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Part II

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Fish and Wildlife Service

50 CFR Part 17

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

**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:** Proposed rule.

**SUMMARY:** We, the U.S. Fish and Wildlife Service (Service), propose to list 10 animal species, including the band-rumped storm-petrel (*Oceanodroma castro*), the orangeblack Hawaiian damselfly (*Megalagrion xanthomelas*), the anchialine pool shrimp (*Procaris hawaiiiana*), and seven yellow-faced bees (*Hylaeus anthracinus*, *H. assimulans*, *H. facilis*, *H. hiliaris*, *H. kuakea*, *H. longiceps*, and *H. mana*), and 39 plant species from the Hawaiian Islands as endangered species under the Endangered Species Act (Act). If we finalize this rule as proposed, it would extend the Act's protections to these species.

**DATES:** We will accept comments received or postmarked on or before November 30, 2015. Comments submitted electronically using the Federal eRulemaking Portal (see **ADDRESSES**, below) must be received by 11:59 p.m. Eastern Time on the closing date. We must receive requests for public hearings, in writing, at the address shown in **FOR FURTHER INFORMATION CONTACT** by November 16, 2015.

**ADDRESSES:** You may submit comments by one of the following methods:

(1) *Electronically:* Go to the Federal eRulemaking Portal: <http://www.regulations.gov>. In the Search box, enter FWS-R1-ES-2015-0125, which is the docket number for this rulemaking. Then, in the Search panel on the left side of the screen, under the Document Type heading, click on the Proposed Rules link to locate this document. You may submit a comment by clicking on "Comment Now!"

(2) *By hard copy:* Submit by U.S. mail or hand-delivery to: Public Comments Processing, Attn: FWS-R1-ES-2015-0125, U.S. Fish and Wildlife Service, MS: BPHC, 5275 Leesburg Pike, Falls Church, VA 22041-3803.

We request that you send comments only by the methods described above. We will post all comments on <http://www.regulations.gov>. This generally means that we will post any personal information you provide us (see *Public Comments*, below, for more information).

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**FOR FURTHER INFORMATION CONTACT:**

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

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

*Why we need to publish a rule.* Under the Act, if a species is determined to be an endangered or threatened species throughout all or a significant portion of its range, we are required to promptly publish a proposal in the **Federal Register** and make a determination on our proposal within 1 year. Listing a species as an endangered or threatened species can only be completed by issuing a rule.

*This rulemaking* proposes to list of the 49 species from the Hawaiian Islands as endangered species. These species are candidate species for which we have on file sufficient information on biological vulnerability and threats to support preparation of a listing proposal, but for which development of a proposed listing rule had been precluded by other higher priority listing activities. This proposed rule reassesses all available information regarding status of and threats to the 49 species.

*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. 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, deer, black-tailed deer, mouflon, cattle); nonnative plants; wildfire; and water extraction.
- Predation or herbivory by nonnative, feral ungulates; rats; slugs; ants; and wasps.

- Inadequate existing regulatory mechanisms to prevent the introduction and spread of nonnative plants and animals.

- Stochastic events such as landslides, flooding, drought, 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.

The effects of climate change are likely to exacerbate the impacts of these threats, and may become a threat in the future.

*We will seek peer review.* We will seek comments from independent specialists to ensure that our designation is based on scientifically sound data, assumptions, and analyses. We will invite these peer reviewers to comment on our listing proposal. Because we will consider all comments and information we receive during the comment period, our final determinations may differ from this proposal.

**Information Requested***Public Comments*

We intend that any final action resulting from this proposed rule will be based on the best scientific and commercial data available and be as accurate and as effective as possible. Therefore, we request comments or information from the public, including land owners and land managers, other concerned governmental agencies, the scientific community, industry, or any other interested parties, concerning this proposed rule. We particularly seek comments concerning:

(1) The biology, range, and population trends of these species, including:

(a) Biological or ecological requirements, including habitat requirements for feeding, breeding, and sheltering;

(b) Genetics and taxonomy;

(c) Historical and current range, including distribution patterns;

(d) Historical and current population levels, and current and projected trends; and

(e) Past and ongoing conservation measures for these species, their habitats, or both.

(2) Factors that may affect the continued existence of these species, which may include habitat modification or destruction, overutilization, disease, predation, the inadequacy of existing

regulatory mechanisms, or other natural or manmade factors.

(3) Biological, commercial trade, or other relevant data concerning any threats (or lack thereof) to these species and existing regulations that may be addressing those threats.

(4) Empirical data or other scientific information describing the specific impacts of climate change on the habitat, life history, and/or ecology of these species, for example, the species' biological response, or likely response, to changes in habitat resulting from climate-change related changes in ambient temperature, precipitation, drought, storm severity, or sea level.

(5) Additional information concerning the historical and current status, range, distribution, and population size of these species, including the locations of any additional populations of these species.

Please include sufficient information with your submission (such as scientific journal articles or other publications) to allow us to verify any scientific or commercial information you include.

Please note that submissions merely stating support for or opposition to the action under consideration without providing supporting information, although noted, will not be considered in making a determination, as section 4(b)(1)(A) of the Act (16 U.S.C. 1531 *et seq.*) directs that determinations as to whether any species is an endangered or threatened species must be made "solely on the basis of the best scientific and commercial data available."

You may submit your comments and materials concerning this proposed rule by one of the methods listed in the **ADDRESSES** section. We request that you send comments only by the methods described in the **ADDRESSES** section.

If you submit information via <http://www.regulations.gov>, your entire submission—including any personal identifying information—will be posted on the Web site. If your submission is made via a hardcopy that includes personal identifying information, you may request at the top of your document that we withhold this information from public review. However, we cannot guarantee that we will be able to do so. We will post all hardcopy submissions on <http://www.regulations.gov>.

Comments and materials we receive, as well as supporting documentation we used in preparing this proposed rule, will be available for public inspection on <http://www.regulations.gov>, or by appointment, during normal business hours, at the U.S. Fish and Wildlife Service, Pacific Islands Fish and

Wildlife Office (see **FOR FURTHER INFORMATION CONTACT**).

#### Public Hearing

Section 4(b)(5) of the Act provides for one or more public hearings on this proposal, if requested. Requests must be received within 45 days after the date of publication of this proposed rule in the **Federal Register** (see **DATES**, above). Such requests must be sent to the address shown in the **FOR FURTHER INFORMATION CONTACT** section. We will schedule public hearings on this proposal, if any are requested, and announce the dates, times, and places of those hearings, as well as how to obtain reasonable accommodations, in the **Federal Register** and local newspapers at least 15 days before the hearing.

#### Peer Review

In accordance with our joint policy on peer review published in the **Federal Register** on July 1, 1994 (59 FR 34270), during the public comment period we will seek the expert opinions of appropriate and independent specialists regarding this proposed rule. The purpose of peer review is to ensure that our listing determinations are based on scientifically sound data, assumptions, and analyses. The peer reviewers have expertise in one or more of the 49 species' biology, habitat, life-history needs, vulnerability to threats, and other physical or biological factors.

#### Previous Federal Action

All 49 species proposed for listing as endangered species are candidate species (79 FR 72450, December 5, 2014). Candidate species are those taxa for which the U.S. Fish and Wildlife Service (we or Service) has sufficient information on their biological status and threats to propose them for listing under the Act, but for which the development of a listing regulation has been precluded to date by other higher priority listing activities. The current candidate species addressed in this proposed rule include the following 10 animal species: The band-rumped storm-petrel (*Oceanodroma castro*), the orangeblack Hawaiian damselfly (*Megalagrion xanthomelas*), the anchialine pool shrimp (*Procaris hawaiiiana*), and seven yellow-faced bees, *Hylaeus anthracinus*, *H. assimulans*, *H. facilis*, *H. hilaris*, *H. kuakea*, *H. longiceps*, and *H. mana*; and the following 39 plant species: *Asplenium diellaciniatum* (no common name (NCN)), *Calamagrostis expansa* (Maui reedgrass), *Cyanea kauaulaensis* (NCN), *Cyclosorus* (previously *Christella*) *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* (previously *Hedyotis*) *fluviatilis* (kamapuaa, pilo), *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 sandwicense* var. *molokaiense* (enaena), *Ranunculus hawaiiensis* (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). The candidate status of these species was most recently reaffirmed in the December 5, 2014, Review of Native Species That Are Candidates for Listing as Endangered or Threatened (CNOR) (79 FR 72450).

On May 4, 2004, the Center for Biological Diversity petitioned the Secretary of the Interior to list 225 species of plants and animals, including 27 of the 49 candidate species listed above, as endangered or threatened under the provisions of the Act. Since then, we have published our annual findings on the May 4, 2004, petition in the CNORs dated May 11, 2005 (70 FR 24870), September 12, 2006 (71 FR 53756), December 6, 2007 (72 FR 69034), December 10, 2008 (73 FR 75176), November 9, 2009 (74 FR 57804), November 10, 2010 (75 FR 69222), October 26, 2011 (76 FR 66370), November 21, 2012 (77 FR 69994), November 22, 2013 (78 FR 70104), and December 5, 2014 (79 FR 72450).

#### Background

##### Hawaiian Islands Species Addressed in this Proposed 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 proposed rule.

TABLE 1A—CANDIDATE PLANT SPECIES PROPOSED FOR LISTING AS ENDANGERED SPECIES

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

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

TABLE 1B—CANDIDATE ANIMAL SPECIES PROPOSED FOR LISTING AS ENDANGERED SPECIES

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

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

The Hawaiian Islands

The State of Hawaii consists of eight “main” larger Hawaiian Islands, and a long chain of older, eroded islands and atolls referred to as the Northwestern Hawaiian Islands (NWHI). These islands are formed as the Pacific plate passes

over a volcanic “hot spot,” an ongoing process over the last 40 million years (Clague in Juvik and Juvik 1998, p. 37). The Pacific plate is currently moving northwestward at about 4 inches (in) (9 centimeters (cm)) per year (Clague in Juvik and Juvik 1998, p. 38). Each island was formed from eruptions of one or

more volcanoes, over several hundred thousand years, with several million years passing before activity ended and the volcano became extinct (Clague in Juvik and Juvik 1998; pp. 38–39). Haleakala volcano, forming east Maui, last erupted in 1790, and is considered dormant. Kilauea volcano, on the island

of Hawaii, has been erupting continuously since 1983. Loihi Seamount, at 3,200 feet (ft) (975 meters (m)) below sea level, and 19 miles (mi)

(29 kilometers (km)) off Hawaii Islands' southeast coast, has infrequent eruptions, earthquake swarms nearly every year, and is destined to emerge as

an island within the next 200,000 years (Clague *in* Juvik and Juvik 1998, pp. 45–46).

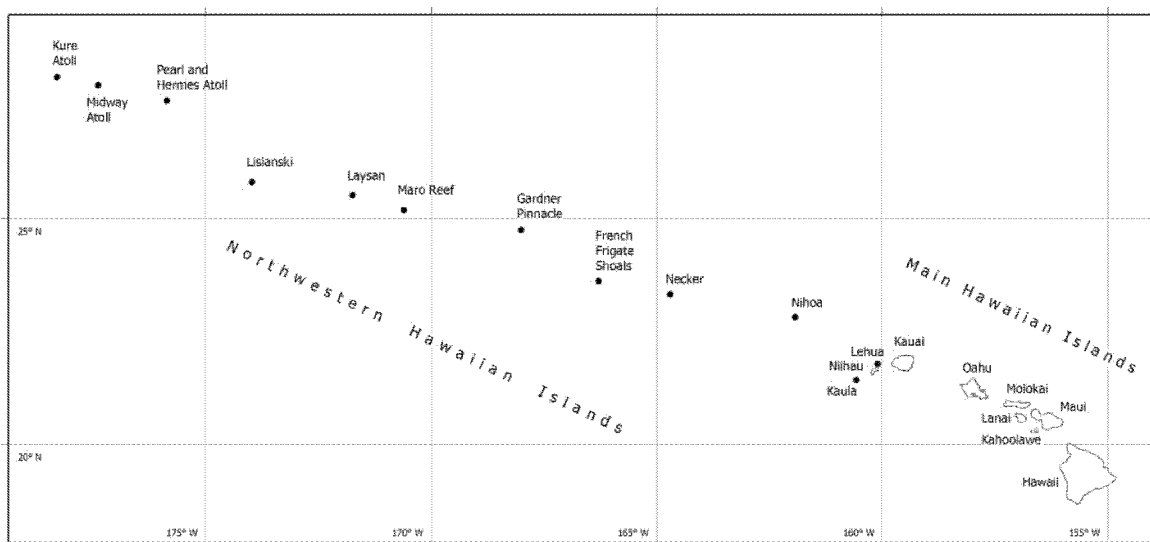


Figure 1. The Hawaiian Islands.

The Northwestern Hawaiian Islands extend more than 1,000 mi (1,600 km) beyond Kauai and include (from southeast to northwest) Nihoa Island (171 acres (ac) (69 hectares (ha))), Necker Island (46 ac (19 ha)), French Frigate Shoals (an atoll with multiple islets totalling 0.1 square (sq) mi (0.2 sq km)), Gardner Pinnacles (2 islets, 6 ac (2.5 ha) with 940 sq mi (2,435 sq km) of surrounding reef), Maro Reef (mostly submerged), Laysan Island (1,016 ac (411 ha)), Lisianski Island (364 ac (147 ha)), Pearl and Hermes Atoll (submerged reef with 7 sandy islets totaling 89 ac (36 ha)), Midway Atoll (2.5 sq mi (6 sq km), consisting of three islands: Sand, Eastern, and Spit), and Kure Atoll (4 sq mi (10 sq km), with two islands: Green and Sand, totaling 213 ac (86 ha)) (Juvik and Juvik 1998, p. 304). All of the NWHI except Kure Atoll are within the U.S. Fish and Wildlife Service's Hawaiian Islands National Wildlife Refuge or Midway Atoll National Wildlife Refuge. In 2006, all of the NWHI were designated as the Papahānaumokuākea Marine National Monument (Monument); in 2010, the Monument was inscribed as a World Heritage Site. The Monument is managed in partnership by the Department of Commerce's National Oceanic and Atmospheric Administration, the Department of the Interior, and the State of Hawaii.

The island of Kauai, the northernmost of the eight main Hawaiian Islands, is 552 sq mi (1,430 sq km) in area (Foote *et al.* 1972, p. 3). Kauai's highest elevations are over 5,000 ft (1,500 m), and the island's summit is one of the wettest areas on earth, receiving over 400 in (11,278 millimeters (mm)) of annual rainfall. The island is over 5 million years old, and erosion has created dramatic canyons (Waimea Canyon) and cliffs on the Na Pali Coast. Kauai has been severely affected by hurricanes, most recently by Hurricane Iniki in 1992. The privately-owned island of Niihau (43 mi (69 km) southwest of Kauai) was formed from a single volcanic shield, is slightly younger than Kauai, and has unique geographic features such as intermittent lakes. Niihau is relatively arid (20 to 40 in annual rainfall) because it lies in the rain shadow of Kauai and lacks the elevation needed to intercept moist air carried by the prevailing northeast trade winds, which would generate rain if forced to sufficiently high altitude by mountains (orographic rainfall) (Stearns and McDonald 1947, p. 31). However, Kona storms (storms from a southerly direction) provide some rainfall. Although only 1,280 ft (390 m) high, there are precipitous sea cliffs on the northern coast. Lehua Island (geologically part of Niihau), a crescent-shaped tuff cone (284 ac (115 ha)), is a

Hawaii State Seabird Sanctuary (Juvik and Juvik 1998, pp. 3–6). Kaula Island (158 ac (64 ha)), also known as Kaula Rock, is small, crescent-shaped, 550 ft (167 m) high, and lies southwest of Niihau. Currently, Kaula is used for gunnery and inert ordnance target practice by the U.S. Navy (Harrison 1990, p. 193; Hawaii Range Complex FEIS 2008, p. 3–124).

The island of Oahu (600 sq mi (1,557 sq km)), the third oldest and third largest of the eight main Hawaiian Islands, is located southeast of Kauai and northwest of Molokai (Foote *et al.* 1972, p. 19; Juvik and Juvik 1998, p. 7). Two shield volcanoes ceased erupting about 1 to 2 million years ago, forming two mountain ranges, the western Waianae range and the eastern Koolau range, with a central plateau connecting them. These mountain ranges are oriented perpendicular to the trade winds, so that distinctive leeward and windward climates result, with the arid Waianae range in the rain shadow of the Koolau range, which receives most of the orographic rainfall (Juvik and Juvik 1998, p. 7; Wagner *et al.* 1999, p. 39). The maximum elevation on Oahu is at the summit of the Waianae Mountains (4,025 ft (1,225 m)) (Wagner *et al.* 1999, pp. 39–41). Rainfall on the island ranges from less than 20 in (500 mm) to more than 250 in (6,350 mm) per year. This island supports the largest population in

the State, nearly one million people (World Population Review 2015, in litt.). The flora and fauna of Oahu have undergone extreme alterations because of past and present land use and other activities.

The island of Molokai (260 sq mi (673 sq km)), the fifth largest of the eight main Hawaiian Islands, lies southeast of Oahu. The island is formed from three shield volcanoes, resulting in the east and west Molokai Mountains and the Kalaupapa Peninsula (Juvik and Juvik 1998, pp. 11, 13). The taller and larger east Molokai Mountain rises 4,970 ft (1,514 m) above sea level and comprises roughly 50 percent of the island's area (Juvik and Juvik 1998, pp. 11). Precipitous cliffs line the windward coast and deep valleys dissect the coastal area. Annual rainfall on the windward side of the island is 75 to more than 150 in (200 to more than 375 cm) (Giambelluca and Schroeder 1998, p. 50).

The island of Lanai (140 sq mi (364 sq km)), the sixth largest of the eight main Hawaiian Islands, is located southeast of Molokai and southwest of west Maui. Lanai was formed from a single shield volcano and is located in the rain shadow of the west Maui Mountains (Clague *in* Juvik and Juvik 1998, p. 42). Lanaihale is the highest point at 3,366 ft (1,027 m), with annual rainfall on the summit of 30 to 40 in (76 to 100 cm). Annual rainfall is much less, 10 to 20 in (25 to 50 cm), over the rest of the island (Giambelluca and Schroeder 1998, p. 56).

The island of Maui (729 sq mi (1,888 sq km)), the second largest of the eight main Hawaiian Islands, is located southeast of Molokai and northwest of Hawaii Island (Juvik and Juvik 1998, p. 14). It arose from two shield volcanoes resulting in formation of the west Maui Mountains, which are about 1.3 million years old, and the east Maui Mountains (Haleakala volcano), about 750,000 years old (Juvik and Juvik 1998, p. 14), which are connected by the central Maui isthmus. The highest point on west Maui is Puu Kukui at 5,788 ft (1,764 m), which receives 400 in (1,020 cm) rainfall per year (Juvik and Juvik 1998, p. 14; Wagner *et al.* 1999, p. 41). East Maui's Haleakala volcano last erupted only 200 years ago and is considered dormant (Juvik and Juvik 1998, p. 14). Haleakala is higher in elevation (10,023 ft (3,055 m)) than Puu Kukui, and since it is geologically younger, lacks the diverse vegetation of the older west Maui Mountains. Annual rainfall is about 35 in (89 cm) at the highest elevations, above the trade wind inversion, resulting in a dry cinder desert (Giambelluca and Schroeder

1998, p. 55). Lower elevations on windward east Maui receive as much as 404 in (1,026 cm) annual rainfall (Giambelluca *et al.* 2013, p. 1).

The island of Kahoolawe (45 sq mi (116 sq km)), the smallest of the eight main Hawaiian Islands, is located south of east Maui, and was formed from a single shield volcano (Clague *in* Juvik and Juvik 1998, p. 42; Juvik and Juvik 1998, pp. 7, 16). The maximum elevation on Kahoolawe is 1,476 ft (450 m) at the summit of Puu O Moaula Nui (Juvik and Juvik 1998, pp. 15–16). Kahoolawe is in the rain shadow of Haleakala and is arid, receiving no more than 25 in (65 cm) of rainfall annually (Juvik and Juvik 1998, p. 16; Mitchell *et al.* 2005, p. 6–66). The island was inhabited as early as 400 A.D., with small fishing villages established along the coast. It was used briefly as a penal colony, for grazing by sheep and goats, and for cattle ranching, until 1941, when the United States declared martial law throughout Hawaii, leading to the use of the island as a training ground and bombing range (Kahoolawe Island Reserve Commission (KIRC) 2015, in litt.). In 1990, the island was placed under the administration of the Kahoolawe Island Reserve Commission. The grazing, ranching, and bombing activities had a serious impact on the environment, resulting in substantial loss of soil through accelerated erosion (KIRC 2015, in litt.). After an extensive 10-year cleanup by the U.S. Navy, unexploded ordnance remains on one-third of the island, including surrounding waters (KIRC 2015, in litt.).

The island of Hawaii, the largest, highest, and youngest of the eight main Hawaiian Islands, is also the easternmost and southernmost island in the chain. At 4,038 sq mi (10,458 sq km), it comprises approximately two-thirds of the land area of the State of Hawaii, giving rise to its common name, the "Big Island." Five large shield volcanoes make up the island: Mauna Kea at 13,796 ft (4,205 m) and Kohala at 5,480 ft (1,670 m), both extinct volcanoes; Hualalai at 8,270 ft (2,520 m), a dormant volcano; and Mauna Loa (13,677 ft (4,169 m)) and Kilauea (4,093 ft (1,248 m)), both active volcanoes (McDonald *et al.* 1990, pp. 345–379; 59 FR 10305, March 4, 1994; U.S. Geological Survey (USGS) 2012, pp. 1–2). Hawaii Island has a greater range of climatic zones than any other island in the State, with the highest and lowest temperatures, and coastal to alpine ecosystems (Juvik and Juvik 1998, p. 22; Wagner *et al.* 1999, p. 38; The Nature Conservancy of Hawaii (TNCH) 2007). The windward slopes receive the most rainfall, but orographic effects cause

drier conditions to prevail in the leeward saddle area and in high-elevation areas. The west, or leeward, side of the island (Kona) is in the rain shadow of the mountains, but does receive convection-driven rainfall in the afternoons, resulting in greater than expected annual rainfall (50 to more than 100 in (127 to 254 cm)), which supports mesic forest (Mitchell *et al.* 2005, pp. 6–71–6–91).

