 plant species in violation of the Hawaii State law prohibiting the take of listed species.

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 (see **FOR FURTHER INFORMATION CONTACT**). Requests for copies of the regulations concerning listed species and general inquiries regarding prohibitions and permits may be addressed to the U.S. Fish and Wildlife Service, Pacific Region, Ecological Services, Endangered Species Permits, Eastside Federal Complex, 911 NE. 11th Avenue, Portland, OR 97232–4181 (telephone 503–231–6131; facsimile 503–231–6243).

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* under Docket No. FWS–R1–ES–2015–0125 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 follows:

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; and 4201–4245, unless otherwise noted.

■ 2. Amend § 17.11(h), the List of Endangered and Threatened Wildlife, as follows:

■ a. By adding an entry for ''Storm-petrel, band-rumped (Hawaii DPS)'' in alphabetical order under BIRDS;

■ b. By adding entries for ''Bee, yellow-faced'' (*Hylaeus anthracinus*), ''Bee, yellow-faced'' (*Hylaeus assimulans*), ''Bee, yellow-faced'' (*Hylaeus facilis*), ''Bee, yellow-faced'' (*Hylaeus hilaris*), ''Bee, yellow-faced'' (*Hylaeus kuakea*), ''Bee, yellow-faced'' (*Hylaeus longiceps*), ''Bee, yellow-faced'' (*Hylaeus mana*), and ''Damselfly, orangeblack Hawaiian'' (*Megalagrion xanthomelas*) in alphabetical order under INSECTS; and

■ c. By adding an entry for ''Shrimp, anchialine pool'' (*Procaris hawaiana*) before the entry for ''Shrimp, anchialine pool'' *(Vetericaris chaceorum)* under CRUSTACEANS.

The additions read as follows:

§ 17.11 Endangered and threatened wildlife.

*   *   *   *   *

(h) * * *

Common name	Scientific name	Where listed	Status	Listing citations and applicable rules
BIRDS				
* *	*	* *		* *
Storm-petrel, band-rumped (Hawaii DPS).	*Oceanodroma castro*	U.S.A. (HI)	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
INSECTS				
Bee, yellow-faced	*Hylaeus anthracinus*	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
Bee, yellow-faced	*Hylaeus assimulans*	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
Bee, yellow-faced	*Hylaeus facilis*	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.

Common name	Scientific name	Where listed	Status	Listing citations and applicable rules
Bee, yellow-faced	*Hylaeus hilaris*	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
Bee, yellow-faced	*Hylaeus kuakea*	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
Bee, yellow-faced	*Hylaeus longiceps*	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
Bee, yellow-faced	*Hylaeus mana*	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Damselfly, orangeblack Hawaiian.	*Megalagrion xanthomelas*	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
CRUSTACEANS				
* *	*	* *		* *
Shrimp, anchialine pool	*Procaris hawaiana*	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *

■ 3. Amend § 17.12(h), the List of Endangered and Threatened Plants, as follows:

■ a. By adding entries for *Calamagrostis expansa, Cyanea kauaulaensis, Cyperus neokunthianus, Cyrtandra hematos, Exocarpos menziesii, Festuca hawaiiensis, Gardenia remyi, Joinvillea ascendens* ssp. *ascendens, Kadua fluviatilis, Kadua haupuensis, Labordia lorenciana, Lepidium orbiculare, Myrsine fosbergii, Nothocestrum latifolium, Ochrosia haleakalae, Phyllostegia brevidens, Phyllostegia helleri, Phyllostegia stachyoides, Portulaca villosa, Pritchardia bakeri, Pseudognaphalium sandwicensium* var. *molokaiense, Ranunculus hawaiensis, Ranunculus mauiensis, Sanicula sandwicensis, Santalum involutum, Schiedea diffusa* ssp. *diffusa, Schiedea pubescens, Sicyos lanceoloideus, Sicyos macrophyllus, Solanum nelsonii, Stenogyne kaalae* ssp. *sherffii,* and *Wikstroemia skottsbergiana* in alphabetical order under FLOWERING PLANTS; and

■ b. By adding entries for *Asplenium diellaciniatum, Cyclosorus boydiae, Deparia kaalaana, Dryopteris glabra* var. *pusilla, Huperzia stemmermanniae, Hypolepis hawaiiensis* var. *mauiensis,* and *Microlepia strigosa* var. *mauiensis* in alphabetical order under FERNS AND ALLIES.

The additions read as follows:

§ 17.12 Endangered and threatened plants.

* * * * *

(h) * * *

Scientific name	Common name	Where listed	Status	Listing citations and applicable rules
FLOWERING PLANTS				
* *	*	* *		* *
Calamagrostis expansa	Maui reedgrass	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Cyanea kauaulaensis	No common name	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Cyperus neokunthianus	No common name	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Cyrtandra hematos	Haiwale	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.

Scientific name	Common name	Where listed	Status	Listing citations and applicable rules
* *	*	* *		* *
Exocarpos menziesii	Heau	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
Festuca hawaiiensis	No common name	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Gardenia remyi	Nanu	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Joinvillea ascendens ssp. *ascendens*.	Ohe	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Kadua fluviatilis	Kamapuaa	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
Kadua haupuensis	No common name	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Labordia lorenciana	No common name	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Lepidium orbiculare	Anaunau	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Myrsine fosbergii	Kolea	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Nothocestrum latifolium	Aiea	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Ochrosia haleakalae	Holei	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Phyllostegia brevidens	No common name	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Phyllostegia helleri	No common name	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Phyllostegia stachyoides	No common name	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Portulaca villosa	Ihi	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.

Scientific name	Common name	Where listed	Status	Listing citations and applicable rules
* *	*	* *		* *
Pritchardia bakeri	Baker's loulu	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Pseudognaphalium sandwicensium var. *molokaiense*.	Enaena	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Ranunculus hawaiensis	Makou	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
Ranunculus mauiensis	Makou	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Sanicula sandwicensis	No common name	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Santalum involutum	Iliahi	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Schiedea diffusa ssp. *diffusa*	No common name	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Schiedea pubescens	Maolioli	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Sicyos lanceoloideus	Anunu	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
Sicyos macrophyllus	Anunu	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Solanum nelsonii	Popolo	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Stenogyne kaalae ssp. *sherffii*	No common name	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Wikstroemia skottsbergiana	Akia	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
FERNS AND ALLIES				
* *	*	* *		* *
Asplenium diellaciniatum	No common name	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* *	*	* *		* *
Cyclosorus boydiae	Kupukupu makalii	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.

Scientific name	Common name	Where listed	Status	Listing citations and applicable rules
Deparia kaalaana	No common name	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
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Dryopteris glabra var. *pusilla*	Hohiu	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* * * * * * *				
Huperzia stemmermanniae	No common name	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
Hypolepis hawaiiensis var. *mauiensis*.	Olua	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
* * * * * * *				
Microlepia strigosa var. *mauiensis*.	No common name	Wherever found	E	81 FR [*Insert* ***Federal Register*** *page where the document begins*]; 09/30/2016.
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Dated: September 12, 2016.

Stephen Guertin,

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

[FR Doc. 2016–23112 Filed 9–29–16; 8:45 am]

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