### **An Ecosystem-Based Approach To Assessing the Conservation Status of the 49 Species in the Hawaiian Islands**

In this document, we have analyzed the threats to each of the 49 species individually to determine the appropriate status of each species on its own merits under the Act. However, because many of these species, and particularly those that share the same habitat types (ecosystems), share a similar suite of threats, we have organized the 49 species addressed in this proposed rule by common ecosystem for efficiency, to reduce repetition for the reader, and to reduce publication costs.

In addition, as an ancillary benefit of assessing the threats to the 49 species using shared ecosystems as an organizational tool, we have laid the groundwork for better addressing threats to these species, should they be listed. In the Hawaiian Islands, native species occurring in the same habitat types depend on many of the same physical and biological features and the successful functioning of specific ecosystems to survive. Because species that share ecosystems face a suite of shared threats, managing or eliminating these threats holistically at an ecosystem level is more cost effective and should lead to better resource protection for all native species. This approach is in accord with the primary stated purpose of the Act (see section 2(b)): "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved."

On all the main Hawaiian Islands, vegetation on land with rich soils was cultivated and altered by the early Hawaiians and, more recently, converted to commercial agricultural and urban use (Gagne and Cuddihy 1999, p. 45). Intentional and inadvertent introduction of alien plant and animal species has also contributed to the reduction in range of native vegetation. Throughout this proposed rule, the terms "alien," "feral," "nonnative," and "introduced" all refer to species that are not native to the Hawaiian Islands. Most of the candidate species included in this proposed rule persist on steep slopes,

precipitous cliffs, valley headwalls, and other regions where unsuitable topography has prevented urbanization and agricultural development, or where inaccessibility has limited

encroachment by nonnative plant and animal species.

Each of the 49 Hawaiian Islands species is found in one or more of the 11 ecosystems types described in this

proposed rule: anchialine pool, coastal, lowland dry, lowland mesic, lowland wet, montane wet, montane mesic, montane dry, subalpine, dry cliff, and wet cliff (see Table 2).

TABLE 2—THE 49 HAWAIIAN ISLANDS SPECIES AND THE ECOSYSTEMS UPON WHICH THEY DEPEND

Species	Island										
	Hawaii	Maui	Kahoolawe	Lanai	Molokai	Oahu	Kauai	Niihau	Lehua	Kaula	NWHI
<b>Plants:</b>											
<i>Asplenium diellaciniatum</i>							MM				
<i>Calamagrostis expansa</i>	MW	MW									
<i>Cyanea kauaulaensis</i>		LW									
<i>Cyclosorus boydiae</i>	LW	LW, MW				MW					
<i>Cyperus neokunthianus</i>		LW									
<i>Cyrtandra hematos</i>					MW						
<i>Deparia kaalaana</i>	LM, LW	LM, LW					LM, LW				
<i>Dryopteris glabra</i> var. <i>pusilla</i>							MW				
<i>Exocarpos menziesii</i>	LM			LM							
	MM										
	MD										
<i>Festuca hawaiiensis</i>	MD	MD									
<i>Gardenia remyi</i>	LM, LW	LW			LM, LW		LM, LW				
<i>Huperzia stemmermanniae</i>	MW	MW									
<i>Hypolepis hawaiiensis</i> var. <i>mauiensis</i>		MW									
<i>Joinvillea ascendens</i> ssp. <i>ascendens</i>	LW, MW	LW MW			LW, MW	LW, MW	LM, MW, MM				
<i>Kadua fluviatilis</i>						LW	LM				
<i>Kadua haupuensis</i>							LM				
<i>Labordia lorenciana</i>							MM				
<i>Lepidium orbiculare</i>							LM				
<i>Microlepia strigosa</i> var. <i>mauiensis</i>	MW, MM	MW					LM				
<i>Myrsine fosbergii</i>						LM, LW	LM, LW, MW				
<i>Nothoecstrum latifolium</i>		LD, LM, DC		LD, LM, DC	LM	LD, LM, DC	DC				
<i>Ochrosia haleakalae</i>	LM, LW	LM, MM, DC									
<i>Phyllostegia brevidens</i>	MW	LW, WC									
<i>Phyllostegia helleri</i>							LW, MW, WC				
<i>Phyllostegia stachyoides</i>	MW, MM	MW, MM			MW						
<i>Portulaca villosa</i>	C, LD, MD	C, LD	C, LD	LD	LD	C, LD		C	C	C	C
<i>Pritchardia bakeri</i>						LM					
<i>Pseudognaphalium sandwicensium</i> var. <i>molokaiense</i>		C	C	C	C	C					
<i>Ranunculus hawaiiensis</i>	MM, MD, SA	SA									
<i>Ranunculus mauiensis</i>	MM, MD	MW, MM, WC			MW, MM, WC	MW	MW, MM				
<i>Sanicula sandwicensis</i>	MM, MD, SA	MM, SA									
<i>Santalum involutum</i>							LM, LW				
<i>Schiedea diffusa</i> ssp. <i>diffusa</i>		LW, MW			MW						
<i>Schiedea pubescens</i>		LW, MM, WC		WC	LW, MW, WC						
<i>Sicyos lanceoloideus</i>						LM, DC	LM, MM				
<i>Sicyos macrophyllus</i>	MM, MD	MW									
<i>Solanum nelsonii</i>	C	C			C			C			C
<i>Stenogyne kaalae</i> ssp. <i>sherffii</i>						LW					
<i>Wikstroemia skottsbergiana</i>							LW				
<b>Animals:</b>											
Band-rumped storm-petrel ( <i>Oceanodroma castro</i> )	DC	DC, WC	C		C	C	DC, WC		C		
Yellow-faced bee ( <i>Hylaeus anthracinus</i> )	C, LD	C, LD	LD	LD	C	C					
Yellow-faced bee ( <i>Hylaeus assimulans</i> )		C, LD	C	LD			C, LD				
Yellow-faced bee ( <i>Hylaeus facilis</i> )		C, LM		LD, LM	C	C, LD, LM					
Yellow-faced bee ( <i>Hylaeus hiliaris</i> )		C, LD		C	C						
Yellow-faced bee ( <i>Hylaeus kuakea</i> )						LM					
Yellow-faced bee ( <i>Hylaeus longiceps</i> )		C, LD		C, LD	C, LD	C					
Yellow-faced bee ( <i>Hylaeus mana</i> )						LM					
Orangeblack Hawaiian damselfly ( <i>Megalagrion xanthomelas</i> )	AP, C*	AP, LD*		C,* LM*	C,* LD*	LM*	C* LD,* LM*				
Anchialine pool shrimp ( <i>Procaris hawaiana</i> )	AP	AP									

C = Coastal ecosystem; MW = Montane Wet ecosystem; DC = Dry Cliff ecosystem; LD = Lowland Dry ecosystem; MM = Montane Mesic ecosystem; WC = Wet Cliff ecosystem; LM = Lowland Mesic ecosystem; MD = Montane Dry ecosystem; AP = Anchialine Pool ecosystem; LW = Lowland Wet ecosystem; SA = Subalpine ecosystem; \* = with species-specific water pool or pond.

**Hawaiian Islands Ecosystems**

Eleven distinct ecosystems (anchialine pool, coastal, lowland dry, lowland mesic, lowland wet, montane mesic, montane wet, montane dry, subalpine, dry cliff, and wet cliff) on the main eight Hawaiian Islands and NWHI currently harbor or historically harbored one or more of the 49 species under consideration for listing as endangered

in this proposed rule. These ecosystems are described below.

**Anchialine Pool**

The anchialine pool ecosystem is found on Oahu, Molokai, Maui, Kahoolawe, and Hawaii Island. Anchialine pools are land-locked bodies of water that have indirect underground connections to the sea and show tidal fluctuations in water level. These pools

are mixohaline (brackish), with salinities typically ranging from 2 parts per thousand (ppt) to concentrations just below that of sea water (32 ppt), although some pools are recorded as having salinities as high as 41 ppt (Maciolek 1983, pp. 607–612; Brock et al. 1987, p. 200). Because all anchialine pools occur within coastal areas, they are technically part of the coastal ecosystem (see below) with the same

climate conditions and many of the same applicable and overlapping habitat threats. However, we are addressing this ecosystem separately because of the uniqueness of the anchialine pools and the biota that occurs within them.

Over 80 percent of the State's anchialine pools are found on the island of Hawaii, with a total of approximately 600 to 650 pools distributed over 130 sites along all but the island's northernmost and steeper northeastern shorelines. On east Maui, eight locations along the north and south coasts have anchialine pools (some containing more than one pool, e.g., the anchialine pool system at Ahihi-Kinau Natural Area Reserve (NAR) consists of dozens of pools) (The Nature Conservancy (TNC) 2009, pp. 2–3). Characteristic animal species within the anchialine pool ecosystem include crustaceans (e.g., shrimps, prawns, amphipods, and isopods), molluscs (e.g., snails, sea slugs, and bivalves), and other invertebrates adapted to the pools' surface and subterranean habitats (TNC 2009, pp. 1–3). Generally, vegetation within the pools consists of various types of algal forms (blue-green, green, red, and golden-brown). The majority of Hawaii's anchialine pools occur in bare or sparsely vegetated lava fields, although some pools occur in areas with various ground cover, shrub, and tree species (Chai *et al.* 1989, pp. 2–24; Brock 2004, p. 35). The anchialine pool shrimp, *Procaris hawaiiana*, and the orangeblack Hawaiian damselfly, *Megalagrion xanthomelas*, which are proposed for listing as endangered species in this rule, are reported currently or historically from this ecosystem on Maui and Hawaii Island (Kensley and Williams 1986, pp. 417–437; Hawaii Biodiversity and Mapping Program (HBMP) 2010).

#### Coastal

The coastal ecosystem is found on all of the main Hawaiian Islands and the NWHI, with the highest native species diversity in the least populated areas and associated islets. The coastal ecosystem includes mixed herblands, shrublands, and grasslands, from sea level to 980 ft (300 m) elevation, generally within a narrow zone above the influence of waves to within 330 ft (100 m) inland, sometimes extending farther inland if strong prevailing onshore winds drive sea spray and sand dunes into the lowland zone (TNCH 2006). The coastal ecosystem is typically dry, with annual rainfall of less than 20 in (50 cm); however, windward rainfall may be high enough (up to 40 in (100 cm)) to support mesic-associated and sometimes wet-

associated vegetation (Gagne and Cuddihy 1999, pp. 54–66). Biological diversity is low to moderate in this ecosystem, but may include some specialized plants and animals such as nesting seabirds, the endangered plant *Sesbania tomentosa* (ohai) (TNCH 2006), and endangered birds in the NWHI (e.g., the Nihoa finch (*Telespyza ultima*) on Nihoa Island). The following plants proposed as endangered in this rule are reported currently or historically from this ecosystem:

*Portulaca villosa* (Hawaii Island, Maui, Kahoolawe, Oahu, Lehua, and Kaula), *Pseudognaphalium sandwicense* var. *molokaiense* (Maui, Lanai, Molokai, and Oahu), and *Solanum nelsonii* (Hawaii Island, Maui, Molokai, Niihau, and the NWHI) (TNCH 2007; HBMP 2010). The following animals proposed as endangered in this rule are reported currently or historically from this ecosystem: the band-rumped storm-petrel (Kahoolawe, Molokai, Oahu, and Lehua); orangeblack Hawaiian damselfly (Hawaii Island, Lanai, and Molokai); the yellow-faced bees *Hylaeus anthracinus* (Hawaii Island, Maui, Molokai, and Oahu), *H. assimulans* (Maui, Kahoolawe, and Oahu), *H. facilis* (Maui, Molokai, and Oahu), *H. hilaris* (Maui, Lanai, and Molokai), and *H. longiceps* (Maui, Lanai, Molokai, and Oahu).

#### Lowland Dry

The lowland dry ecosystem is found on all the main Hawaiian Islands and includes shrublands and forests generally below 3,300 ft (1,000 m) elevation that receive less than 50 in (130 cm) annual rainfall, or are in otherwise prevailing dry substrate conditions that range from weathered reddish silty loams to stony clay soils, rocky ledges with very shallow soil, or relatively recent little-weathered lava (Gagne and Cuddihy 1999, p. 67). Areas consisting of predominantly native species in the lowland dry ecosystem are now rare and are best represented on the leeward sides of the islands (Gagne and Cuddihy 1999, p. 67; TNCH 2006). Native biological diversity is low to moderate in this ecosystem, and includes specialized animals and plants such as the Hawaiian owl (pueo) and *Santalum ellipticum* (iliahialoe, coastal sandalwood) (Wagner *et al.* 1999, pp. 1220–1221; TNCH 2006). The following plants proposed for listing as endangered in this rule reported currently or historically from this ecosystem are: *Nothocestrum latifolium* (Maui, Lanai, and Oahu) and *Portulaca villosa* (Hawaii Island, Maui, Kahoolawe, Lanai, Molokai, and Oahu). The following animals proposed for listing as endangered in this rule

reported currently or historically from this ecosystem are: the orangeblack Hawaiian damselfly (Maui, Molokai), the yellow-faced bees *Hylaeus anthracinus* (Hawaii Island, Maui, Kahoolawe, and Lanai), *H. assimulans* (Maui, Lanai, and Oahu), *H. facilis* (Lanai and Oahu), *H. hilaris* (Maui), and *H. longiceps* (Maui, Lanai, and Molokai) (TNCH 2007; HBMP 2010).

#### Lowland Mesic

The lowland mesic ecosystem is found on all the main Hawaiian Islands except Kahoolawe and Niihau, and includes a variety of grasslands, shrublands, and forests, generally below 3,300 ft (1,000 m) elevation, that receive between 50 and 75 in (130 and 190 cm) annual rainfall (Gagne and Cuddihy 1999, p. 75; TNCH 2006). Native biological diversity is high in this system (TNCH 2006). The following plants proposed for listing as endangered in this rule reported currently or historically from this ecosystem are: *Deparia kaalaana* (Hawaii Island, Maui, and Kauai), *Exocarpos menziesii* (Hawaii Island and Lanai), *Gardenia remyi* (Hawaii Island, Molokai, and Kauai), *Joinvillea ascendens* ssp. *ascendens* (Kauai), *Kadua fluviatilis* (Kauai), *K. haupuensis* (Kauai), *Lepidium orbiculare* (Kauai), *Microlepia strigosa* var. *mauiensis* (Oahu), *Myrsine fosbergii* (Oahu and Kauai), *Nothocestrum latifolium* (Maui, Lanai, Molokai, and Oahu), *Ochrosia haleakalae* (Hawaii Island and Maui), *Pritchardia bakeri* (Oahu), *Santalum involutum* (Kauai), and *Sicyos lanceoloideus* (Oahu and Kauai) (TNCH 2007; HBMP 2010). The following animals proposed for listing as endangered in this rule reported currently or historically from this ecosystem are: the orangeblack Hawaiian damselfly (Lanai, Oahu), and the yellow-faced bees *Hylaeus facilis* (Maui, Lanai, and Oahu), *H. kuakea* (Oahu), and *H. mana* (Oahu).

#### Lowland Wet

The lowland wet ecosystem is generally found below 3,300 ft (1,000 m) elevation on the windward sides of the main Hawaiian Islands, except for Kahoolawe and Niihau (Gagne and Cuddihy 1999, p. 85; TNCH 2006). These areas include a variety of wet grasslands, shrublands, and forests that receive greater than 75 in (190 cm) annual rainfall, or are in otherwise wet substrate conditions (TNCH 2006). This system is best developed in wet valleys and slopes on Kauai, Oahu, Molokai, Maui, and Hawaii Island (TNCH 2006). Native biological diversity is high in this system (TNCH 2006). The following



plants proposed for listing as endangered in this rule reported currently or historically from this ecosystem are: *Cyanea kauaulaensis* (Maui), *Cyclosorus boydiae* (Hawaii Island and Maui), *Cyperus neokunthianus* (Maui), *Deparia kaalaana* (Hawaii Island, Maui, and Kauai), *Gardenia remyi* (Hawaii Island, Maui, Molokai, and Kauai), *Joinvillea ascendens* ssp. *ascendens* (Hawaii Island, Maui, Molokai, and Oahu), *Kadua fluviatilis* (Oahu), *Myrsine fosbergii* (Oahu and Kauai), *Ochrosia haleakalae* (Hawaii Island), *Phyllostegia brevidens* (Maui), *P. helleri* (Kauai), *Santalum involutum* (Kauai), *Schiedea diffusa* ssp. *diffusa* (Maui), *S. pubescens* (Maui and Molokai), *Stenogyne kaalae* ssp. *sherffii* (Oahu), and *Wikstroemia skottsbergiana* (Kauai) (TNCH 2007; HBMP 2010).

#### Montane Wet

The montane wet ecosystem is composed of natural communities (grasslands, shrublands, forests, and bogs) at elevations between 3,300 and 6,500 ft (1,000 and 2,000 m), in areas where annual rainfall is greater than 75 in (190 cm) (TNCH 2006). This system is found on all of the main Hawaiian Islands except Niihau and Kahoolawe (TNCH 2006). Native biological diversity is moderate to high (TNCH 2006). The following plants proposed for listing as endangered in this rule reported currently or historically from this ecosystem are: *Calamagrostis expansa* (Hawaii Island and Maui), *Cyclosorus boydiae* (Maui and Oahu), *Cyrtandra hematos* (Molokai), *Dryopteris glabra* var. *pusilla* (Kauai), *Huperzia stemmermanniae* (Hawaii Island and Maui), *Hypolepis hawaiiensis* var. *mauiensis* (Maui), *Joinvillea ascendens* ssp. *ascendens* (Hawaii Island, Maui, Molokai, Oahu, and Kauai), *Microlepia strigosa* var. *mauiensis* (Hawaii Island and Maui), *Myrsine fosbergii* (Kauai), *Phyllostegia brevidens* (Hawaii Island), *P. helleri* (Kauai), *P. stachyoides* (Hawaii Island, Maui, and Molokai), *Ranunculus mauiensis* (Maui, Molokai, Oahu, and Kauai), *Schiedea diffusa* ssp. *diffusa* (Maui and Molokai), *S. pubescens* (Molokai), and *Sicyos macrophyllus* (Maui) (TNCH 2007; HBMP 2010).

#### Montane Mesic

The montane mesic ecosystem is composed of natural communities (forest and shrublands) found at elevations between 3,300 and 6,500 ft (1,000 to 2,000 m), in areas where annual rainfall is between 50 and 75 in (130 and 190 cm), or are in otherwise mesic substrate conditions (TNCH

2006). This system is found on Kauai, Molokai, Maui, and Hawaii Island (Gagne and Cuddihy 1999, pp. 97–99; TNCH 2007). Native biological diversity is moderate, and this habitat is important for Hawaiian forest birds (Gagne and Cuddihy 1999, pp. 98–99; TNCH 2006). The following plants proposed for listing as endangered in this rule reported currently or historically from this ecosystem are: *Asplenium diellaciniatum* (Kauai), *Exocarpos menziesii* (Hawaii Island), *Joinvillea ascendens* ssp. *ascendens* (Kauai), *Labordia lorenciana* (Kauai), *Microlepia strigosa* var. *mauiensis* (Hawaii Island), *Ochrosia haleakalae* (Maui), *Phyllostegia stachyoides* (Hawaii Island and Maui), *Ranunculus hawaiiensis* (Hawaii Island), *R. mauiensis* (Hawaii Island, Maui, Molokai, Kauai), *Sanicula sandwicensis* (Hawaii Island and Maui), *Schiedea pubescens* (Maui), *Sicyos lanceoloideus* (Kauai), and *S. macrophyllus* (Hawaii Island) (TNCH 2007; HBMP 2010).

#### Montane Dry

The montane dry ecosystem is composed of natural communities (one grassland type, shrublands, forests) found at elevations between 3,300 and 6,500 ft (1,000 and 2,000 m), in areas where annual rainfall is less than 50 in (130 cm), or are in otherwise dry substrate conditions (TNCH 2006). This system is found on Maui and Hawaii Island, and is best developed in the saddle region between mountains on Hawaii Island, with rich native plant communities (Gagne and Cuddihy 1999, pp. 93–97; TNCH 2007). The following plants proposed for listing as endangered in this rule reported currently or historically from this ecosystem are: *Exocarpos menziesii* (Hawaii Island), *Festuca hawaiiensis* (Hawaii Island and Maui), *Portulaca villosa* (Hawaii Island), *Ranunculus hawaiiensis* (Hawaii Island), *R. mauiensis* (Hawaii Island), *Sanicula sandwicensis* (Hawaii Island), and *Sicyos macrophyllus* (Hawaii Island) (TNCH 2007; HBMP 2010).

#### Subalpine

The subalpine ecosystem is composed of natural communities (grasslands, shrublands, forests) at elevations between 6,500 and 9,800 ft (2,000 and 3,000 m), in areas where annual rainfall is seasonal, between 15 and 40 in (38 and 100 cm), or are in otherwise dry substrate conditions (TNCH 2006). Native biodiversity is not high in this system, but contains specialized invertebrates and plants adapted to dry, exposed conditions (Gagne and Cuddihy 1999, p. 107). Because rainfall is low in

this area, fog drip is an important moisture source (Gagne and Cuddihy 1999, p. 110). The following plants proposed for listing as endangered in this rule reported currently or historically from this ecosystem are: *Ranunculus hawaiiensis* (Hawaii Island and Maui) and *Sanicula sandwicensis* (Hawaii Island and Maui) (TNCH 2007; HBMP 2010).

#### Dry Cliff

The dry cliff ecosystem is composed of vegetation communities occupying steep slopes (greater than 65 degrees) in areas that receive less than 75 in (190 cm) of annual rainfall, or are in otherwise dry substrate conditions (TNCH 2006). This ecosystem is found on all the main Hawaiian Islands except Niihau, and is best represented along the leeward slopes of Lanai, Maui, the Waianae Mountains of Oahu, and Kauai (TNCH 2006). A variety of shrublands occur within this ecosystem (TNCH 2006). Native biological diversity is low to moderate (TNCH 2006). The following plants proposed for listing as endangered in this rule reported currently or historically from this ecosystem are: *Nothoctrum latifolium* (Maui, Lanai, Oahu, and Kauai), *Ochrosia haleakalae* (Maui), and *Sicyos lanceoloideus* (Oahu) (TNCH 2007; HBMP 2010). The band-rumped storm-petrel is reported currently or historically from the dry cliff ecosystem on Hawaii Island, Maui, and Kauai (TNCH 2007).

#### Wet Cliff

The wet cliff ecosystem is generally composed of shrublands on near-vertical slopes (greater than 65 degrees) in areas that receive more than 75 in (190 cm) annual rainfall, or are in otherwise wet substrate conditions (TNCH 2006). This system is found on all the main islands except for Niihau and Kahoolawe (TNCH 2006). Native biological diversity is low to moderate (TNCH 2006). The following plants proposed for listing as endangered in this rule reported currently or historically from this ecosystem are: *Phyllostegia brevidens* (Maui), *P. helleri* (Kauai), *Ranunculus mauiensis* (Maui and Molokai), and *Schiedea pubescens* (Maui, Lanai, and Molokai) (TNCH 2007; HBMP 2010). The band-rumped storm-petrel is reported currently or historically from the wet cliff ecosystem on Maui and Kauai (TNCH 2007).

### Description 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 factors affecting its continued existence. We summarize, below, the biological condition of, and factors affecting, each of the 49 species to assess whether each species should be listed as 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 section “Summary of Factors Affecting the 49 Species Proposed for Listing,” below.

#### *Climate Change Vulnerability Assessment for Hawaiian Plants*

Twenty-eight of the plant species proposed for listing and 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 3 (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.* p. 42). However, all 28 of these plant species scored moderately or highly 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). Therefore, if the species is moderately to highly vulnerable, then the likelihood of its persistence with the impacts of climate change is low, and the environmental changes associated with climate change are likely to become a threat to these

species’ continued existence 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). This fern has extremely variable frond morphology, depending on age, development, and possibly microhabitat (Wood and Aguraiuja, pers. obs. in Lorence *et al.* 2013, p. 167). Stipes (stalks joining the stem to the blade) and rachis (blade midribs) are black or purple-black to maroon and shiny. Blade divisions are entire to shallowly or deeply cut into lobes or twice-divided, with free veins that seldom join to form a vein network (Lorence *et al.* 2013, p. 170). Hillebrand (1888, pp. 621–622) recognized this species as *Lindsaya laciniata* (Botanischer Garten und Botanisches Museum (BGBM) 2014, in litt.). Brackenridge also interpreted *Diellia* as lindsaeoid (ferns having morphological characteristics of those in the genus *Lindsaea*) (1854, pp. 218–220), followed by other Hawaiian authors, and this fern was described as *Diellia laciniata* in Rock (1913, p. 59) and in Wagner (1952, pp. 11, 57–63). Palmer did not recognize *D. laciniata* as separate from *D. erecta* (2003, p. 117). Molecular phylogenetic studies by Schneider *et al.* (2005, pp. 455–460) placed *Diella* within *Asplenium*, and with further taxonomic reassessment (Lorence *et al.* 2013, pp. 167, 170–171), this species is recognized as *Asplenium diellaciniatum*. 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. This fern is found in the montane mesic ecosystem at Kawaiiki, approximately 4.5 mi (7 km) southeast of the original collection site (Palmer 2003, p. 117; HBMP 2010; Lorence *et al.* 2013, p. 167) in 2 occurrences, once totaling approximately 100 individuals (TNCH 2007; HBMP 2010; Lorence *et al.* 2013, p. 167; however, currently, there are only 31 mature and 9 juvenile individuals (Wood 2013, in litt.; PEPP 2014, p. 33).

Feral pigs, goats, 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 (HBMP 2010; Wood 2013, in litt.). Feral pigs, goats, and black-tailed deer may also forage on *A. diellaciniatum* (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 to eliminate 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 in the Kawaiiki area, such as *Buddleja asiatica* (dog tail), *Lantana camara* (lantana), and *Sphaeropteris cooperi* (Australian tree fern), compete with *A. diellaciniatum* and modify and destroy its native habitat, and displace it and other native Hawaiian 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; Wood 2013, in litt.). Additionally, the small number of individuals of *A. diellaciniatum* may limit this species’ ability to adapt to environmental change.

The remaining occurrences of *Asplenium diellaciniatum* and its habitat for its reintroduction are at risk; *A. diellaciniatum* numbers are observed to be decreasing on Kauai, and both the species and its habitat continue to be negatively affected by modification and destruction by ungulates and by direct competition by nonnative plants, combined with predation by nonnative ungulates. We find that this species should be listed throughout all of 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.

*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). This species was described by Hitchcock (1922, p. 148) and is recognized as a distinct taxon in O’Connor (1999, p. 1509) and in Wagner and Herbst (2003, p. 59), the most recently accepted taxonomic treatments for this species. Historically, *Calamagrostis expansa* was known from wet forest, open bogs, and bog margins 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.). Currently, this species is known from 13 occurrences totaling fewer than 750 individuals from both islands. On

the island of Maui, there are 2 occurrences in the west Maui Mountains (approximately 100 individuals) and 7 occurrences in the east Maui Mountains (totaling about 200 individuals), in the montane wet ecosystem (Wood 2005, in litt.; TNCH 2007; Welton 2008 and 2010, in litt.; Fay 2010, in litt.; HBMP 2010; Oppenheimer 2010 in litt.; Agorastos 2011, in litt.). On the island of Hawaii, there are 3 occurrences in the Kohala Mountains (totaling approximately 400 individuals) and 1 occurrence of a few individuals in Hawaii Volcanoes National Park, in the montane wet ecosystem (Perry 2006, in litt.; TNCH 2007; HBMP 2010).

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 of Hawaii Volcanoes National Park (Hobdy 1996, in litt.; Medeiros 1996, in litt.; Perlman 1996, in litt.; Wood 1996, in litt.; Perry 2006, 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 to eliminate herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR-DLNR 2010, in litt.). Rats have been noted by biologists to affect *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 may limit this species' ability to adapt to environmental change. Climate change may result in alteration of the environmental conditions and ecosystem that support this species. The species, which already is affected by multiple stressors, may be unable to tolerate or adapt to projected changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 68).

The remaining occurrences of *Calamagrostis expansa* and habitat for its reintroduction 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, and by direct competition from nonnative plants, combined with herbivory by nonnative ungulates and rats. The effects of climate change are

likely to further exacerbate these threats. We find that this species should be listed throughout all of 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.

*Cyanea kauaulaensis* (NCN), a shrub in the bellflower family (Campanulaceae), is endemic to Maui (Oppenheimer and Lorence 2012, p. 15). This species is 6.5 to 13 ft (2 to 4 m) tall, and is distinguished from other *Cyanea* species by its many-branched habit, with branches often rooting when coming in contact with the soil. Leaves are glabrous and narrow (2 to 3 in (5 to 7 cm) wide), clustered near the end of the branches, flowers are white and tubular, and fruit are bright orange (Oppenheimer and Lorence 2012, pp. 15–23). *Cyanea kauaulaensis* is recognized as a distinct taxon by Oppenheimer and Lorence (2012, pp. 15–23).

*Cyanea kauaulaensis* occurs on leeward west Maui, on talus or basalt boulder-strewn slopes along perennial streams at 2,400 to 3,000 ft (730 to 900 m), in the lowland wet ecosystem (TNCH 2007; HBMP 2010; Oppenheimer and Lorence 2010, pp. 17–18). Associated native species include those within *Metrosideros* (ohia) lowland wet forest, with herbaceous plants, ferns, and some riparian plants (Oppenheimer and Lorence 2010, 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 50 individuals) and Waikapu Valley (12 individuals) (Oppenheimer and Lorence 2012, pp. 15–16, 20).

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, p. 20). Rats and slugs are noted as a threat to *Cyanea kauaulaensis* by herbivory and seed predation (Oppenheimer and Lorence 2012, p. 20). Additionally, nonnative plants modify and destroy native habitat and outcompete native species, negatively affecting *C. kauaulaensis* and its habitat (Oppenheimer and Lorence 2012, p. 20). Although feral ungulates are present on west Maui, the known occurrences of *C. kauaulaensis* are likely not at risk from ungulates because of their location in extremely steep and rugged terrain; however, because of the terrain,

landslides and flooding may impact this species (Oppenheimer and Lorence 2012, pp. 20–21). Because of the threats described above, we find that this species should be listed throughout all of 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.

*Cyclosorus boydiae* (previously *Christella boydiae*) (kupukupu makalii) is a small to medium-sized member of the thelypteroid fern family (Thelypteridaceae), with reclining or erect stems and a large, tangled mass of roots that form a holdfast (Pukui and Elbert 1986, p. 186; Palmer 2003, pp. 87–88). In 1879, Eaton (pp. 361–362) named it for the original collector, Miss E.S. Boyd, calling it *Aspidium* (*Cyrtomium*) *boydiae*, for those plants occurring on Oahu. In 1888, Hillebrand (p. 572) described two varieties, *A. cyatheoides* var. *depauperatum*, occurring on the islands of Hawaii and Oahu, and *A. cyatheoides* var. *exaltatum* occurring on Kauai. Iwatsuki moved the two species to the genus *Thelypteris* in 1964 (Iwatsuki 1964, p. 28 in Medeiros *et al.* 1993, pp. 87–88; Palmer 2003, pp. 87–88). In 1999, Wagner (W.H., *et al.*) moved the genus *Aspidium* to *Cyclosorus* and recognized two varieties: *Cyclosorus* variety *boydiae* on Oahu and *Cyclosorus* variety *kipahuluensis* on Maui (Wagner *et al.* 1999, pp. 153, 156–157). In 2003, Palmer returned the species to *Christella* and did not recognize any varieties (2003, pp. 87–88). Following Smith (*et al.* 2006, p. 716), *Christella* was merged into *Cyclosorus*. *Cyclosorus boydiae* is the most recently accepted scientific name for this fern. Typical habitat for *Cyclosorus boydiae* is exposed, rocky, or moss-covered banks of stream courses in dense-wet *Metrosideros-Acacia* (ohia-koa) forest, at 4,300 to 4,400 ft (1,300 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).

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, *Cyclosorus boydiae* is found only at higher elevations on Oahu and east Maui, in 7 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 5 occurrences (approximately 360 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 (Palmer 2003, pp. 87–88; Wood 2007, in litt.; Kam 2008, in litt.; Oppenheimer 2008 and 2010, in litt.; HBMP 2010; Welton 2010, in litt.; Ching 2011, 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 the activities of feral pigs 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 2007, in litt.; Wood 2013, 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 to eliminate 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 alteration, landslides and flooding, nonnative plant species invading lower elevation stream courses, and man-made stream diversions (Medeiros *et al.* 1993, p. 88; Palmer 2003, p. 88). Nonnative plants such as *Tibouchina herbaceae* (glorybush) modify and destroy native habitat of *C. boydiae*, 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; Wood 2013, in litt.). Herbivory by feral pigs negatively impacts this species (HBMP 2010). Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Cyclosorus boydiae*, which already is affected by multiple stressors, may be unable to tolerate or adapt to projected changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 72).

The remaining occurrences of *Cyclosorus boydiae* and habitat for its reintroduction are at risk; *C. boydiae* populations are decreasing on Oahu, Maui, and Hawaii Island, and the species continues to be negatively affected by habitat loss and destruction by ungulates, direct competition with

nonnative plants, and herbivory by ungulates. The effects of climate change are likely to further exacerbate these threats. We find that this species should be listed throughout all of 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.

*Cyperus neokunthianus* (NCN) is a perennial plant in the sedge family (Cyperaceae). Culms are three-sided, 16 to 47 in (40 to 120 cm) tall, with short and slightly thickened rhizomes. Leaves are shorter than to as long as the culm, with flat or curved margins and reddish brown to dark brown sheaths. Inflorescences are umbelliform (with a short axis), open to moderately dense, bearing numerous spikelets (flower clusters). Achenes (fruit) are oblong, 3-sided, and about 1 in (2 mm) long (Koyama 1999, p. 1420).

*Cyperus neokunthianus* was previously recognized as *Mariscus kunthianus*, following the taxonomic treatment of Koyama (1990, p. 1420). In 1997, Strong and Wagner (p. 39) following Tucker (1994, p. 9), and more recently Wagner and Herbst (2003, pp. 52–53; 2012, p. 81), moved all Hawaiian species of *Mariscus* to *Cyperus*, and provides the most currently accepted taxonomic treatment of this species. *Cyperus neokunthianus* occurs in riparian areas of the lowland wet ecosystem on west Maui (Wagner *et al.* 1999, p. 1420; TNCH 2007; HBMP 2010). Historically, this species is known from Honokohau Falls at 2,800 ft (854 m) and Waihee Valley (HBMP 2010; Global Biodiversity Information Facility (GBIF) database 2014). 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).

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 to eliminate herbivory by these animals (Anderson *et al.* 2007, in

litt.; HAR–DLNR 2010, in litt.). Additionally, nonnative plants degrade 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; however, if it is extant, low numbers make this species more vulnerable to extinction because of the higher risks from genetic bottlenecks, random demographic fluctuations, and localized catastrophes.

Habitat for any remaining individuals of *Cyperus neokunthianus*, and for its reintroduction, is at risk; the species continues to be negatively affected by habitat modification and destruction by nonnative animals and plants. We find that this species should be listed throughout all of 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.

*Cyrtandra hematos* (haiwale), a shrub in the African violet family (Gesneriaceae), is endemic to Molokai (Wagner *et al.* 1999, pp. 760, 762). This species is 1 to 6.5 ft (0.3 to 2 m) tall, with minimally branched stems. The leaves are in whorls of 3 to 4 per node, often closely spaced and borne on the upper 5 to 8 nodes. Flowers are solitary, white with a greenish calyx, and narrowly tubular. Flower stalks are 0.3 to 0.4 in (8 to 10 mm) long, and tubes are about 0.7 in (18 mm) long (Wagner *et al.* 1999, pp. 760, 762). *Cyrtandra hematos* is recognized as a distinct taxon by Wagner *et al.* (1999, pp. 760, 762), who provide the most recently accepted taxonomic treatment of this species. *Cyrtandra hematos* occurs in wet forest at 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 the Olokui Plateau, Kawela, and Kahuoahu Valley on Molokai (Wagner *et al.* 1999, pp. 760, 762). Currently, approximately 30 individuals are known from Kapulei, but this occurrence has not been monitored since 1999 (USFWS Rare Taxon Database, 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 (USFWS Rare Taxon Database, 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 to eliminate herbivory by these animals

(Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Additionally, nonnative plants modify and destroy native habitat of *C. hematos* 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 (USFWS Rare Taxon Database, in litt.). This species may experience 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). The reasons for this species' lack of regeneration in the wild are unknown at this time. Climate change may result in alteration of the environmental conditions and ecosystem that support this species. *Cyrtandra hematos*, which already is affected by multiple stressors, may be unable to tolerate or adapt to projected changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 72).

The remaining occurrences of *Cyrtandra hematos* and habitat for its reintroduction 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 by direct competition with nonnative plants combined with predation by nonnative ungulates. The low number of remaining individuals may limit this species' ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats. We find that this species should be listed throughout all of 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.

*Deparia kaalaana* (NCN), a small, terrestrial fern in the ladyfern family (Athyraceae), is recognized as a distinct taxon by Palmer (2003, pp. 109–111) and Christenhusz *et al.* (2012, p. 16). Fronds (fern leaves) are 6 to 12 in (15 to 30 cm) long, sometimes bearing plantlets at the end of the rachis (the midrib of the fern blade, which is the expanded part of the frond above the stipe). Stipes (the stalk of the frond joining the stem to the blade) are straw-colored and sparsely scaly. Blades are oblong-lanceolate, with 9 to 11 pairs of pinnae. This species is distinguished from *D. marginalis* by its smaller, short-stalked and obliquely arranged pinnae, ultimate segments, and veins (Palmer 2003, pp. 109–111).

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 (Oppenheimer and Bustamente 2014, p. 103; Palmer 2003, pp. 109–111; PEPP 2014, p. 95; HBMP 2010; TNCH 2007). *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 (Oppenheimer and Bustamente 2014, p. 106; Cuddihy and Stone 1990, p. 63). 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 to eliminate 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* (prickly Florida blackberry) are capable of displacing all of the riparian habitat elements, such as native plants, in the area where *D. kaalaana* occurs. Nonnative slugs such as *Deroceras laevis* and *Limax maximus* are common in the area and can consume young plants (Joe and Daehler 2008, pp. 252–253). Climate change may induce frequent and severe drought or cause extreme flooding events, and may impact the habitat and *D. kaalaana* directly (Chu *et al.* 2010, pp. 4887, 4891, 4898). A single catastrophic event may result in extirpation of the remaining individual.

The remaining occurrence of *Deparia kaalaana* and habitat for its reintroduction are 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. We find that this species should be listed throughout all of 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.

*Dryopteris glabra* var. *pusilla* (hohiu) is a small, terrestrial fern in the wood

fern family (Dryopteridaceae). Fronds are 1.5 to 12 in (4 to 30 cm) long and densely clustered, with very thin stipes, and fertile when small. Blades are 2- to 3-pinnate, with winged rachises, and marginal to submarginal sori (clusters of sporangia, the spore-bearing (reproductive) structures of ferns, along the blade edge). This species is recognized as a distinct taxon by Palmer (2003, p. 144). Habitat for *Dryopteris 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 Kawaiikoi stream area (HBMP 2010). Currently, this species is known from fewer than 250 individuals in the Alakai Wilderness Preserve (including the Kawaiiko stream area) on Kauai (National Tropical Botanical Garden (NTBG) Herbarium Database 1995, in litt.; HBMP 2010).

*Dryopteris glabra* var. *pusilla* is at risk from habitat degradation by nonnative plants and feral ungulates, loss of reproductive vigor, and the species' vulnerability to climate change. Habitat modification and destruction by nonnative plants and feral ungulates is an ongoing threat to *Dryopteris glabra* var. *pusilla*. Although most individuals occur in the Alakai Wilderness Preserve, 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 to eliminate herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, 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. Climate change may result in alteration of the environmental conditions and ecosystem that support this species. *Dryopteris glabra* var. *pusilla* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 74). Because of these threats, we find that this species plant should be listed as endangered throughout all of 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.

*Exocarpos menziesii* (heau) is shrub in the sandalwood family (Santalaceae). Individuals are from 2 to 6.5 ft (0.5 to 2 m) tall. Stems are densely branched toward the ends, with conspicuously maroon-tinged tips. The leaves are usually scale-like, with occasional oblanceolate, foliaceous leaves 0.4 to 0.6 in (10 to 14 mm) long. Flowers are red and drupes are reddish brown to red at maturity, ovoid, 0.3 to 0.4 in (7 to 10 mm) long, with a small terminal beak partially embedded in a yellow, fleshy, receptacle (Wagner *et al.* 1999, p. 1218). *Exocarpos menziesii* is recognized as a distinct taxon by Wagner *et al.* (1999, p. 1218), who provide the most recently accepted taxonomic treatment of this species. 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; HBMP 2010). Historically, this species was also found in the lowland mesic (Lanai and Hawaii Island) and montane mesic ecosystems (Hawaii Island) (TNCH 2007; HBMP 2010).

*Exocarpos menziesii* is historically known from the island of Lanai (Kaiholena Gulch) and was formerly more wide-spread on the island of Hawaii (from Kahuku Ranch in the south to Hualalai and Puukapele on the leeward slopes) (Wagner *et al.* 1999, p. 1218; TNCH 2007; HBMP 2010). Currently, there is 1 scattered occurrence of fewer than 20 individuals on the slopes of Hualalai and approximately 1,800 individuals in the U.S. Army's Pohakuloa Training Area (PTA) on the island of Hawaii (PEPP 2013, pp. 10, 33; Thomas 2014, in litt.; Evans 2015, in litt.). There are no known occurrences of this species on Lanai today.

Feral goats, mouflon, and sheep modify and destroy the habitat of *Exocarpos menziesii* on Hawaii Island, with evidence of the activities of these animals reported in the areas where this species occurs (USFWS Rare Taxon Database 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 to eliminate 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. These plants are provided some protection within fenced management units in the training area; however, feral

goats are still being removed from within the fenced area (Evans 2015, in litt.; Nadig 2015, in litt.). Any individuals of *E. menziesii* outside of fenced enclosures or outside of the managed area are at risk. Occurrences and numbers of individuals have declined on the island of Hawaii (HBMP 2010; Thomas 2014, in litt.), once widely distributed from the south to the west sides of the island, and are now restricted to two locations; consequently *E. menziesii* may experience 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 potential threat to this species; although the U.S. Army has constructed firebreaks and has standard operating procedures in place for prevention and suppression of wildfires at PTA, wildfires may encroach from other areas (U.S. Army Garrison 2013, in litt.). The small number of individuals outside the occurrence at PTA may limit this species' ability to adapt to environmental change. Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Exocarpos menziesii* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 76).

The remaining occurrences of *Exocarpos menziesii* and suitable locations for reintroductions are at risk from habitat modification and destruction; from herbivory, by feral goats, mouflon, and sheep; and from the small number of remaining occurrences. Fire is a potential threat to this species. The effects of climate change are likely to exacerbate these threats. Because of these threats, we find that this species should be listed throughout all of 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.

*Festuca hawaiiensis* (NCN) is a caespitose (growing in tufts or clumps) annual in the grass family (Poaceae) (O'Connor 1999, p. 1547). This species has numerous erect culms (stems or stalks) 2 to 5 ft (0.5 to 1.5 m) tall, branching above the base, which are glabrous to slightly hairy. Sheaths are open and blades are flat and smooth, 10 to 16 in (25 to 40 cm) long, and 0.1 to 0.5 in (0.3 to 1 cm) wide. Branched inflorescences are composed of 6 to 8

alternate racemes (many flowers on one branch), with a flattened rachis (main axis) with flat hairs. The fruits are ellipsoid, dorsally compressed, and approximately 0.2 in (5 mm) long (O'Connor 1999, p. 1547). *Festuca hawaiiensis* was treated by Hillebrand (1888, pp. 534–535) as an introduced species, *F. drymeia*; however, *F. hawaiiensis* is currently recognized as a distinct taxon in O'Connor (1999, p. 1547), the most recently accepted Hawaiian plant taxonomy.

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 PTA on the island of Hawaii (HBMP 2010). These remaining four occurrences are within an area of less than 10 square miles (26 square kilometers) and total approximately 1,500 individuals (U.S. Army Garrison 2013, in litt.; Evans 2015, in litt.).

Habitat destruction by feral goats, sheep, and mouflon is a threat to the habitat of *Festuca hawaiiensis*. These ungulates browse on native plants such as grasses, and likely browse on *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 to eliminate 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. These plants are provided some protection within fenced management units in the training area; however, goats were recently removed from within fenced areas (Evans 2015, in litt.; Nadig 2015, in litt.). Any individuals of *F. hawaiiensis* outside of fenced enclosures 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* likely 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 potential threat to this species, especially because of the ingress of nonnative grass species. Although the U.S. Army has constructed firebreaks and has standard operating procedures in place for prevention and suppression of wildfires at PTA, fires may encroach from other areas, exacerbated by fuel loads provided by nonnative grasses (U.S. Army Garrison 2013, in litt.). Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Festuca hawaiiensis* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 76).

The remaining occurrence of *Festuca hawaiiensis* and habitat for its reintroduction 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, especially on Maui. Fire is a potential threat to the species and its habitat. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that this species should be listed throughout all of 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.

*Gardenia remyi* (nanu) is a tree in the coffee family (Rubiaceae). This species is 10 to 43 ft (3 to 13 m) tall with branches that are quadrangular and covered with fine, short, sticky hairs. Leaves are clustered towards the tips of the branches, broadly elliptic to ovate, 4 to 10 in (9 to 24 cm) long, 2 to 4 in (5 to 10 cm) wide, with a glabrous upper surface and dull lower surface. Flowers are fragrant, solitary, with a 6- to 8-lobed white corolla. Fruit are orange, round to ellipsoid, 1 in (3 cm) in diameter, with small seeds (Wagner *et al.* 1999, p. 1133). *Gardenia remyi* was described by Mann (1867, p. 171). This species is recognized as a distinct taxon in Wagner *et al.* (1999, p. 1133), which provides the most recently accepted taxonomic treatment of this species. Typical habitat for *G. remyi* is mesic to wet forest at 190 to 2,500 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).

Historically, this species was found on the island of Hawaii at Wao Kele O Puna NAR, Waiakea Forest Reserve (FR), Pahoa, and Hakalau Nui. On Maui, this species was known from Wailuaiki and Waikamoi in the Koolau FR, and from Papaea 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 FRs, including Hanakapiai Valley, Mahaulepu, and east Wahiawa Bog. Currently, *Gardenia remyi* is known from 19 occurrences totaling approximately 90 individuals on the islands of Hawaii, Maui, Molokai, and Kauai (Wood 2005, in litt.; Oppenheimer 2006, pers. comm.; Perry 2006, in litt.; Welton 2008, in litt.; Agorastos 2010, in litt.; HBMP 2010; Perlman 2010, in litt.). On Hawaii, individuals occur in Puu O Umi NAR (12), Wao Kele O Puna (3), Waiakea FR (1), and in Kohala NAR (1 individual in poor health and threatened by habitat modification and destruction and competition with *Melastoma* sp.). On east Maui, there is 1 individual at Kipahulu, and on west Maui, there are 2 individuals at Honokohau drainage, an occurrence of 21 individuals at Honolua peak, and 9 individuals at Honokohau-Hononana ridge (Oppenheimer 2006, pers. comm.; Welton 2009, in litt.). The number of individuals in the Molokai FR declined from 20 to 4 over a period of 5 years (Oppenheimer 2006, pers. comm.). Currently, on Molokai, there are 2 individuals within the Molokai FR, 1 individual at Manuahi ridge, and possibly 1 remaining individual at Mapulehu. On Kauai there are 6 individuals at Limahuli, 14 at Kalalau, 1 at Puuauuka, 2 at Puu Kolo, 1 at Waioli Valley, 1 at Kahili, and 6 at Waipa (NTBG 2008, in litt.; Perlman 2010, in litt.).

Habitat modification and destruction by feral pigs, goats, and deer negatively affects *Gardenia remyi* and areas 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* in the Kohala Mountains and at Wao Kele O Puna on the island of Hawaii; the Halelea and Lihue-Koloa FRs on Kauai; the West Maui FR and West Maui NAR, and the Puu Kukui Preserve on Maui; and the Molokai FR. Goats and signs of their activities are reported at the occurrences of *G. remyi* on the island of Kauai at the Kalalau Valley, and on the island of Molokai in Pelekunu Preserve and the Molokai FR. Axis deer and signs

of their activities are reported at the occurrences of *G. remyi* in the Molokai FR (HBMP 2010). Herbivory by these ungulates is a likely threat to *G. remyi*, as they browse on leaves and other parts of almost any woody or fleshy plant species. Nonnative plants modify and destroy native habitat of *G. remyi* and outcompete this and other native plant for water, nutrients, light, and space, in areas where *G. remyi* occurs on Hawaii Island, Kauai, Maui, and Molokai (Oppenheimer 2006, pers. comm.; Perry 2006, in litt.; Welton 2008, in litt.; HBMP 2010). Landslides are a threat to the occurrences and habitat of *G. remyi* ranging from Honopue to Waipio in the Kohala Mountains 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 at Wao Kele O Puna FR on the island of Hawaii (PEPP 2010, p. 73). Similarly, Agorastos (2011, in litt.) reported no viable seed production in the wild or within *ex situ* collections at Volcano Rare Plant Facility and no recruitment in the wild among the 14 individuals observed on the island of Hawaii, for unknown reasons. Predation of seeds by rats is reported as a threat to individuals on Kauai (NTBG 2008, in litt.). Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Gardenia remyi* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 76).

The remaining occurrences of *Gardenia remyi* and habitat for its reintroduction 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 these threats, we find that this species should be listed throughout all of 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.

*Huperzia stemmermanniae* (NCN) is an epiphytic, hanging fir-moss (a fern ally) in the club moss family (Lycopodiaceae). Sterile stem bases are unforked or once-forked, short, usually less than 6 in (15 cm) long, green to pale yellow, with fertile terminal strobili (fertile leaves). The strobili fork at an acute angle and the branches are usually straight (Palmer 2003, pp. 257–259). *Huperzia stemmermanniae* was first described as *Phlegmariurus stemmermanniae* by Medeiros and Wagner (Medeiros *et al.* 1996, pp. 90–96). Kartesz (1999, in NatureServe Explorer 2014, in litt.) moved the species to the genus *Huperzia*. Currently this species is recognized as a distinct taxon in the latest treatment (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 east Maui and the island of Hawaii, at 3,200 to 3,800 ft (975 to 1,160 m), in the montane wet ecosystem (Medeiros *et al.* 1996, p. 93; Palmer 2003, pp. 257, 259; TNCH2007; 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.* 1996, p. 93; HBMP 2010). Currently, approximately 30 individuals occur in the Laupahoehoe area on the island of Hawaii. One individual occurred in Kaapahu Valley on east Maui, but this individual has not been relocated since 1995 (Perry 2006, in litt.; Welton 2008, in litt.; HBMP 2010; Conry 2012, 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.* 1996, p. 96; Wood 2003, in litt.; HBMP 2010). Herbivory by feral pigs, goats, cattle, and axis deer is a potential threat to *H. stemmermanniae*. Nonnative plants modify and destroy the forest habitat that supports the native species upon which this epiphytic plant grows, and drought may also negatively affect this species and its habitat (Medeiros *et al.* 1996, p. 96; Perry 2006, in litt.; HBMP 2010). *Huperzia stemmermanniae* may experience 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). Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Huperzia stemmermanniae* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 77).

The remaining occurrences of *Huperzia stemmermanniae* and habitat for its reintroduction 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* may reduce the probability of its long-term persistence. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that this species should be listed throughout all of 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.

*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). This variety is a miniature form of *H. hawaiiensis*. Fronds are 2.5 to 10 in (6 to 25 cm) long; rhizomes are slender, 0.04 to 0.1 in (1 to 3 mm) in diameter; and parts are covered with chainlike, acute-tipped, tan hairs. Fronds are fully fertile at their smallest size (Palmer 2003, pp. 168–169). *Hypolepis hawaiiensis* var. *mauiensis* occurs in mesic and wet forest, but predominately in the montane wet ecosystem (Palmer 2003, pp. 168–170). This species is historically known from Eke Crater, Kapunakea, and Puu Kukui, on west Maui (Palmer 2003, pp. 168–170). Currently, 5 to 10 individuals are known from openings between bogs above 5,000 ft on west Maui, and a few individuals occur at Hanawi on east Maui (Maui Nui Task Force (MNTF) 2010, in litt.).

Nonnative plants 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 Hawaiian 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). This fern may experience 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). Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Hypolepis hawaiiensis* var. *mauiensis* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 78).

The remaining occurrences of *Hypolepis hawaiiensis* var. *mauiensis* and habitat for its reintroduction are at risk. Nonnative plants modify and destroy native habitat, and also outcompete native Hawaiian plants. This variety is moderately vulnerable to the impacts of climate change, and the small number of remaining individuals may limit this variety's ability to adapt to environmental change. Because of these threats, we find that this plant should be listed throughout all of 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.

*Joinvillea ascendens* ssp. *ascendens* (ohe) is an erect, perennial herb in the Joinvillea family (Joinvilleaceae) (Wagner *et al.* 1999, p. 1450). This subspecies is 5 to 16 ft (2 to 5 m) tall. Leaf blades are narrowly elliptic, up to 32 in (80 cm) long and 6 in (16 cm) wide. Both leaf surfaces have scattered bristles, with the lower surface also sparsely to moderately pubescent. Fruit are 0.2 in (6 mm) in diameter (Wagner *et al.* 1999, p. 1450). *Joinvillea ascendens* ssp. *ascendens* was described by Brongniart and Gris (Brongniart 1861, pp. 264–269), and is recognized as a distinct taxon by Wagner *et al.* (1999, pp. 1450–1451), who provide the most recently accepted taxonomic treatment of this subspecies. *Joinvillea ascendens* ssp. *ascendens* occurs in wet to mesic *Metrosideros polymorpha*-*Acacia koa* lowland and montane forest, and along intermittent streams, at 1,000 to 4,300 ft (305 to 1,300 m); in the lowland mesic (Kauai), 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, it occurred in the summit area, and on east Maui, it ranged on the northeastern side from the Koolau FR south to Kipahulu Valley. On Hawaii Island, it occurred almost island-wide. Currently, *Joinvillea ascendens* ssp. *ascendens* is still found on the same islands, in 56 occurrences totaling approximately 200 individuals (HBMP 2010; Conry 2012, in litt.). On Kauai, this subspecies is no longer known from the east and south side of the island (since the 1930s), but there are approximately 10 known occurrences on the north side of the island. On Oahu, this subspecies no longer occurs in the southern Koolau Mountains (range reduction since the 1930s), about 12 of the 20 known occurrences remain, with the range and numbers of occurrences remaining about the same (6) in the Waianae Mountains. On east Maui, the known occurrences have decreased from 12 to 4 (since the 1980s); on west Maui, 1 formerly large occurrence has decreased to approximately 40 individuals (since 1980), with 1 other occurrence approximately 2 mi to the east. On Molokai, the number of occurrences has increased to 20, but these are restricted to a much smaller central area of the island (range reduction since the 1930s). On Hawaii Island, the known occurrences have decreased from 17 locations to 2 since the 1950s (HBMP 2010; Oahu Task Force Meeting (OTFM) 2014, in litt.).

Nonnative ungulates modify and destroy habitat on all of the islands where *Joinvillea ascendens* ssp. *ascendens* occurs (Oppenheimer 2006, pers. comm.; Moses 2006, in litt.; Welton and Haus 2008, p. 16; HBMP 2010; Perlman 2010, in litt.). Herbivory by feral pigs, goats, deer, and rats is a likely threat to this species. Many nonnative plant species modify and destroy habitat, and outcompete this subspecies (HBMP 2010). Randomly occurring natural events, such as landslides, are a likely threat to the occurrences of *J. ascendens* ssp. *ascendens* on Kauai and Molokai (HBMP 2010). Fire is a potential threat to this species 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, the seedlings rarely survive to maturity, with a loss of individuals through attrition. It is uncertain if this rarity of reproduction is typical, or if it is related to habitat disturbance (Wagner *et al.* 1999, p. 1451). Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Joinvillea ascendens* ssp. *ascendens* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 76).

The remaining occurrences of *Joinvillea ascendens* ssp. *ascendens* and habitat for its reintroduction are at risk. The known individuals continue to be negatively affected by habitat modification and destruction by ungulates, compounded with possible herbivory by ungulates and rats. The small number of remaining individuals, smaller distribution, and poor recruitment in the wild may limit this subspecies' ability to adapt to environmental changes. Because of these threats, we find that this subspecies should be listed throughout all of 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.

*Kadua fluviatilis* (previously *Hedyotis fluviatilis*) (kamapuaa, pilo) is a climbing shrub in the coffee family (Rubiaceae) family. Plants are foetid when bruised. Stems are cylindrical and slightly flattened, 1 to 8 ft (0.3 to 3 m) long, with short lateral branches. Leaves are widely spaced, papery, elliptic-oblongate to elliptic-lanceolate, 3 to 7 in (8 to 17 cm) long, and 1 to 2 in (3 to 5 cm) wide. White flowers are fleshy and waxy, with several small, sac-like glands between corolla lobes. Capsules are woody, strongly quadrangular or winged, 0.5 in (1 cm) long, and 0.5 in (1 cm) in diameter. Seeds are translucent reddish brown, wedge-shaped, and minutely reticulate (netted) (Wagner *et al.* 1999, pp. 1142–1144). First described as *Kadua fluviatilis* by Forbes (1912, p. 6), this species was moved to the genus *Hedyotis* by Fosberg (1943, p. 90), and was recognized as a distinct taxon in Wagner *et al.* (1999, pp. 1142–1144). Terrell *et al.* (2005, pp. 832–833) placed *Hedyotis fluviatilis* in synonymy with *Kadua fluviatilis*, the earlier, validly published name, and this is the currently accepted scientific name. Typical habitat for this species on Kauai is mixed native shrubland and *Metrosideros* forest at 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 (HBMP 2010; TNCH 2007).

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, ranging from Koloa Gulch to Waipio (HBMP 2010). Currently, this species is known from only 11 occurrences totaling between 400 and 900 individuals on the islands of Kauai and Oahu (Wood 2005, p. 7; NTBG 2009, in litt.; HBMP 2010). On Kauai, *K. fluviatilis* is known from two locations: Hanakapiai on the north coast and Haupu Mountain on the south coast. On Oahu, *K. fluviatilis* is no longer found in the most northern and southern historical locations in the Koolau Mountains, and currently ranges in the north from Kaipapau to Helemano (HBMP 2010; U.S. Army database 2014).

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 Hanakapiai and Haupu occurrences on Kauai, and at all of the Oahu occurrences (Wood 1998, in litt.; HBMP 2010). Feral goats and evidence of their activities have been observed at Hanakapiai on Kauai (HBMP 2010). Herbivory by feral pigs and goats is a likely threat to *K. fluviatilis*. Nonnative plants modify and destroy native habitat of *K. fluviatilis* 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; Wood 1998, in litt.; HBMP 2010). *Kadua fluviatilis* is negatively affected by landslides on Kauai (HBMP 2010). Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Kadua fluviatilis* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 78).

The remaining occurrences of *Kadua fluviatilis* and habitat for its reintroduction are at risk. Numbers of occurrences and individuals are decreasing on Oahu and Kauai, from 16 occurrences to 11, and from over 1,000 individuals to between 400 and 900

individuals (HBMP 2010; Oahu Task Force Meeting 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 should be listed throughout all of 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.

*Kadua haupuensis* (NCN) is a shrub in the coffee family (Rubiaceae). This species is subdioecious (male and female flowers on separate plants, with sporadic hermaphroditic flowers), 3 to 5 ft (1 to 1.5 m) tall, with erect, brittle stems and glabrous branchlets with minutely hairy nodes. Older branches are brown with longitudinally fissured bark. Leaves are oblong to lanceolate or lanceolate-ovate and glabrous or sparsely hairy, 1 to 5 in (3 to 12 cm) long and 0.4 to 1 in (1 to 3 cm) wide, with conspicuous reticulate veins. Petioles are narrowly winged. Flowers are white or greenish-white with a purple tint. Fruit capsules produce numerous brown or blackish seeds (Lorence *et al.* 2010, pp. 137–144). *Kadua haupuensis* is recognized as a distinct taxon by Lorence *et al.* (2010, pp. 137–144). There is no historical information for this species as it was recently discovered and described (Lorence *et al.* 2010, pp. 137–144). *Kadua haupuensis* was discovered in 2007, just below and along cliffs in an isolated area on the north face of Mt. Haupu, 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, there are no known extant individuals of *K. haupuensis* in the wild; however, there are 11 individuals of this species propagated from collections from the wild plants.

Feral pigs modify and destroy the habitat of *Kadua haupuensis* on Kauai (Lorence *et al.* 2010, p. 140). Predation of fruits and seeds by rats is a potential threat. Landslides are an additional threat to this species at its last known occurrence. Nonnative plants such as *Caesalpinia decapetala* (wait-a-bit) and *Passiflora laurifolia* (yellow granadilla), and various grasses that modify and destroy native habitat and outcompete native plants are found at the last known location of *K. haupuensis*. The small number of remaining individuals in propagation, and no known remaining wild individuals, may limit

this species' ability to adapt to environmental change. Because of these threats, we find that *K. haupuensis* should be listed throughout all of 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.

*Labordia lorenciana* (NCN) is a small tree in the Logania family (Loganiaceae). Individuals are 10 to 13 ft (3 to 4 m) tall. The bark is grayish brown and mottled white or dark brown. Leaves are opposite, chartaceous (papery), and hairy. Flowers, functionally unisexual, are green, forming unbranched cymes. Fruit mature to brown capsules 1 to 1.5 in (25 to 37 mm) with ellipsoid 0.08 to 0.12 in (2 to 3 mm) seeds (Wood *et al.* 2007, pp. 195–197). *Labordia lorenciana* was discovered and validated by Wood *et al.* (2007, pp. 195–199). 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 in Kawaiiki Valley. 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 potential problems associated with small populations. Feral pigs and goats modify and destroy the habitat of *Labordia lorenciana* (Wood *et al.* 2007, p. 198). 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. Predation of seeds by rats is a likely threat to this species (Wood *et al.* 2007, p. 198). Competition with nonnative plant species, including *Lantana camara*, *Passiflora tarminiana* (banana poka), *Psidium cattleianum* (strawberry guava), and *Rubus argutus*, is a threat to *L. lorenciana*, as these nonnative plants have the ability to spread rapidly and cover large areas in the forest understory, and can outcompete native plants (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 a likely threat to *L. lorenciana* where it occurs on Kauai (Wood *et al.* 2007, p. 198). This species may experience 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). Because of these threats, we find that *L. lorenciana* should be listed throughout all of 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.

*Lepidium orbiculare* (anaunau) is a small, many-branched shrub in the mustard family (Brassicaceae). Individuals are 2 to 4 ft (0.6 to 1 m) tall (St. John 1981, pp. 371–373; Wagner *et al.* 1999, p. 409). Glabrous leaves are thin and crowded at the stem apex, not very fleshy and usually elliptical, occasionally lanceolate or oblanceolate, 3 to 7 in (6 to 17 cm) long, with rounded serrate margins. White flowers are in indeterminate racemes with branches subtended by linear, leaf-like bracts (1 in (2 cm)) long, with fine, short hairs. Seeds are reddish brown, orbicular (the name *L. orbiculare* is in reference to the seed shape) with pale, membranous-winged margins (Wagner *et al.* 1999, p. 409; St. John 1981, pp. 371–373). *Lepidium orbiculare* was resurrected from synonymy with *L. serra* and is recognized as a distinct taxon by Wagner and Herbst (2003, p. 13). This species occurs in mesic forest on Mt. Haupu, on the island of Kauai, in the lowland mesic ecosystem (Wagner *et al.* 1999, p. 409; HBMP 2010; PEPP 2014, p. 34; TNCH 2007). Historically, *Lepidium orbiculare* 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 at Mt. Haupu (Wagner *et al.* 2012, p. 19; PEPP 2014, p. 34; Smithsonian Institution 2015, in litt.).

Feral pigs have been documented to modify and destroy habitat of other rare and endangered native plant species at the same location on Mt. Haupu, Kauai (Lorence *et al.* 2010, p. 140); therefore, we consider that activities of feral pigs also pose a threat to *Lepidium orbiculare*. Nonnative plants degrade native habitat and outcompete native plants, are found at the last known location of *L. orbiculare*. Landslides are an additional threat to this species. *Lepidium orbiculare* may experience 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* and habitat for its reintroduction are at risk; the species continues to be negatively affected by habitat modification and destruction by

feral pigs, and by direct competition from nonnative plants. Natural events such as landslides are a threat to the only known occurrence of the species (HBMP 2010). The small number of individuals may limit this species' ability to adapt to environmental change. Because of these threats, we find that this species should be listed throughout all of 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.

*Microlepia strigosa* var. *mauiensis* (NCN) is a terrestrial, medium-sized fern in the bracken fern family (Dennstaedtiaceae), with fronds to 40 in (100 cm) long. This variety is extremely hairy, with the stipes, rachises (midribs), costae (frond rib), and entire fronds covered with uniform, jointed hairs with pointed tips. The rachises are often zigzag (Palmer 2003, p. 186). This fern was originally described as *Microlepia mauiensis* by Wagner (1993, pp. 73–75) from a collection made at Hanaula, west Maui. In the most recent treatment of all Hawaiian ferns, Palmer (2003, p. 186) recognizes this entity as an endemic variety of the indigenous *Microlepia strigosa*. Typical habitat for *Microlepia strigosa* var. *mauiensis* is mesic to wet forest at 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 *Microlepia strigosa* var. *mauiensis*; however, it had a wide range on the islands of Hawaii, Maui, and Oahu (HBMP 2010). Currently, *Microlepia strigosa* var. *mauiensis* is known most recently from nine occurrences totaling fewer than 100 individuals on the islands of Oahu (15 to 20 individuals), Maui (fewer than 20 individuals last observed in 2007), 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.).

*Microlepia strigosa* var. *mauiensis* is highly threatened by habitat modification and destruction by feral pigs and goats (Oppenheimer 2007, in litt.; Bily 2009, in litt.; HBMP 2010). Herbivory by feral pigs is a likely threat to *M. strigosa* var. *mauiensis* (Oppenheimer 2007, in litt.; Bily 2009, in litt.; HBMP 2010). Nonnative plants degrade habitat and outcompete *M. strigosa* var. *mauiensis* on Maui (Oppenheimer, in litt. 2007). Hybridization with other varieties of *Microlepia* is a threat to this species on

Oahu that is compounded by the low number of individuals (Kawelo 2010, in litt.). Climate change may result in alteration of the environmental conditions and ecosystems that support *M. strigosa* var. *mauiensis*. This variety may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 82), and the effects of climate change are likely to exacerbate the threats listed above. Because of those threats, we find that this plant should be listed throughout all of 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.

*Myrsine fosbergii* (kolea) is a branched shrub or small tree in the myrsine family (Myrsinaceae). This species is 7 to 13 ft (2 to 4 m) tall, with dark reddish brown, glabrous branches and glabrous, narrowly elliptic leaves clustered at the tips of the branches (dark green with dark purple bases). Flowers are perfect or possibly unisexual (dioecious), arising on short woody knobs among the leaves. Drupes are purplish black, globose, 0.2 to 0.4 in (6 to 9 mm) in diameter (Wagner *et al.* 1999, p. 940). *Myrsine fosbergii* was described by Hosaka (1940, pp. 46–47). This species is recognized as a distinct taxon in Wagner *et al.* (1999, p. 40), Wagner and Herbst (2003, p. 35), and Wagner *et al.* (2012, p. 53), the most recently accepted taxonomic treatment of this species. There is some question whether individuals found on Kauai are in fact *M. fosbergii*; if they are not, this species would be endemic to Oahu, with fewer than 50 known individuals (Lau 2012, pers. comm. in Conry 2012, in litt.). Typical habitat for *Myrsine fosbergii* on Oahu is *Metrosideros*-mixed native shrubland, at 2,200 to 2,800 ft (670 to 850 m) (Wagner *et al.* 1999, p. 940; HBMP 2010; TNCH 2007). Typical habitat on Kauai is *Metrosideros-Diospyros* (ohia-lama) lowland mesic forest and *Metrosideros-Cheirodendron* (ohia-olapa) montane wet forest, often on watercourses or stream banks, at 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 Koolau Mountains of Oahu at the Puu Lanihuli and Kuliouou summit ridges (HBMP 2010). This species was never observed or collected on Kauai before 1987, but is assumed to have been there historically. Currently, *M. fosbergii* is known from 14 occurrences, totaling a little more than 100 individuals. On Oahu, there are

widely scattered occurrences along the Koolau Mountains summit ridge (48 individuals) (lowland mesic and lowland wet ecosystems) (HBMP 2010). On Kauai, this species was once widely scattered in the northwest and central areas, but is currently known from only 55 remaining individuals in those same areas (Wood 2005 and 2007, in litt.; HBMP 2010).

*Myrsine fosbergii* is at risk from habitat modification and destruction by nonnative plants and animals; herbivory by feral pigs and goats; the displacement of individuals through competition with nonnative plants for space, nutrients, water, air, and light; and the low number of individuals. On Oahu, evidence of the activities of feral pigs has been reported at all summit populations (HBMP 2010). On Kauai, evidence of the activities of feral pigs has been reported at the centrally located occurrences (Wood 2005 and 2007, in litt.; HBMP 2010), and evidence of the activities of feral goats has been reported at the north-central occurrences (HBMP 2010). Herbivory by feral pigs and goats is a likely threat to *M. fosbergii* (Wood 2005 and 2007, in litt.; HBMP 2010). Nonnative plants compete with *M. fosbergii*, and modify and destroy its native habitat on Oahu and Kauai (HBMP 2010). The small number of remaining individuals may limit this species' ability to adapt to environmental change. Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Myrsine fosbergii* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 82). The effects of climate change are likely to further exacerbate the threats listed above. Because of these threats, we find that *M. fosbergii* should be listed throughout all of 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.

*Nothocestrum latifolium* (aiea) is a small tree in the nightshade family (Solanaceae). Individuals are 33 ft (10 m) tall, with a gnarled trunk, rigid ascending branches, and young parts with yellowish-brown pubescence. The thick, pubescent leaves, usually clustered toward the ends of the branches, are seasonally deciduous. Flowers occur in clusters on short spurs and have a greenish-yellow corolla with the corolla tube about twice as long as the calyx. Berries are yellowish-orange, succulent, and depressed-globose (Symon 1999, p. 1263). *Nothocestrum*

*latifolium* was described by Gray (1862). This species is recognized as a distinct taxon in Symon (1999, p. 1263), the most recently accepted taxonomic treatment of this species.

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, *Nothocestrum latifolium* was known from Waieli, Kaumokuni, and Kupehau gulches, and Makua Valley, in the Waianae Mountains of Oahu; the Kawela and Kapaakea gulches on Molokai; from Koele, Kaohai, and Maunalei Valleys on Lanai; and from the southwest rift zone of Haleakala on Maui (HBMP 2010). This species was never observed or collected on Kauai before 1986, but is assumed to have been there historically, and the current status of this individual is unknown. On the island of Oahu, there is one individual in Manuwai Gulch, one individual at Kaluaa could not be relocated, and the three individuals located at west Makaleha were found to have died (Moses 2006, in litt.; Starr 2006, in litt.; Oppenheimer 2006, pers. comm.; HBMP 2010; Kawakami 2010, in litt.; Kawelo 2010, in litt.; Welton 2010, in litt.; Ching 2011, in litt.; Oppenheimer 2011, in litt.). On Molokai, at least four individuals were observed in 2009, above Makolelau; however, their current status is unknown (Moses 2006, in litt.). There are 18 occurrences totaling approximately 1,600 individuals on east and west Maui (Ching 2011, in litt.). One occurrence on east Maui is the largest, consisting of as many as 1,500 individuals (HBMP 2010). On Lanai, none of the individuals in the occurrence near the State Cooperative Game Management Area at Kanepuu could be relocated in 2011 (Duvall 2011, in litt.; Oppenheimer 2011, in litt.). Also on Lanai, no individuals within the Kanepuu Preserve (Kahue Unit) were found during surveys in 2012, although there are plans to continue surveying the area and other suitable habitat (PEPP 2012, p. 129). The species' range on each island has decreased dramatically since 2001 (Kawelo 2005 and 2010, in litt.; Oppenheimer 2011, in litt.; HBMP 2010).

Feral pigs (Oahu, Maui, Kauai), goats (Maui, Kauai), mouflon and sheep (Lanai), axis deer (Lanai, Maui), and black-tailed deer (Kauai) modify and destroy habitat of *Nothocestrum latifolium* (HBMP 2010). Herbivory by these animals also poses a threat to this species. Nonnative plants outcompete *N. latifolium*, and modify and destroy

habitat at all known occurrences. Fire is a potential threat to this species. Low numbers of individuals may limit this species' ability to adapt to environmental change. Climate change may result in alteration of the environmental conditions and ecosystems that support this species (Fortini *et al.* 2013, p. 83), and the effects of climate change are likely to further exacerbate the threats listed above. Additionally, for unknown reasons, there is an observed lack of regeneration in *N. latifolium* in the wild (HBMP 2010). Because of these threats, we find that this species should be listed throughout all of 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.

*Ochrosia haleakalae* (holei), a tree in the dogbane family (Apocynaceae), is 7 to 27 ft (2 to 8 m) tall. The elliptic leaves are clustered three or four per node. Tubular white flowers occur in relatively open inflorescences. Robust, ovoid drupes are yellow or plum-colored, streaked with brown, and often have irregular ridges at maturity due to differential thickening of the exocarp (outermost layer of the fruit) (Wagner *et al.* 1999, p. 218). *Ochrosia haleakalae* was described by St. John (1978, pp. 199–220). This species is recognized as a distinct taxon in Wagner *et al.* (1999, p. 218), the most recently accepted taxonomic treatment of this species. Typical habitat for this species is dry to mesic forest, sometimes wet forest, and often lava, at 2,300 to 4,000 ft (700 to 1,200 m), in the dry cliff (Maui), lowland mesic (Maui and Hawaii Island), lowland wet (Hawaii Island), and montane mesic (Maui) ecosystems (Wagner *et al.* 1999, p. 218; HBMP 2010; TNCH 2007). On east Maui, this species occurs in diverse mesic forest (Medeiros *et al.* 1986, pp. 27–28; TNCH 2007; Medeiros 2007, in litt.). On the island of Hawaii, *O. haleakalae* is known from gulches and valleys in the Hamakua district and from *Metrosideros polymorpha-Pisonia sandwicensis* (ohia-papala kepa) mesic forest in the Kohala Mountains (Perlman and Wood 1996, in litt.; Wagner *et al.* 1999, p. 218).

Historically, *Ochrosia haleakalae* was known from two islands, Maui and Hawaii. On Maui, the species was known from the Koolau FR and Makawao FR, the northern slope of Haleakala, and from Auwahi and Kanaio on the southern slopes of Haleakala (HBMP 2010). On the island of Hawaii, this species was known from valleys in the Kohala Mountains (Pololu, Honopue, and Waipio) and from Kalopa gulch on the eastern (Hamakua) slope of

Mauna Kea (HBMP 2010). Currently, *O. haleakalae* is known from 4 occurrences totaling 15 individuals at Makawao FR and Auwahi-Kanaio on the island of Maui, and from 4 occurrences (Alakahi gulch, Honopu Valley, Kalopa gulch, and Laupahoehoe) on the island of Hawaii, totaling 16 individuals (Pratt 2005, in litt.; Medeiros 2007, in litt.; Oppenheimer 2008, in litt.; HBMP 2010).

On Hawaii, the status of the individuals at Alakahi Gulch is uncertain after a strong earthquake in 2006; the individual found at Kailikaula Stream was last observed in 2011, and is vulnerable to landslides (Hadway 2013, in litt.), and the individual at Kalopa has not been confirmed since 1999 (Agorastos 2010 and 2011, in litt.; Conry 2012, in litt.; Hadway 2013, in litt.). More than 100 propagated individuals have been outplanted at Kipuka Puauu and Kipuka Ki in Hawaii Volcanoes National Park; however, survivorship of these individuals is unknown (Pratt 2005, in litt.; Agorastos 2007, pers. comm.; Bio 2008, in litt.; HBMP 2010; Pratt 2011, in litt.; Conry 2012, in litt.). Feral pigs and goats modify and destroy the habitat of *O. haleakalae* on Maui and Hawaii Island, and goats and cattle modify and destroy the habitat of *O. haleakalae* on Maui (Medeiros 1995, in litt.; Oppenheimer 2004, in litt.; Pratt 2005, in litt.; Agorastos 2007, pers. comm.). In dry areas, the possibility of wildfires affecting the habitat of *O. haleakalae* is exacerbated by the presence of introduced plant species such as *Pennisetum clandestinum* (kikuyu grass) (HBMP 2010). In addition, nonnative plant species modify and destroy habitat and outcompete native plants, including *O. haleakalae* (HBMP 2010). Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Ochrosia haleakalae* may be unable to tolerate or respond to changes in temperature or moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 83). This species may experience reduced reproductive vigor due to reduced levels of genetic variability resulting from 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).

*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; and the small number of remaining individuals; and moderate vulnerability to the effects of climate change. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that this species should be listed throughout all of 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.

*Phyllostegia brevidens* (NCN) is a scandent (climbing) subshrub in the mint family (Lamiaceae). Stems are glabrous, and ovate leaves are 3 to 5 in (7 to 13 cm) long, also glabrous or sparsely minute-haired. Leaf margins are dentate to serrate. There are 14 to 20 white, tubular (with a longer lower lip) flowers per unbranched inflorescence, with bracts 1 to 2.5 in (2 to 6 cm) long, very minutely-haired along nerves, and minutely glandular-dotted. Nutlets are about 0.2 in (6 mm) (Wagner *et al.* 1999, pp. 814–815). *Phyllostegia brevidens* is recognized as a distinct taxon by Wagner *et al.* (1999, pp. 814–815), the most recently accepted taxonomic treatment of this species. This species occurs in wet forest on the islands of Maui and Hawaii at 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 FR, 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 2014, in litt.). Currently, there is one known occurrence of two individuals on the island of Maui (PEPP 2009, p. 90; Wagner *et al.* 2012, p. 46; PEPP 2014, p. 136).

Feral pigs, sheep, mouflon, and cattle on Hawaii Island modify and destroy the habitat of *Phyllostegia brevidens*, and feral pigs modify and destroy habitat on Maui (PEPP 2014, p. 136). Nonnative plants outcompete *P. brevidens* on Maui. Herbivory by slugs poses a threat to the remaining individuals on Maui (PEPP 2014, p. 136). In addition, natural events such as landslides are a potential threat to the occurrence on Maui (PEPP 2014, p. 136). The small number of remaining individuals may limit this species' ability to adapt to environmental change. Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Phyllostegia brevidens* may be unable to tolerate or respond to

changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 84).

The remaining occurrences of *Phyllostegia brevidens* and habitat for its reintroduction are at risk. Only two individuals are known to persist at the occurrence on Maui; no individuals have been observed recently on Hawaii Island. 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* should be listed throughout all of 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.

*Phyllostegia helleri* (NCN) is a weakly erect to climbing shrub in the mint family (Lamiaceae). Stems have small, curved hairs. Leaves are thin and somewhat wrinkled; ovate; 4 to 6 in (1 to 14.5 cm) long, with uneven, shiny crinkly hairs; with or without inconspicuous glandular dots, and serrate margins. Tubular flowers are white with lavender-tinged lobes, with the upper lobe shorter than the lower lobe. Nutlets are 1 in (2.5 cm) long (Wagner *et al.* 1999, pp. 816–817). *Phyllostegia helleri* is recognized as a distinct taxon in the Manual of Flowering Plants of Hawaii (Wagner *et al.* 1999, pp. 816–817), the most recently accepted taxonomic treatment of this species. Habitat for *Phyllostegia helleri* is ridges or spurs at 2,800 to 4,000 ft (860 to 1,200 m) in diverse wet forest on Kauai, in the lowland wet, montane wet, and wet cliff ecosystems (Wagner *et al.* 1999, p. 817; TNCH 2007; HBMP 2010).

Historically, *Phyllostegia helleri* was wide-ranging on the island of Kauai, extending from the north and east sides throughout the central plateau (Wagner *et al.* 1999, p. 817; HBMP 2010). Currently, this species is limited to 1 occurrence of 10 individuals in Wainiha Valley (PEPP 2014, p. 35).

Feral pigs and goats modify and destroy the habitat of *Phyllostegia helleri* on Kauai (HBMP 2010). 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 *Kalanchoe pinnata* (air plant), *Rubus rosifolius* (thimbleberry), *Erigeron*

*karvinskianus* (daisy fleabane), *Psidium guajava* (common guava), and various grasses, modify and destroy native habitat and outcompete native plants, and are found at the last known location of *P. helleri* (HBMP 2010). This species may experience 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 (Barret and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Phyllostegia helleri* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 84).

The remaining occurrence of *Phyllostegia helleri* and habitat for its reintroduction are 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 10 individuals. These 10 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 10 individuals. The small number of remaining individuals may limit 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* should be listed throughout all of 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.

*Phyllostegia stachyoides* (NCN) is a weakly erect to climbing subshrub in the mint family (Lamiaceae). Stems have forward-facing hairs; leaves are somewhat wrinkled and lanceolate to ovate, 8 in (20 cm) long and 3 in (8 cm) wide, with both surfaces moderately to sparsely hairy. The lower leaf surface is usually moderately glandular-dotted. The upper lip of the tubular white flower is tinged pink. Nutlets are 1 in (3 cm) long (Wagner *et al.* 1999, p. 823). *Phyllostegia stachyoides* is recognized as a distinct taxon in the Manual of Flowering Plants of Hawaii (Wagner *et al.* 1999, p. 823), the most recently accepted taxonomic treatment of this species. *Phyllostegia stachyoides* occurs

in mesic to wet forest at 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 widely ranging occurrences on Hawaii Island (north and south Kona, Kohala, and Hawaii Volcanoes National Park) (Wagner *et al.* 1999, p. 823; HBMP 2010). Currently, *P. stachyoides* is known from seven occurrences, totaling 20 individuals. Occurrences on west Maui, at Honokokau, Puu Kukui, Luakoi, and Lihau, total about 15 individuals. Those on Molokai occur at Kamakou, Hanalilolilo, and Kumueli (total of 5 individuals). Several individuals resembling *P. stachyoides* were observed at Kaohe on Hawaii Island; however, their identity is not yet confirmed (PEPP 2012, p. 156.).

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). Nonnative plants such as *Erigeron karvinskianus*, *Tibouchina herbacea*, and *Ageratina adenophora* (Maui pamakani) compete with *P. stachyoides*, modify and destroy its native habitat, and displace other native Hawaiian plant species (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 in Cuddihy and Stone 1990, p. 74). 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 drought pose a threat to small, isolated occurrences of *P. stachyoides*, and rockfalls and landslides pose a threat to occurrences on Molokai (PEPP 2014, pp. 140–142). This species may experience 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). Climate change may result in alteration of the environmental conditions and ecosystems that support this species, through flooding and drought.

*Phyllostegia stachyoides* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 84).

The remaining occurrences of *Phyllostegia stachyoides* and habitat for

its reintroduction 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 may limit 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 should be listed throughout all of 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.

*Portulaca villosa* (ihi) is a perennial herb in the purslane family (Portulacaceae). The taproot is fleshy to woody, with stems prostrate to weakly ascending and 12 in (30 cm) long. The small leaves are linear to oblong and pale grayish green. White or pink flowers are in groups of three to six arranged in small bunches at the ends of the branches. The fruit capsules of *P. villosa* are 0.2 in (5 mm) long and contain dark reddish-brown seeds (Wagner *et al.* 1999, p. 1074). *Portulaca villosa* is recognized as a distinct taxon by Wagner *et al.* (1999, p. 1074), the most recently accepted taxonomic treatment of this species. *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 from Nihoa (NWHI); however, their current status is unknown. This species has not been observed on Oahu since the 1960s, when it was locally abundant at Kaohikaipu Island (HBMP 2010). *Portulaca villosa* is known from Molokai at Kauhako Crater (a few), from east Maui on Alau islet (2 individuals), from west Maui at Lihau (about 24 individuals), and from Kahoolawe at Puu Koaie, Aleale, and above Kamalio (fewer than 15 individuals) (MNFTF 2010, in litt.). On the island of Lanai, two individuals were observed at Kaohai in 1996 (HBMP 2010). On the

island of Hawaii, there are five occurrences in the Pohakuloa Training Area, totaling 10 individuals (Evans 2015, in litt.).

Axis deer (Maui and Lanai), mouflon, sheep, and goats (Lanai), and cattle (Hawaii Island) modify and destroy the habitat of *Portulaca villosa* (HBMP 2010). These animals may also forage directly on this species. Nonnative plants compete with and modify and destroy native habitat of *P. villosa*; displace this species and other native Hawaiian plants; and pose a threat to the known occurrences on Hawaii Island, Maui, Kahoolawe, Lanai, and Molokai (Smith 1985, pp. 180–250; Vitousek *et al.* 1987 in Cuddihy and Stone 1990, p. 74). *Portulaca villosa* occurs in drier coastal and lowland habitats, all of which are at risk from wildfires. Some coastal habitat includes exposed cliffs, which erode and cause rockfalls in areas where *P. villosa* occurs (Kahoolawe), posing a threat to this species (HBMP 2010). This species may experience 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). Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Portulaca villosa* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 86).

The remaining occurrences of *Portulaca villosa* and habitat for its reintroduction are at risk; the number of occurrences have decreased on Oahu, Lanai, and Hawaii Island, and the species continues to be negatively affected by continued habitat modification and destruction, and by competition from 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 may limit 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 should be listed throughout all of 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.

*Pritchardia bakeri* (Baker's loulu) is a small to medium-sized palm in the palm

family (Arecaceae). This palm species, endemic to Oahu, is 23 to 30 ft (7 to 10 m) tall, with a smooth, grayish trunk 8 to 10 in (20 to 25 cm) in diameter. Its crown contains up to 40 ascending to stiffly spreading leaves, 2 to 3 ft (0.6 to 0.9 m) long and wide, on 1 to 2 ft (0.3 to 0.6 m) leaf stalks. The leaf blades are glossy green above and silvery grayish below. The flower and fruit stalks have up to three long primary branches that are nearly equal in length to the leaf when in flower, but greatly exceed the leaf length when in fruit. Fruit are shiny, black, and spherical, up to 2 in (5 cm) long and 2 in (4 cm) wide when mature (Hodel 2009, pp. 173–179; Hodel 2012, pp. 70–73). *Pritchardia bakeri* is recognized as a distinct taxon by Hodel (2009, pp. 173–179; 2012, pp. 70–73), the most currently accepted taxonomic treatments of this species. *Pritchardia bakeri* occurs in the lowland mesic ecosystem in the Koolau Mountains on Oahu, at 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 (Hodel 2012, pp. 71–73). *Pritchardia bakeri* was first described as a new species in 2009 by Hodel (pp. 173–179). This palm occurs on the northern end (Pupukea) and southern end (Kuliouou) of the Koolau Mountain range, on the island of Oahu (Bacon *et al.* 2012, pp. 1–17; Hodel 2012, pp. 71–73). Currently, occurrences total approximately 250 individuals (Hodel 2012, pp. 42, 71).

Habitat modification and destruction by feral pigs affect the range and abundance of *Pritchardia bakeri*. Rats eat the fruit before they mature (Hodel 2012, pp. 42, 73). Nonnative plants compete with and degrade and destroy native habitat of *P. bakeri* and displace this species and other native Hawaiian plants 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 damage or kill plants. This species may experience 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).

Based on our evaluation of habitat degradation and loss by feral pigs and nonnative plants, fruit predation by rats,

and the small number and reduced range of remaining individuals, we find that this species should be listed throughout all of 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.

*Pseudognaphalium sandwicense* var. *molokaiense* (enaena) is a perennial herb in the sunflower family (Asteraceae). This species has prostrate stems 4 to 12 in (10 to 31 cm) long, with densely white woolly pubescence on the entire plant. Leaves are spatulate to narrowly obovate, 0.3 to 0.8 in (7 to 20 mm) wide. Whitish to pale yellow flower heads occur in terminal, leafless clusters (Wagner *et al.* 1999, p. 321). First described by Sherff and Degener (1948) as an infraspecific taxon in the genus *Gnaphalium*, Wagner (1997) moved the entire species to *Pseudognaphalium*. This variety is recognized as a distinct taxon in Wagner *et al.* (1999, pp. 321–322) and Wagner and Herbst (2003, p. 8), the most recently accepted taxonomic treatments of this species. In evaluating the status of botanical varieties for listing as threatened or endangered or threatened under the Act, we consider them to be equivalent to subspecies (43 FR 17910, April 26, 1978, see p. 17912). Typical habitat for *Pseudognaphalium sandwicense* var. *molokaiense* 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 found on Molokai (Halawa Valley and Waiahawahewa Gulch), on Oahu (on the coast between Diamond Head and Koko Head, and along the Waimanalo coast), on Maui (Wailuku area), and on Lanai (along the Munro trail) (HBMP 2010; MNTF 2010, in litt.). Currently, *Pseudognaphalium sandwicense* var. *molokaiense* is known only from Molokai on the northwestern coast at Ilio Point (as many as 20,000 individuals, depending on rainfall) and Kauhako Crater (a few individuals), and from northwest coast of Maui at Waiehu dunes (scattered individuals) and Puu Kahulianapa (5 to 10 individuals) (Moses 2006, in litt.; Starr 2006, in litt.; Kallstrom 2008, in litt.). This variety was last observed on Lanai in 1960, and on Oahu at Diamond Head (5 individuals) in the 1980s (HBMP 2010).

Goats and axis deer modify and destroy the habitat of *Pseudognaphalium sandwicense* 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 to eliminate herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Additionally, nonnative plants, such as *Atriplex semibaccata* (Australian saltbush), *Cenchrus ciliaris* (buffelgrass), and *Prosopis pallida* (kiawe), compete with and displace this and other native Hawaiian plants 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 2009, in litt.). This variety may experience 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). *Pseudognaphalium sandwicense* var. *molokaiense* occurs on a sea cliff on west Maui, and rockfalls and landslides pose a threat (HBMP 2010). Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Pseudognaphalium sandwicense* var. *molokaiense molokaiense* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 86).

The remaining occurrences of *Pseudognaphalium sandwicense* var. *molokaiense* and habitat for its reintroduction 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 may limit 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 should be listed throughout all of 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.

*Ranunculus hawaiiensis* (makou) is an erect or ascending perennial herb in the buttercup family (Ranunculaceae). This species is 2 to 6.5 ft (0.6 to 2 m) tall with fibrous roots. Stems are densely covered with golden or whitish hairs. Basal

leaves are twice compound, with leaflets lanceolate and the terminal leaf largest and irregularly toothed and lobed. The yellow, glossy flowers are numerous in branched open cymes and contain a scale-covered nectary at the base. Fruit are numerous and are margined with a narrow wing (Duncan 1999, p. 1088). *Ranunculus hawaiiensis* was described by Gray (1854) and is recognized as a distinct taxon by Duncan (1999, p. 1088), the most recently accepted taxonomic treatment of this species. Typical habitat is mesic forest on grassy slopes and scree, and in open pastures, at 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 (Medeiros 2007, pers. comm.; Pratt 2007, in litt.; Duncan 1999, p. 1088; HBMP 2010; TNCH 2007).

Historically, *Ranunculus hawaiiensis* was wide-ranging on the island of Hawaii, from Kona, Hualalai, Mauna Kea, and Kau. 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 (Hakalau NWR, Puu Kanakaleonui, Kolekole Gulch, Kahuku, Kapapala FR, and Kipahoe NAR) (Bio 2008, in litt.; PEPP 2008, p. 108; Pratt 2008, in litt.; HBMP 2010; Agorastos 2011, in litt.; Imoto 2013, in litt.). On Maui, a few individuals were observed on a cliff in the Waikamoi Preserve 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 hawaiiensis* on Hawaii Island, with evidence of the activities of these animals reported in the areas where *R. hawaiiensis* occurs (HBMP 2010). These ungulates, and rats, may also forage on *R. hawaiiensis*. Nonnative plants, such as *Holcus lanatus* (common velvet grass), *Ehrharta stipoides* (meadow ricegrass), and various grasses that modify and destroy native habitat and outcompete native plants have been reported in areas where *R. hawaiiensis* occurs (HBMP 2010). Drought and erosion pose a threat to the last known occurrence of *R. hawaiiensis* on Maui (PEPP 2013, p. 177). This species may experience 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 (Barret and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Ranunculus hawaiiensis* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 86).

The remaining occurrences of *Ranunculus hawaiiensis* and habitat for its reintroduction 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 ungulates, and by direct competition with nonnative plants, combined with predation by ungulates. Drought and erosion pose a threat to the occurrence on Maui. The small number of remaining individuals may limit this species' ability to adapt to environmental changes. Because of these threats, we find that this species should be listed throughout all of 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.

*Ranunculus mauiensis* (makou) is an erect to weakly ascending perennial herb in the buttercup family (Ranunculaceae). This species is 2 to 6.5 ft (0.5 to 2 m) tall, with stems sparsely to densely pubescent with scattered whitish hairs. Basal leaves are compound with ovate leaflets with the terminal leaflet being the largest and irregularly serrate. Yellow flowers are few, in branched loose cymes. Fruit are numerous in a globose head and have smooth faces (Wagner *et al.* 1999, p. 1089). *Ranunculus mauiensis* was described by Gray (1854) and is recognized as a distinct taxon in Wagner *et al.* (1999, p. 1089), the most recently accepted taxonomic treatment of this species. Typical habitat for *R. mauiensis* is open sites in mesic to wet forest and along streams, at 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), montane dry (Hawaii Island), and wet cliff (Molokai and Maui) ecosystems (Wagner *et al.* 1999, p. 1089; TNCH 2007; HBMP 2010).

Historically, *Ranunculus mauiensis* was known from five islands: Kauai (Kuia, Kokee, and Na Pali Kona), Oahu (Waianae Mountains), Molokai (Kamakou, Kalae, Waikolu, and Kaluaaha), Maui (Puu Kukui, Kapunakea, Pohakea, Olinda, Kipahulu, Waikamoi, and Puu Alaea), and Hawaii (Kealakekua) (HBMP 2010). Currently,

*R. mauiensis* is known from 14 occurrences (totaling approximately 200 individuals) on three islands: Kauai, Maui, and Molokai. On Kauai, *R. mauiensis* is found at Kalalau-Honopu (34 individuals), Nualolo (12 individuals), Kawaiiki ridge (4 individuals), Nawaimaka (1 individual), and Nawaimaka stream (2 individuals) (Perlman 2007, in litt.; Wood 2007, in litt.; HBMP 2010; PEPP 2011, p. 161; PEPP 2013, p. 177). On Molokai, there are two individuals in Kamakou Preserve; however, these plants were not relocated during recent surveys (PEPP 2010, p. 105; Bakutis 2011, in litt.). Oahu occurrences have not been observed since the 1800s (HBMP 2010). On west Maui, this species is found at Kapunakea Preserve (5 individuals), Pohakea Gulch (5 individuals), Lihau (5 individuals), Kauaula Valley (1 individual), and Puehuhunui (34 individuals); and on east Maui, this species is found at Waikamoi Preserve (20 individuals), Makawao Forest Reserve (30 individuals), Kahikinui (10 individuals), and Manawainui (10 individuals) (PEPP 2013, p. 177; Perlman 2007, in litt.; Wood 2007, in litt.; Bily 2007, pers. comm.). Hawaii Island occurrences have not been observed since 1980 (HBMP 2010).

Feral pigs, goats, axis deer, black-tailed deer, and cattle modify and destroy the habitat of *R. mauiensis* on Kauai, Molokai, and Maui, with evidence of the activities of these animals reported in the areas where this species occurs (PEPP 2014, pp. 155–156; 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 to eliminate herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants modify and destroy the native habitat of *R. mauiensis*, and displace this species and other native Hawaiian plants 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; HBMP 2010; PEPP 2014, p. 155). Herbivory by slugs (Maui) and seed predation by rats (Maui, Kauai) are both reported to pose a threat to *R. mauiensis* (PEPP 2014, pp. 154–155; HBMP 2010). Stochastic events such as drought (Maui), landslides (Kauai), and fire (Maui) are also reported to pose a threat to *R. mauiensis* (HBMP 2010). Erosion is a threat to occurrences on Maui and Kauai (PEPP 2014, p. 155–



156). This species may 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). Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Ranunculus mauiensis* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 86).

The remaining occurrences of *Ranunculus mauiensis* and habitat for its reintroduction are at risk, the known individuals are restricted to small areas on Kauai, 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. Because of its small, isolated occurrences, landslides, drought, and erosion may also have negatively impact this species. The small number of remaining individuals may limit this species' ability to adapt to environmental changes. Because of these threats, we find that this species should be listed throughout all of 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.

*Sanicula sandwicensis* (NCN) is a stout, erect, perennial herb in the parsley family (Apiaceae). This species is 8 to 28 in (20 and 70 cm) tall, with multiple, profusely-branched stems arising from the rootstalk. The basal leaves are numerous, chartaceous, orbicular, 1 to 5 in (3 to 12 cm) wide, and palmately 3-parted or 5-parted nearly to the petiole. The yellow flowers are umbellately arranged in terminal clusters of 2 to 5 stalks, with up to 20 flowers. Fruit is ovoid, 0.2 in (4 mm) long, and covered with stout, hooked, bulbous prickles (Constance and Affolter 1999, p. 210). *Sanicula sandwicensis* is recognized as a distinct taxon by Constance and Affolter *in* Wagner *et al.* (1999, p. 210), the most recently accepted taxonomic treatment of this species. *Sanicula sandwicensis* occurs at 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; HBMP 2010).

*Sanicula sandwicensis* is historically known from the islands of Maui (Haleakala) and Hawaii (Mauna Kea, Mauna Loa, and Hualalai) (Constance and Affolter 1999, p. 210). Currently, there are fewer than 20 individuals of *S. sandwicensis* on east and west Maui (MNTF 2010, in litt.; PEPP 2011, pp. 162–164). This species has not been observed on Hawaii Island since the 1990s (HBMP 2010; MNTF 2010, in litt.).

Feral 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). 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 to eliminate 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 this species and other native Hawaiian plants 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 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*, *Pinus* spp., *Prunella vulgaris*, and *Rubus argutus* (PEPP 2011, pp. 162–164). Seed predation by rats is likely to adversely affect this species (HBMP 2010). Stochastic events such as drought, flooding, and fires are all reported to pose a threat to this species (PEPP 2011, pp. 162–164). Erosion is a threat to occurrences on Maui (PEPP 2011, pp. 162–163). This species may 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). Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Sanicula sandwicensis* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 88).

The remaining occurrences of *Sanicula sandwicensis* and habitat for its reintroduction are at risk; the known individuals are restricted to a small area on Maui and continue to be negatively affected by habitat modification and destruction by feral goats and by direct competition with nonnative plants. Stochastic events such as drought, flooding, and fires all pose threats to this species. The small number of remaining individuals may limit this species' ability to adapt to environmental changes. Because of these threats, we find that this species should be listed throughout all of 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.

*Santalum involutum* (iliahi) is a shrub or small tree in the sandalwood family (Santalaceae). This species is 7 to 23 ft (2 to 7 m) tall, with yellowish-green to grayish-green leaves that are thinly chartaceous and often appearing droopy. The flowers are cream to purple, or greenish with a purple interior (Harbaugh *et al.* 2010, pp. 827–838). *Santalum involutum*, originally described by St. John in 1984 (pp. 217–226), was not recognized by Wagner *et al.* (1999, p. 1218); however, genetic analyses conducted by Harbaugh *et al.* (2010, pp. 827–838) revived this species as a valid taxon. Habitat for *Santalum involutum* is mesic and wet forest on Kauai, at 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 in Pohakuao and Kalalau valleys (Harbaugh *et al.* 2010, p. 835).

Feral pigs, goats, and black-tailed deer 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). 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 to eliminate 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 this species and other native Hawaiian plants 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; HBMP 2010). Nonnative plants reported to modify and destroy habitat of *S. involutum* are: *Psidium guajava*, *P. cattleianum*, *Lantana camara*, *Rubus argutus*, *Hedychium gardnerianum*, *Clidemia hirta*, *Melinis minutiflora* (molasses grass) (Harbaugh *et al.* 2010, p. 836). Herbivory and seed predation by rats is reported to pose a threat to *S. involutum* (Harbaugh *et al.* 2010, p. 836). Wildfire is a potential threat to this species in mesic areas (Harbaugh *et al.* 2010, p. 836). This species may 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 remaining occurrences of *Santalum involutum* and habitat for its reintroduction 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 may limit this species' ability to adapt to environmental changes. Because of these threats, we find that this species should be listed throughout all of 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.

*Schiedea diffusa* ssp. *diffusa* (NCN) is a reclining or weakly climbing vine in the pink family (Caryophyllaceae). This species is woody at the base, and glabrous or nearly so below, with purple-tinged hairs. Lanceolate to ovate leaves are 2 to 5 in (4 to 12 cm) long. Inflorescences have 20 to 90 flowers with purple or purple-tinged stalks. Capsules are very broadly ovoid, 0.2 to 0.3 in (5 to 7 mm) long. *Schiedea diffusa* ssp. *diffusa* was described by Wawra (1825, in Wagner *et al.* 2005, pp. 103–104) as *S. diffusa* ssp. *angustifolia*, now a synonym. This subspecies is currently recognized as a distinct taxon in Wagner *et al.* (1999, pp. 511–512) and in the *Schiedea* monograph by Wagner *et al.* (2005, pp. 103–106), the most recently accepted taxonomic treatments of this subspecies. *Schiedea diffusa* ssp. *diffusa* occurs in wet forest at 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; HBMP 2010; TNCH 2007).

*Schiedea diffusa* ssp. *diffusa* was historically found on the islands of Molokai and Maui. On Molokai, this subspecies was known from Kawela to Waikolu valleys; on Maui, it was widespread on both the east and west mountains (Wagner *et al.* 2005, p. 106). Currently, *S. diffusa* ssp. *diffusa* is known from east Maui in six occurrences (fewer than 50 individuals total), in a much smaller range, from Puu o Kalae to Keanae (spanning about 5 mi (8 km)). On Molokai, there were two occurrences totaling fewer than 10 individuals, one at west Kawela Gulch, and one on the rim of Pelekunu Valley, last observed in the 1990s (HBMP 2010).

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 (PEPP 2014, p. 159; 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 to eliminate 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. diffusa* ssp. *diffusa*, and displace this subspecies and other native Hawaiian plants 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; HBMP 2010; PEPP 2014, p. 159). Herbivory by slugs and seed predation by rats are both reported to pose a threat to this subspecies (HBMP 2010; PEPP 2014, p. 159). This subspecies may 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 remaining occurrences of *Schiedea diffusa* ssp. *diffusa* and habitat for its reintroduction are at risk. The known individuals are restricted to small areas on Maui and on Molokai (where it has not been observed for 20 years or longer), 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 may limit this subspecies' ability to adapt to

environmental changes. Because of these threats, we find that this subspecies should be listed throughout all of 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.

*Schiedea pubescens* (maolioli) is a reclining or weakly climbing vine in the pink family (Caryophyllaceae). This species is glabrous except for the inflorescence which has dense, purple-tinged hairs. The stems are 3 to 20 ft (1 to 6 m) long with internodes usually 2.5 to 5 in (6 to 12 cm) long. Opposite, leathery, narrowly lanceolate leaves are sometimes purple-tinged, especially along the midrib. The tiny flowers are perfect and are arranged in open cymes 12 to 20 in (30 to 50 cm) long (30 to 88 flowers) with purple hairs, and green to purple bracts and sepals. Capsules are 0.1 in (3 mm) long (Wagner *et al.* 1999, p. 519; Wagner *et al.* 2005, pp. 99–102). *Schiedea pubescens* was described by Hillebrand (1888, pp. 31–32), and is recognized as a distinct taxon in Wagner *et al.* (1999, p. 519), and in the *Schiedea* monograph by Wagner *et al.* (2005, pp. 99–102), the most recently accepted taxonomic treatments. *Schiedea pubescens* occurs in diverse mesic to wet *Metrosideros* forest at 2,000 to 4,000 ft (640 to 1,220 m), in the lowland wet (Maui and Molokai), montane wet (Molokai), montane mesic (Maui), and wet cliff (Maui, Lanai, and Molokai) ecosystems (Wagner *et al.* 1999, p. 519; Wagner *et al.* 2005, p. 100; HBMP 2010; TNCH 2007).

*Schiedea pubescens* was historically found on the islands of Molokai, Lanai, and Maui. On Molokai, this species was found from Kalae to Pukoo ridge; on Lanai, it was known from the Lanaihale summit area, and on Maui, it was known from the western mountains at Olowalu, Kaanapali, and Waihee, and 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; has not been observed on Lanai since 1922 and is believed extirpated; and from five occurrences on Maui (Wood 2001, in litt.; Oppenheimer 2006, in litt.; Bakutis 2010, in litt.; MNTF 2010, in litt.; Oppenheimer 2010, in litt.; Perlman 2010, in litt.; HBMP 2010; PEPP 2014, pp. 162–163). It was determined that a report of 4 to 6 individuals of *S. pubescens* in PTA on the island of Hawaii was a misidentification of the species *S. 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, Lanai,

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 to eliminate 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. pubescens*, and displace this species and other native Hawaiian plants 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; HBMP 2010; PEPP 2014, pp. 162–163). Herbivory by slugs and seed predation by rats are both reported to pose a threat to *S. pubescens* on Maui (HBMP 2010; PEPP 2014, p. 162). Stochastic events such as drought, erosion, and flooding are also reported to pose a threat to *S. pubescens* (HBMP 2010; PEPP 2014, pp. 162). This species may 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). Climate change may result in alteration of the environmental conditions and ecosystem that support this species. *Schiedea pubescens* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 88).

The remaining occurrences of *Schiedea pubescens* and habitat for its reintroduction 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, and drought may impact this species. The small number of remaining individuals may limit this species' ability to adapt to environmental changes. Because of these threats, we find that this species should be listed throughout all of 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.

*Sicyos lanceoloideus* (anunu) is a perennial vine in the gourd family

(Cucurbitaceae). Stems are 49 ft (15 m) long with a woody base. Leaves are broadly ovate and palmately 3- to 5-lobed. Inflorescences are branched, 3 to 8 in (8 to 20 cm) long, with white flowers. Fruit are green, up to 1 in (25 mm) long and beaked (Telford 1999, p. 581). In 1999, Wagner and Shannon (pp. 441–447) prepared a series of papers analyzing the names published in 1987 and 1988 by St. John, in which the nomenclature was evaluated and the taxa incorporated in a current classification. This provided a new combination for *Sicyos* sp. A as *Sicyos lanceoloideus* (Telford p. 581; Wagner and Shannon 1999, p. 444). *Sicyos lanceoloideus* is recognized as a distinct taxon in Wagner *et al.* (2012, p. 31), the most recently accepted taxonomic treatment. *Sicyos lanceoloideus* occurs on ridges or spurs in mesic forest at 1,800 to 2,700 ft (550 to 800 m), in the dry cliff (Oahu), lowland mesic (Oahu and Kauai), and montane mesic (Kauai) ecosystems (Telford p. 581; HBMP 2010; TNCH 2007).

*Sicyos lanceoloideus* was historically found on the islands of Kauai (Kalalau Valley and Waimea Canyon) and Oahu (Waianae Mountains) (Telford 1999, p. 581). Currently, *S. lanceoloideus* occurs on Kauai in one occurrence in the Na Pali-Kona FR (exact number of individuals unknown), and on Oahu in four locations in the Waianae Mountains, totaling fewer than 35 individuals (HBMP 2010; U.S. Army 2014 database). There may be more individuals, but because this species is a vine, it is difficult to determine exact numbers (PEPP 2013, p. 189).

Feral pigs and goats 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 (PEPP 2013, p. 189; PEPP 2014, p. 166; 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 to eliminate 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. lanceoloideus*, and displace this species and other native Hawaiian plants 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; HBMP 2010). Drought and fire are also reported to pose a threat to *S. lanceoloideus* (PEPP 2014, pp. 166; HBMP 2010). Owing to the small remaining number of

individuals, this species may 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). Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Sicyos lanceoloideus* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 89).

The remaining occurrences of *Sicyos lanceoloideus* and habitat for its reintroduction 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. The small number of remaining individuals may limit 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 should be listed throughout all of 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.

*Sicyos macrophyllus* (anunu) is a perennial vine in the gourd family (Cucurbitaceae). This species has sparsely pubescent stems with black spots, 49 ft (15 m) long. Leaves are broadly ovate and deeply lobed, with the upper surface glabrous and lower surface densely pubescent. Tendrils are twice branched. Flowers are either male or female, occur in pubescent panicles, and have a greenish-yellow corolla. The fruit is round and green (Telford 1999, p. 578). In 1987, a plant that occurred at Kipahulu on Maui was identified as *Sicyocarya kipahuluensis* by St. John (1987, p. 52). Since that time, Wagner and Shannon (1999, p. 444) synonymized this species under *Sicyos macrophyllus*. As a result, this species is not endemic to Hawaii Island, but occurs on both Maui and Hawaii. *Sicyos macrophyllus* is recognized as a distinct taxon in Telford (1999, p. 519) and in Wagner and Shannon (1999), the most recently accepted taxonomic treatments for this species. Typical habitat is wet *Metrosideros polymorpha* forest and *Sophora chrysophylla-Myoporum sandwicense* (mamane-naio) forest, at 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, *Sicyos macrophyllus* was known from Puuwaawaa, Laupahoehoe, Puna, and South Kona on the island of Hawaii, 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 the island of Hawaii at Puu Mali, Puuwaawaa (Puu Iki), Honaunau, Hakalau NWR-Kona Unit, Koahe, Kukuioepae, Kipuka Maunaiu, Kipuka Ki, and Puu Huluhulu (Bio 2008, in litt.; Pratt 2008, pers. comm.; HBMP 2010). It is reported that wild individuals at Kipuka Ki at Hawaii Volcanoes National Park are reproducing; however, seeds have not been successfully germinated under nursery conditions (Pratt 2005, pers. comm.). 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 to eliminate 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. macrophyllus*, and displace this species and other native Hawaiian plants 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; 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 to pose a threat to *S. macrophyllus* (HBMP 2010). This species may 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). Climate change may result in alteration of the environmental conditions and ecosystem that support this species. *Sicyos macrophyllus* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 89).

The remaining occurrences of *Sicyos macrophyllus* and habitat for its reintroduction are at risk. The only known individuals are restricted to small areas on Hawaii Island 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 may limit 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 should be listed throughout all of 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.

*Solanum nelsonii* (popolo) is a sprawling or trailing shrub up to 3 ft (1 m) tall, in the nightshade family (Solanaceae) family. Plants form clumps up to 5 ft (2 m) in diameter. Young stems and leaves are densely pubescent and do not have spines. Broadly ovate leaves are grayish green, have entire margins, and are arranged alternately along the stems. Flowers are perfect and have a white tubular corolla that is tinged with lavender to pale purple. Round berries are usually black when mature with numerous seeds. *Solanum nelsonii* is unusual in the genus with its doubly curved, purple anthers, which possibly suggest different pollinators than bees (Symon 1999, pp. 1273–1274). *Solanum nelsonii* was described by Dunal (1852, 690 pp.) and is recognized as a distinct taxon in the Manual of Flowering Plants of Hawaii (Symon 1999, pp. 1273–1274), the most recently accepted Hawaiian plant taxonomy. 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, *Solanum nelsonii* was known from the island of Hawaii (Kaalualu, Kamilo, and Kaulana Bay, South Point; 5 individuals total); the island of Niihau at Kealea Bay, Kawaewaae, and Leahii; Nihoa Island; Laysan Island; Pearl and Hermes Reef (North Island, Seal-Kittery Island, and Grass Island); and at Kure Atoll (Green Island) (Lamoreaux 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). Currently, *S. nelsonii* occurs in the coastal ecosystem, on the islands of

Hawaii and Molokai (approximately 50 individuals), and on the northwestern 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, in litt.; Vanderlip 2011, in litt.; Conry 2012, in litt.; PEPP 2013, pp. 190–191).

Axis deer and cattle modify and destroy the habitat of *Solanum nelsonii* on the main Hawaiian islands of Maui, Molokai, and Hawaii (except axis deer), 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 to eliminate 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. nelsonii*, both on the main Hawaiian Islands and on some of the Northwestern Hawaiian Islands (HBMP 2010). Nonnative plants displace this species and other native Hawaiian plants 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; HBMP 2010). Seed predation by rats has been reported to pose a threat to *S. nelsonii* on Molokai (PEPP 2014, p. 167). Stochastic events such as drought, erosion, fire, and flooding are also reported to pose a threat to *S. nelsonii* (PEPP 2014, p. 167; HBMP 2010). In 2011, a tidal wave swept over Midway Atoll's Eastern Island and Kure Atoll's Green Island, spreading plastic debris and destroying seabird nesting areas as far as about 500 ft (150 m) inland (DOFAW 2011, in litt.; USFWS 2011, in litt.). Tsunami, and potential sea level rise with global warming, could modify and destroy habitat for *S. nelsonii* in the low-lying Northwestern Hawaiian Islands. Occurrences of this species on the main Hawaiian Islands may 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). Climate change may result in alteration of the environmental conditions and

ecosystems that support this species. *Solanum nelsonii* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 89).

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. The relatively isolated occurrences of *S. nelsonii* on the Northwestern Hawaiian Islands are negatively affected (on the low-lying islands) by nonnative plants and by stochastic events such as tsunami. The small number of remaining individuals in the main Hawaiian Islands may limit this species' ability to adapt to environmental changes. Because of these threats, we find that this species should be listed throughout all of 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.

*Stenogyne kaalae* ssp. *sherffii* (NCN) is a climbing vine in the mint family (Lamiaceae). Stems are quadrangular, 3 to 7 ft (1 to 2 m) long, either glabrous or pubescent in grooves. Leaves are glossy and 5 in (12 cm) long. Flowers are very dark maroon and narrowly bell-shaped. Nutlets are 0.2 in (4 mm) long, fleshy, and dark purple (Weller and Sakai 1999, p. 838; Wagner and Weller 1999, pp. 448–449). In 1994, after publication of the treatment of *Stenogyne* by Weller and Sakai (in Wagner *et al.* 1990, p. 838), a new occurrence of the plant described as *Stenogyne sherffii* was discovered in the Koolau Mountains of Oahu. Upon further study, the morphological distinctions, coupled with the geographic separation from the Waianae Mountain individuals, clearly indicated it was not *S. kaalae*. The new taxon was identified as a subspecies of *S. kaalae* and given the name *S. kaalae* ssp. *sherffii* (Wagner and Weller 1999, pp. 448–449). *Stenogyne kaalae* ssp. *sherffii* occurs in the Koolau Mountains of Oahu, in diverse wet forest at 1,500 to 1,600 ft (450 to 490 m), in the lowland wet ecosystem (Wagner and Weller 1999, pp. 448–449; HBMP 2010; U.S. Army 2014 database; TNCH 2007).

*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 above, it was

believed to be a different species, *S. sherffii*, until the mid-1990s). This subspecies occurred within a very small range in the northern Koolau Mountains, at Opaepa and Kawailoa, but is now extinct in the wild. There are propagules from the original collections that have been outplanted in the same area (PEPP 2014, p. 169).

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, or to eliminate herbivory by these animals (Anderson *et al.* 2007, in litt.; HAR–DLNR 2010, in litt.). Nonnative plants destroy and modify the native habitat of *S. kaalae* ssp. *sherffii*, and displace this subspecies and other native Hawaiian plants 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; HBMP 2010). This subspecies may 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). Climate change may result in alteration of the environmental conditions and ecosystems that support this species. *Stenogyne kaalae* ssp. *sherffii* may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini *et al.* 2013, p. 90).

Any remaining occurrences of *Stenogyne kaalae* ssp. *sherffii* and habitat for its reintroduction are at risk, the known individuals were restricted to a very small area on Oahu, and the area continues to be negatively affected by habitat modification and destruction by ungulates and direct competition with nonnative plants. The small number of remaining individuals (*ex situ* only) may limit 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 should be listed throughout all of 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.

*Wikstroemia skottsbergiana* (akia) is a shrub or small tree in the akia family (Thymelaceae). Leaves are pale green, membranous, and 2 to 5 in (6 to 12 cm) long. Flowers are green, with the calyx tube 0.3 to 0.4 in (6 to 10 mm) long and outer lobes 0.1 to 0.2 in (2.5 to 5 mm) long. Fruit is red, ellipsoid, 0.3 in (8 mm) in diameter (Peterson 1999, p. 1290). *Wikstroemia skottsbergiana* is recognized as a distinct taxon in Peterson (1999, p. 1290), the most recently accepted taxonomic treatment of this species. This species occurs in wet forest on the island of Kauai, in the lowland wet ecosystem (Peterson 1999, p. 1290; TNCH 2007), and 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 site (PEPP 2012, p. 26).

Feral pigs 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.). 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 to eliminate 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 this and other native Hawaiian plants 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; HBMP 2010). Predation of seeds by rats may pose a threat to this species (DLNR 2005, in litt.). This species may 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 (DLNR 2005, in litt.; Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361).

The remaining occurrences of *Wikstroemia skottsbergiana* and habitat for its reintroduction 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 may limit this species'

ability to adapt to environmental changes. Because of these threats, we find that this species should be listed throughout all of 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.

#### Animals

##### Band-rumped storm-petrel (*Oceanodroma castro*)

The band-rumped storm-petrel (*Oceanodroma castro*) is a small seabird, about 8 in (20 cm) long, with a wingspan of about 19 in (47 cm), and about 2 ounces (50 grams) in weight. The tail is only slightly notched and may appear almost square. Plumage is an overall blackish-brown with a white band across the “rump” (above the tail). This species typically flies with a relatively shallow wing-beat, and glides on slightly bowed wings as a regular part of flight (Slotterback 2002, p. 2). Sexes are alike in size and appearance. The band-rumped storm-petrel is long-lived (15 to 20 years) and probably does not breed until its third year (Harrison *et al.* 1990, p. 48). Vocalizations at breeding colonies can be used to further distinguish this species from other seabirds (Allan 1962, p. 279; James and Robertson 1985, pp. 391–392). The band-rumped storm-petrel is a member of the family Hydrobatidae (order Procellariiformes) and a member of the Northern Hemisphere subfamily Hydrobatinae (Slotterback 2002, p. 2). Prior to 1900, this species had been described as an unnamed petrel in the genus *Thalassidroma* (Dole 1869, 1879 in Stejneger 1887, p. 78), as *Cymochorea cryptoleucura* (Ridgeway 1882, pp. 337–338), and as *Oceanodroma cryptoleucura* (Stejneger 1887, p. 78). After Henshaw’s 1902 publication, the Hawaiian population was known as *O. castro cryptoleucura*, the Hawaiian storm-petrel (Harrison *et al.* 1990, p. 47). Hawaiian names for this bird include oeo, oweowe, and akeake (Harrison *et al.* 1990, p. 47). Austin (1952, pp. 395–396) examined 11 museum skins from Hawaii and concluded that, although the various populations exhibited minor size differences, these differences were not significant and the populations in Hawaii were best considered as belonging to a single species with no subspecies. Harris (1969, pp. 95, 97–99) also supported this determination. 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.* 2007a, pp. 18590–18592; Smith *et al.* 2007, p. 770), 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), and potentially between populations on individual Hawaiian islands (Bogardus 2015, in litt.)

When not at nesting sites, adult band-rumped storm-petrels spend their time foraging on the open ocean (Slotterback 2002, p. 7). Food is taken from the ocean surface and consists mostly of small fish and squid (Slotterback 2002, p. 7; Harris 1969, p. 105). Nests are placed in crevices, holes, and 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). Adults visit the nest site after dark, where they can be detected by their distinctive calls. In Hawaii, adults establish nesting sites in April or May, and the nesting season occurs during the summer months. The incubation period averages 42 days (Harris 1969, p. 109), and the young reach fledging stage in 64 to 70 days (Allan 1962, p. 285; Harris 1969, p. 109).

The band-rumped storm-petrel is found in several areas of the subtropical Pacific and Atlantic Oceans (del Hoyo 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 areas under U.S. jurisdiction. Three widely separated breeding areas occur in the Pacific: in Japan, in Hawaii, and in the 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 (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 used as a source of food and possibly 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, and in high-elevation lava fields on Hawaii Island (Wood *et al.* 2002, pp. 17–18; Hu 2005, pers. comm.; VanderWerf *et al.* 2007, pp. 1, 5; Joyce and Holmes 2010, p. 3). Vocalizations were heard in Haleakala Crater on Maui in 1992 (Johnston 1992, in Wood *et al.* 2002, p. 2) and more recently in 2006 (Ackerman 2006, pers. comm.). 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.

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; Johnston 1992, in litt.; Wood *et al.* 2002, pp. 2–3; Wood 2005, pers. comm.; Holmes and Joyce 2009, 4 pp.; Joyce and Holmes 2010, pp. 1–3). The band-rumped storm-petrel is also known from Lehua Island (VanderWerf *et al.* 2007, p. 1), from Maui (Hawaii’s Comprehensive Wildlife Conservation Strategy (CWCS) 2005, in litt.), Kahoolawe (Olson 1992, pp. 38, 112), and Hawaii Island (CWCS 2005, in litt.). Additional surveys have been conducted on several islands in recent years, including surveys confirming the presence of band-rumped storm-petrels at PTA on the island of Hawaii, but further data are not yet available (Swift 2015, in litt.).

We do not have a current estimate of total numbers in Hawaii at this time.

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 auro-punctatus*), 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; Wood 2005, pers. comm.). Attraction of fledglings to artificial lights and collisions with structures, such as communication towers and utility lines, is also a threat (Banko *et al.* 1991, p. 651; Cooper and Day 1998, p. 18; Harrison *et al.* 1990, p. 49; Holmes and Joyce 2009, p. 2; Podolsky *et al.* 1998, pp. 21, 27–30; Reed *et al.* 1985, p. 377; Telfer *et al.* 1987, pp. 412–413). Monitoring of power lines on Kauai has recorded over 1,000 strikes by seabirds annually (mostly Newell's shearwaters (*Puffinus auricularis newelli*); Travers *et al.* 2014, in litt.) 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 2014, p. 4–13; Travers *et al.* 2014, in litt.). Since 1979, 40 band-rumped storm-petrels downed by light attraction have been retrieved on Kauai by the Save Our Shearwater program (Anderson 2014, 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. Therefore, we conclude that these are potential threats to the band-rumped storm-petrel as well. Erosion and landslides at nest sites caused by nonnative ungulates is a potential threat in some locations on the island of Kauai. 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. Other potential threats include commercial fisheries, ocean pollution, and the small population size and limited distribution in Hawaii (Soulé 1987, p. 8; Lande *et al.* 1988, pp. 1455, 1458–1459; Harrison *et al.* 1990, p. 50;

Furness 2003, p. 33). A single hurricane during the breeding season could cause reproductive failure and kill a significant number of adult birds. In this proposed rule, our proposed listing determination would apply only to the Hawaiian population of the band-rumped storm-petrel (see “Distinct Population Segment,” 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 should be listed as 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 *H. anthracinus*, are commonly known as yellow-faced bees or masked bees for their yellow-to-white facial markings. *Hylaeus* bees are similar in structure to other hymenopterans (bees, wasps, and ants) in that adults have three main body parts—a head, thorax, and abdomen. One pair of antennae arises from the front of the head, between the eyes. Two pairs of wings and three pairs of legs are attached to the thorax, and the abdomen is composed of multiple segments (Borror *et al.* 1989, pp. 665–666). 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, p. 55).

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, p. 24). The diet of the larval stage 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* has clear to smoky wings and black legs. The male has a single large yellow spot on the face, and below the antennal sockets the face is yellow. The female is entirely black and can be distinguished by black hairs on the end of the abdomen and an unusual mandible with three teeth, a characteristic shared only with *H. flavifrons*, a closely related species on

Kauai (Daly and Magnacca 2003, p. 53). *Hylaeus anthracinus* was first described as *Prosopis anthracina* by Smith in 1873 (in Daly and Magnacca 2003, p. 55) and transferred to *Nesoprosopis* 20 years later (Perkins 1899, p. 75). *Nesoprosopis* was reduced to a subgenus of *Hylaeus* in 1923 (Meade-Waldo 1923, p. 1). Although the distinctness of this species remains unquestioned, recent genetic evidence suggests *H. anthracinus* may be composed of three cryptic (not recognized) species or subspecies that represent populations on Hawaii, Maui and Kahoolawe, and Molokai and Oahu (Magnacca and Brown 2010, pp. 5–7). However, this has not been established scientifically; therefore, we treat *H. anthracinus* as a single species.

*Hylaeus anthracinus* is a solitary bee, and after mating, females seek existing cavities in coral rubble or rocky substrates for nest construction (Magnacca and King 2013, pp. 13–14). Adult bees have been observed visiting the flowers of native coastal plants (*Argemone glauca* (pua kala), *Chamaesyce celastroides* (akoko), *C. degeneri* (akoko), *Heliotropium anomalum* (hinahina), *H. foertherianum* (tree heliotrope), *Myoporum sandwicense* (naio), *Sesbania tomentosa* (ohai), *Scaevola taccada* (naupaka kahakai), and *Sida fallax* (ilima)). This species has also been collected from inside the fruit capsule of *Kadua coriacea* (kiolele) (Magnacca 2005a, p. 2).

*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” (Magnacca and King 2013, pp. 13–14). 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; Magnacca 2007a, p. 44). 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 2007b, pp. 186–188). Currently, *H. anthracinus* is known from 15 small patches of coastal and lowland dry forest habitat (Magnacca 2005a, p. 2); 5 locations on the island of Hawaii in the coastal and lowland dry ecosystems; 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, p. 2; Magnacca 2007a, p. 44; Magnacca and King 2013, pp. 13–14). 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, 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 on Hawaii, Maui, Lanai, Molokai, and Oahu with potentially suitable habitat from which other species of *Hylaeus* were collected (Daly and Magnacca 2003, pp. 4, 55; Magnacca 2008, pers. comm.).

Habitat destruction and modification by urbanization and land use conversion leads to the direct fragmentation of foraging and nesting areas of *Hylaeus anthracinus*. Habitat destruction and modification by nonnative plants adversely impact native Hawaiian 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; such habitat destruction and modification result in removal of food sources and nesting sites for the *H. anthracinus*. Habitat modification and destruction by nonnative animals such as feral pigs (*Sus scrofa*), goats (*Capra hircus*), axis deer (*Axis axis*), and cattle (*Bos taurus*), are 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 potential threat to *H. anthracinus*, as it destroys native plant communities on which it depends, and opens habitat for increased invasion by nonnative plants. Random, naturally occurring events such as hurricanes and drought can modify and destroy habitat of *H. anthracinus* by creating disturbed areas conducive to invasion by nonnative plants (Kitayama and Mueller-Dombois 1995, p. 671; Businger

1998, pp. 1–2). Fire is a potential threat to *H. anthracinus*, as it destroys native coastal and lowland dry 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 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) and could destroy food and nesting resources for *H. anthracinus*. 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.). 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 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. 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). 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, Australian colletid bees) for nectar and pollen is a potential threat to *H. anthracinus* (Magnacca 2007b, p. 188). 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 and drought (Daly and Magnacca 2003, p. 3; Magnacca 2007b, p. 173). Changes in precipitation resulting from the effects of climate change may degrade habitat

for all *Hylaeus* species; however, we are unable to determine the extent of these negative impacts at this time.

The remaining populations of *H. anthracinus* and its habitat are at risk. The known individuals are restricted to 15 locations on Hawaii, Maui, Kahoolawe, Molokai, and Oahu 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 potential threat. Randomly occurring events such as hurricanes and drought may 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 potential threat. The small number of remaining populations may limit this species' ability to adapt to environmental changes. Because of these threats, we find that *Hylaeus anthracinus* should be listed throughout all of 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 bee (*Hylaeus assimulans*)

*Hylaeus assimulans* is distinguished by its large size relative to other coastal *Hylaeus* species and by its slightly smoky to smoky-colored wings and black legs. The male is black with yellow face marks, with an almost entirely yellow clypeus (lower face region) with additional marks on the sides that narrow dorsally (towards the top). The male also has brown appressed (flattened) hairs on the tip of the abdomen. The female is entirely black, large-bodied, and has distinct punctuation on the abdomen (Daly and Magnacca 2003, p. 56). *Hylaeus assimulans* was first described as *Nesoprosopis assimulans* (Perkins 1899, pp. 75, 101–102). *Nesoprosopis* was reduced to a subgenus of *Hylaeus* in 1923 (Meade-Waldo 1923, p. 1). The species was most recently described as *Hylaeus assimulans* by Daly and Magnacca in 2003 (pp. 55–56).

Nests of *H. assimulans* are usually constructed opportunistically within existing burrows, or other similarly small natural cavities under bark or rocks that they suit to their own needs (Magnacca 2005b, p. 2). Adult bees have been observed visiting the flowers of its likely primary nesting native host plant,



*Sida fallax* (ilima), as well as the flowers of native *Lipochaeta lobata* (nehe) (Daly and Magnacca 2003, p. 58). *Hylaeus assimulans* appears to be closely associated with plants in the genus *Sida*, and studies thus far suggest this yellow-faced bee species may be more common where this plant is abundant (Daly and Magnacca 2003, pp. 58, 217; Magnacca 2007b, p. 183). Recent survey efforts indicate that *H. assimulans* is more common in dry forest, which may be related to the greater abundance of *Sida* in the understory (Magnacca 2005b, p. 2). It is likely that *H. assimulans* visits several other native plants, including *Acacia koa* (koa), *Metrosideros polymorpha* (ohia), *Leptecophylla tameiameia* (pukiawe), *Scaevola* sp. (naupaka), and *Chamaescybe* sp. (akoko), which are known to be frequented by other *Hylaeus* species (Magnacca 2005, pers. comm.).

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 (Xerces Society 2009, p. 4; Daly and Magnacca 2003, pp. 56, 217; Magnacca 2005b, p. 2; Magnacca 2007b, pp. 177, 181, 183). Currently, *H. assimulans* is known from a few small patches of coastal and lowland dry forest habitat (Magnacca 2005b, p. 2); 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, 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, p. 2).

Habitat destruction and modification due to urbanization and land use

conversion leads to fragmentation and eventual loss of, foraging and nesting areas for *Hylaeus assimulans*. Habitat destruction and modification by nonnative plants (*Asystasia gangetica* (Chinese violet), *Atriplex semibaccata*, *Cenchrus ciliaris*, *Chloris barbata* (swollen fingergrass), *Digitaria insularis* (sourgrass), *Leucaena leucocephala* (koa haole), *Panicum maximum* (guinea grass), *Pluchea indica* (Indian fleabane), *P. carolinensis* (sourbush), and *Verbesina encelioides* (golden crown-beard)) adversely impact native Hawaiian 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; such habitat destruction and modification result in removal of food sources and nesting sites for *H. assimulans*. Habitat modification and destruction by nonnative animals, such as feral pigs, goats, axis deer, and cattle, is also 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 potential threat to *H. assimulans*, as it destroys native coastal and lowland dry 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 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), 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 and drought can modify and destroy habitat of *H. assimulans* by creating disturbed areas conducive to invasion by nonnative plants (Kitayama and Mueller-Dombois 1995, p. 671; Businger

1998, pp. 1–2). 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 potential 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, Australian colletid bees) for nectar and pollen is a potential threat to *H. assimulans* (Magnacca 2007b, p. 188). 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 2007b, p. 173). Changes in precipitation resulting from the effects of climate change may degrade habitat for all *Hylaeus* species; however, we are unable to determine the extent of these negative impacts at this time.

The remaining populations of *H. assimulans* and its habitat are at risk. The known individuals are restricted to 5 locations on Maui, Kahoolawe, and Lanai 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 potential threat. Randomly occurring events such as hurricanes and drought may 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 potential threat. The small number of remaining populations may limit this species' ability to adapt to

environmental changes. Because of these threats, we find that *H. assimulans* should be listed throughout all of 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 bee (*Hylaeus facilis*)

*Hylaeus facilis* is a medium-sized bee with smoky-colored wings. The male has an oval yellow mark on the face that covers the entire clypeus, and a narrow stripe beside the eyes, but is otherwise unmarked. The large, externally visible gonoforceps (paired lateral outer parts of the male genitalia) distinguish *H. facilis* from the closely related *H. simplex* (Daly and Magnacca 2003, p. 83). The female is entirely black and indistinguishable from females of *H. difficilis* and *H. simplex* (Daly and Magnacca 2003, p. 56). *Hylaeus facilis* is a member of the *H. difficilis* species group, and is closely related to *H. chlorostictus* and *H. simplex*. *Hylaeus facilis* was first described as *Prosopis facilis* by Smith in 1879 (Daly and Magnacca 2003, p. 80), based on a specimen erroneously reported from Maui. According to Blackburn and Cameron (1886 and 1887), the species' type locality was Pauoa Valley on Oahu (Daly and Magnacca 2003, p. 80). The species was later transferred to the genus *Nesoprosopis* (Perkins 1899, pp. 75, 77). *Nesoprosopis* was subsequently reduced to a subgenus of *Hylaeus* (Meade-Waldo 1923, p. 1). The species was most recently recognized by Daly and Magnacca (2003, p. 80) as *H. facilis*.

Nests of *Hylaeus facilis* are probably constructed opportunistically within existing burrows, or other similarly small natural cavities under bark or rocks (Daly and Magnacca 2003, p. 83; Magnacca 2005c, p. 2). The native host plants of adult *H. facilis* are unknown, but it is likely this species visits several plants other *Hylaeus* species are known to frequent, including *Acacia koa*, *Metrosideros polymorpha*, *Leptecophylla tameiameia*, *Scaevola* spp., and *Chamaesyce* spp. (Daly and Magnacca 2003, p. 11). *Hylaeus facilis* has been observed visiting nonnative *Heliotropium foertherianum* for nectar and pollen (Magnacca 2007b, p. 181).

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 and all of Maui Nui (Maui, Lanai, and Molokai) (Magnacca 2007b, p. 183).

Although the species was widely collected, it likely prefers dry to mesic forest and shrubland (Magnacca 2005c, p. 2), which are increasingly rare and patchily distributed habitats (Smith 1985, pp. 227–233; Juvik and Juvik 1998, p. 124; Wagner *et al.* 1999, pp. 66–67, 75; Magnacca 2005c, p. 2). Researchers believe the wet forest site on Oahu where *H. facilis* was observed likely had an open understory (mesic conditions), and represents an outlier or residual population (Liebherr and Polhemus 1997, p. 347; Perkins 1899, p. 76). *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 2007b, 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 localities (Magnacca 2007b, p. 183) and was not observed at 26 additional sites with potentially suitable habitat (Daly and Magnacca 2003, pp. 7, 81–82; Magnacca 2007b, 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 lowland mesic ecosystem (Daly and Magnacca 2003, pp. 81–82; Magnacca 2005c, 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 leads to fragmentation of, and eventual loss of, foraging and nesting areas of *Hylaeus facilis*. Habitat destruction and modification by nonnative plants adversely impact native Hawaiian 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; such habitat destruction and modification 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*, *Brachiaria mutica* (California grass), *Prosopis pallida*, *Psidium cattleianum* (strawberry guava), and *Rubus* spp. are noted to negatively affect the habitat of *H. facilis* (Hawaii Division of Forestry and Wildlife (DOFAW) 2007, pp. 20–22; Cuddihy and Stone 1990, p. 105).

Habitat modification and destruction by nonnative animals, such as feral pigs, goats, axis deer, and cattle, are 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 potential 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 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) 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 and drought can modify and destroy habitat of *H. facilis* by creating disturbed areas conducive to invasion by nonnative plants (Kitayama and Mueller-Dombois 1995, p. 671; Businger 1998, pp. 1–2). 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 potential 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. 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, Australian

colletid bees) for nectar and pollen is a potential threat to *H. facilis* (Magnacca 2007b, p. 188). 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 2007b, p. 173). Changes in precipitation resulting from the effects of climate change may degrade habitat for all *Hylaeus* species; however, we are unable to determine the extent of these negative impacts at this time.

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 potential threat. Randomly occurring events such as hurricanes and drought may 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 potential threat. The small number of remaining populations may limit this species' ability to adapt to environmental changes. Because of these threats, we find that *H. facilis* should be listed throughout all of 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 bee (*Hylaeus hilaris*)

*Hylaeus hilaris* is distinguished by its large size (male wing length is 0.19 in (4.7 mm)) relative to other coastal *Hylaeus* species. The wings of this species are slightly smoky to smoky-colored, and it is the most colorful of the *Hylaeus* species. The face of the male is almost entirely yellow, with yellow markings on the legs and thorax, and the metasoma (posterior portion of the abdomen) are usually predominantly red. Females are drab colored, with various brownish markings. As with other cleptoparasitic species (those that steal food and nests of other bees for their own young; see below), *H. hilaris* lacks the specialized pollen-sweeping hairs of the front legs (Daly and Magnacca 2003, pp. 9, 106).

It is also one of only two Hawaiian *Hylaeus* species to possess apical (at the end of a structure) bands of fine white hairs on the segments of the metasoma. *Hylaeus hilaris* was first described as *Prosopis hilaris* by Smith in 1879 (in Daly and Magnacca 2003, pp. 103–104), and transferred to the genus *Nesoprosopis* 20 years later (Perkins 1899, p. 75). *Nesoprosopis* was reduced to a subgenus of *Hylaeus* in 1923 (Meade-Waldo 1923, p. 1). In 2003, Daly and Magnacca (pp. 103–104) described the species as *Hylaeus hilaris*, and is the most recently accepted taxonomic treatment of this species.

Most adult *Hylaeus* species consume nectar for energy; however, *H. hilaris* has yet to be observed actually feeding from flowers. *Hylaeus hilaris* and four related species (*H. hostilis*, *H. inquilina*, *H. sphecodoides*, and *H. volatilis*) are known as cleptoparasites or cuckoo bees. The mated female does not construct a nest or collect pollen, but instead enters the nest of another species and lays an egg in a provisioned cell. Upon hatching, the larva of *H. hilaris* kills the host egg, consumes the provisions, pupates, and eventually emerges as an adult. This species is known to lay its eggs within nests of *H. anthracinus*, *H. assimulans*, and *H. longiceps* (Perkins 1913, p. lxxxi). *Hylaeus hilaris* depends on related *Hylaeus* host species to support larval life stage, its population size is observed to be much smaller than its host species, and this species is probably the most at risk of extinction because of these features (Magnacca 2007b, p. 181).

Historically, *Hylaeus hilaris* was known from coastal habitat on Maui, Lanai, and Molokai, and from 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 2007b, 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 The Nature Conservancy's Moomomi Preserve on Molokai, in the coastal ecosystem (Daly and Magnacca 2003, pp. 103, 106; Magnacca 2005d, p. 2; Magnacca 2007b, 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 other 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 impact native Hawaiian 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; such habitat destruction and modification result 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, are 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 potential 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 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) and could destroy food and nesting resources for *Hylaeus* species which *H. hilaris* parasitizes. 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. hilaris* by creating disturbed areas conducive to invasion by nonnative plants (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 also a threat to *H. hilaris* (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 potential 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, Australian colletid bees) for nectar and pollen is a potential threat to the host yellow-faced bees of *H. hilaris* (Magnacca 2007b, p. 188). 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 2007b, p. 173). Changes in precipitation resulting from the effects of climate change may degrade habitat for all *Hylaeus* species; however, we are unable to determine the extent of these negative impacts at this time. Because of these threats, we find that *Hylaeus hilaris* should be listed throughout all of its range, and, therefore, we find that it is unnecessary to analyze whether it is endangered, threatened, or in a significant portion of its range.

#### Yellow-faced bee (*Hylaeus kuakea*)

*Hylaeus kuakea* is a small, black bee with slightly smoky-colored wings. This species does not fit into any of the well-defined *Hylaeus* species groups. Its facial marks are similar to those of the *H. difficilis* group and to *H. anthracinus*, but it has an unusual ivory facial marking covering the clypeus. *Hylaeus kuakea* has a denser, more distinct arrangement of setae (sensory hairs) on the head and narrow marks next to the compound eyes (Daly and Magnacca 2003, p. 125; Magnacca 2005e, p. 2). Only four adult male specimens have been collected; females have yet to be collected or observed. *Hylaeus kuakea* was first described by Daly and Magnacca (2003, pp. 1, 125–127) from specimens collected in 1997 in the Waianae Mountains of Oahu.

*Hylaeus kuakea* is believed to be a stem-nesting species and likely constructs nests opportunistically within existing burrows inside dead twigs or plant stems (Magnacca and Danforth 2006, p. 403). The native host plants of the adult *H. kuakea* are unknown, but it is likely this species visits several plants other *Hylaeus* species are known to frequent, including *Acacia koa*, *Metrosideros polymorpha*, *Leptecophylla tameiameia*, *Scaevola* spp., and *Chamaesyce* spp. (Magnacca 2005e, p. 2).

Because the first collection of *Hylaeus kuakea* was not made until 1997, its historical range is unknown (Magnacca 2005e, p. 2; Magnacca 2007a, 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 2007b, 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, and eventual loss, of foraging and nesting areas of *Hylaeus kuakea*. Habitat destruction and modification by nonnative plants adversely impact native Hawaiian 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; such habitat destruction and modification result 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 potential 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 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) 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.). The only known occurrences of *H. kuakea* are close to military training areas, where the risk of fire is elevated. Several fires on Oahu have impacted rare or endangered species in lowland mesic habitat similar to that where *H. kuakea* has been found (TNC 2005, in litt.; U.S. Army Garrison 2007, p. 3; DLNR 2014, in litt.; KHON 2014, 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 (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 potential 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, Australian colletid bees) for nectar and pollen is a potential threat to *H. kuakea* (Magnacca 2007b, p. 188). 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). Changes in precipitation resulting

from the effects of climate change may degrade habitat for all *Hylaeus* species; however, we are unable to determine the extent of these negative impacts at this time. Because of these threats, we find that *Hylaeus kuakea* should be listed throughout all of 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 bee (*Hylaeus longiceps*)

*Hylaeus longiceps* is a small to medium-sized black bee with clear to slightly smoky-colored wings. Its distinguishing characteristics are its long head and the facial marks of the male. The lower face of the male is marked with a yellow band that extends at the sides of the face in a broad stripe above the antennal sockets. The area above the clypeus is very long and narrow, and the scape (the first antennal segment) is noticeably twice as long as it is wide. The female is entirely black and unmarked (Daly and Magnacca 2003, p. 133). *Hylaeus longiceps* was first described in 1899 as *Nesoprosopis longiceps* (Perkins 1899, pp. 75, 98), and then *Nesoprosopis* was reduced to a subgenus of *Hylaeus* in 1923 (Meade-Waldo 1923, p. 1). Daly and Magnacca (2003, pp. 133–134) most recently described the species as *H. longiceps*.

*Hylaeus longiceps* is a ground-nesting species, constructing nests opportunistically within existing burrows or small natural cavities under bark or rocks (Magnacca 2005f, p. 2). Adult bees have been observed visiting the flowers of a wide variety of native plants including *Chamaesyce degeneri* (akoko), *Myoporum sandwicense* (naio), *Santalum ellipticum* (iliahialoe), *Scaevola coriacea* (dwarf naupaka), *Sesbania tomentosa* (ohai), *Sida fallax* (ilima), and *Vitex rotundifolia* (pohinahina) (Daly and Magnacca 2003, p. 135). It is likely *H. longiceps* also visits several plant species other *Hylaeus* species are known to frequently visit, including *Heliotropium foertherianum* (tree heliotrope) and *Jacquemontia ovalifolia* (pauohiiaaka) (Magnacca 2005f, p. 2).

*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 Maui, Lanai, Molokai, and

Oahu (Magnacca 2005f, p. 2). 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 six of the surveyed sites: three sites on Lanai (in the coastal and lowland dry ecosystems) and one site on each of the islands of Maui (in the coastal ecosystem), Molokai (in the coastal ecosystem), and Oahu (in the coastal ecosystem). Only one of the historical locations surveyed, Waieue dunes on Maui, still supports a population of *H. longiceps* (Daly and Magnacca 2003, p. 135).

Most of the coastal and lowland dry habitat of *Hylaeus longiceps* has been developed or degraded, and is no longer suitable (Liebherr and Polhemus 1997, pp. 346–347; Magnacca 2007b, pp. 186–188). Habitat destruction and modification by axis deer (Lanai) and urbanization (Maui and Molokai) leads to fragmentation, 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 potential 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 impacts native Hawaiian 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 potential 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 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) 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 and drought can modify and destroy habitat of *H. longiceps* 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 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, Australian colletid bees) for nectar and pollen is a potential threat to *H. longiceps* (Magnacca 2007b, p. 188). 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 2007b, p. 173). Changes in precipitation resulting from the effects of climate change may degrade habitat for all *Hylaeus* species; however, we are unable to determine the extent of these negative impacts at this time. Because of these threats, we find that *Hylaeus longiceps* should be listed throughout all of 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 bee (*Hylaeus mana*)

*Hylaeus mana* is an extremely small, gracile (gracefully slender) black bee with yellow markings on the face. The smallest of all Hawaiian *Hylaeus* species, *H. mana* is a member of the *Dumetorum* species group. The face of the male is mostly yellow below the antennae, extending dorsally in a narrowing stripe. The female's face has three yellow lines: one against each eye and a transverse stripe at the apex of the clypeus. The female's outer markings are the same as the male's (Daly and Magnacca 2003, p. 135). *Hylaeus mana*

can be distinguished from *H. mimicus* and *H. specularis* (species with overlapping ranges) by its extremely small size, the shape of the male's genitalia, the female's extensive facial marks, and a transverse rather than longitudinal clypeal marking (Daly and Magnacca 2003, p. 138). *Hylaeus mana* was first described by Daly and Magnacca (2003, pp. 135–136), from four specimens collected in 2002, on the leeward side of the Koolau Mountains on Oahu, and is the most currently accepted taxonomy.

The nesting habits of *H. mana* are not well known, but it is assumed the species is closely related to other wood-nesting Hawaiian *Hylaeus* species, and uses an available cavity (stems of coastal shrubs) for nest construction (Magnacca 2005g, p. 2; Magnacca and Danforth 2006, p. 403). Adult specimens of *H. mana* were collected while they visited flowers of the native plants *Psychotria* spp. and *Santalum freycinetianum* var. *freycinetianum* (iliahi, sandalwood) (Wagner *et al.* 1999, p. 1221). It is likely *H. mana* visits several other native plant species including *Acacia koa*, *Metrosideros polymorpha*, *Leptecophylla tameiameia*, *Scaevola* spp., and *Chamaesyce* spp. (Magnacca 2005g, p. 2).

*Hylaeus mana* is known only from lowland mesic forest dominated by native *Acacia koa* located along the Manana Trail 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 Manana Trail 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, p. 2; Magnacca and King 2013, pp. 17–18).

Habitat destruction and modification by feral pigs leads to fragmentation, and eventual loss, of foraging and nesting areas of *H. mana* (Daly and Magnacca 2003, pp. 217–229). Habitat destruction and modification by nonnative plants adversely impacts native Hawaiian 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 *A. 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 potential 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 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) 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 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) (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, Australian colletid bees) for nectar and pollen is a potential threat to *H. mana* (Magnacca 2007b, p. 188). 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 fire, hurricanes, and drought (Daly and Magnacca 2003, p. 3; Magnacca 2007b, p. 173). Changes in precipitation resulting from the effects of climate change may degrade habitat for all *Hylaeus* species; however, we are unable to determine the extent of these negative impacts at this time. Because of these threats, we find that *Hylaeus mana* should be listed throughout all of 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.

Orangeblack Hawaiian damselfly (*Megalagrion xanthomelas*)

The orangeblack Hawaiian damselfly (*Megalagrion xanthomelas*; family Coenagrionidae) is small in size. The adults measure from 1.3 to 1.5 in (33 to 37 mm) in length and have a wingspan of 1.4 to 1.6 in (35 to 40 mm). Males are bright red in color, females are pale tan in color, and both sexes exhibit strong patterns including striping. Naiads (the immature aquatic stage) of this species exhibit flattened, leaf-like gills (Asquith and Polhemus 1996, p. 91). The orangeblack Hawaiian damselfly was first described by Selys-Longchamps (1876).

Habitat for this species is standing or very slow-moving water. The naiads are active swimmers and rest on exposed areas of the bottom on submerged vegetation (Williams 1936, p. 314). They have been observed breeding in garden pools, large reservoirs, pools of an intermittent stream, a pond formed behind a cobble bar at the seaward terminus of a large stream, coastal springs, and freshwater marshes (Polhemus 1996, pp. 36, 42–45; Williams 1936, pp. 239, 310). In 1913, Perkins (p. clxxviii) described it as a common insect in Honolulu gardens and in lowland districts generally, not usually partial to the mountains, though in the Kona district of Hawaii Island it was common in stagnant pools up to elevations of about 3,000 ft (900 m).

The orangeblack Hawaiian damselfly was once Hawaii's most abundant damselfly species because it utilizes 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 coastal, lowland dry, and lowland mesic ecosystems (Perkins 1913, p. clxxviii; Zimmerman 1948a, 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 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, Naalehu, and Panaewa Forest Reserve (FR) (Polhemus 1996, pp. 42–47).

Currently, the orangeblack Hawaiian damselfly occurs on five islands. In 1994, on Oahu, a very small population was discovered in pools of an intermittent stream at the Tripler Army Medical Facility (Englund 2001, p. 256). On Molokai, populations occur at the mouths of Pelekunu and Waikolu streams, and at the Palaau wetlands on the south coast (Polhemus 1996, p. 47). On Lanai, a large population occurs in an artificial pond at Koele (Polhemus 1996, p. 47). The species is present on Maui at Ukumehame stream (west Maui) and near anchialine pools at La Perouse Bay (leeward east Maui) (Polhemus *et al.* 1999, p. 29). Several large populations exist in coastal wetlands on Hawaii Island at the following locations: Anaehoomalu Bay, Kawa Bay, Hilea Stream, Hilo, Honokohau, Kiholo Bay, Ninole Springs, Onomea Bay, Whittington Beach, Keaukaha, Kapoho, Honaunau, and Pohue Bay (Polhemus 1996, pp. 42–47). 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, feral ungulates, and destruction of perched aquifer and surface water resources, 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 *Brachiaria mutica* (California grass) form dense, monotypic stands that can completely eliminate any open water habitat of the orangeblack Hawaiian damselfly, and nonnative grasses provide fuel for wildfires (Smith 1985, p. 186). Other stochastic events such as flooding and hurricanes can also modify and destroy habitat, and kill individuals. Predation by nonnative fish and nonnative aquatic invertebrates on the orangeblack Hawaiian damselfly is a significant threat. Hawaiian damselflies evolved with few, if any, predatory fish and the exposed behavior of most of the fully aquatic damselfly species, including the orangeblack Hawaiian damselfly, makes them particularly vulnerable to predation by nonnative fish (Englund 1999, pp. 225–225, 235). The damselfly is not observed in any bodies of water that support nonnative fish (Henrickson 1988, p. 183; McPeck 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 including damselfly naiads (Borror *et al.* 1989, p. 296). Several species of backswimmers have become established in Hawaii, and their presence in aquatic habitat can cause orangeblack Hawaiian damselflies to reduce foraging, thereby reducing its growth, development, and survival (Heads 1986, pp. 374–375). Hawaii State law (State Water Code) does not provide for permanent or minimal instream flow standards, and stream channels can be undertaken at any time by the Water Commission or via public petitions to revise flow standards or modify stream channels, possibly resulting in modification and destruction of the aquatic habitat of the orangeblack Hawaiian damselfly (Hawaii Administrative Rule (HAR)-State Water Code, title 13, chapter 169–36). In addition, competition with nonnative invertebrates for space and resources by a nonnative insect group, the *Trichoptera* (caddisflies), is a potential threat to the orangeblack Hawaiian damselfly (Flint *et al.* 2003, p. 38).

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 and by nonnative

plants, combined with predation by nonnative fish and nonnative invertebrates. Competition with nonnative insects is a potential threat to the orangeblack Hawaiian damselfly. Because of these threats, we find that this species should be listed throughout all of 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.

#### Anchialine Pool Shrimp (*Procaris hawaiana*)

The anchialine pool shrimp *Procaris hawaiana* (family Procarididae) ranges in total length from 0.4 to 1.2 in (10 to 30 mm). This species has a pink to light-red pigmentation that is darkest along the midline with the dorsal thorax white to yellow. Black pigments are associated with the eyes. Conspicuous chelapeds (claws) are lacking. Locomotion is accomplished by swimming with the swimmerets (modified appendages) and occurs just above the substrate to mid-water (Holthius 1973, pp. 12–19). *Procaris hawaiana* was described by Holthius in 1973, and is recognized as a valid taxon in McLaughlin *et al.* (2005, p. 212), the most recently accepted taxonomy.

*Procaris hawaiana* is known to occur in mid-salinity (19 to 25 parts per thousand (ppt)) anchialine pools. Except for some records of native eels, anchialine pools in Hawaii do not typically support native fish species; however, nonnative fish have been introduced to pools, and they prey on native invertebrates such as *P. hawaiana* (Bailey-Brock and Brock 1993, p. 354; Brock 2004, p. i). Little is known of the reproductive biology or the diet of *P. hawaiana*, although it has been documented to scavenge other species of anchialine shrimp and has taken frozen brine shrimp when in captivity (Holthius 1973, pp. 12–19).

Although anchialine pools are widespread, being found in areas such as Saudi Arabia, Madagascar, Fiji, and other Indo-Pacific islands, the total area they occupy globally is extremely small (Maciolek 1983, pp. 607–612). While many species of anchialine pool shrimp have disjunct, global distributions, most geographic locations contain some endemic taxa (*i.e.*, taxa found nowhere else on Earth) (Maciolek 1983, pp. 607–612). The shrimp family Procarididae is represented by a small number of species globally, with only two species within the genus *Procaris* (Holthius 1973, pp. 12–19). *Procaris hawaiana* is an endemic 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 *Procaris hawaiiana*. During nocturnal-diurnal surveys conducted from 2009 to 2010, 19 pools within the Manuka Natural Area Reserve (NAR) were found to contain *P. hawaiiana*. Five additional pools located on unencumbered State land adjacent to Manuka NAR also contained *P. hawaiiana* (from the total 24 recorded pools within the Manuka watershed). A single pool located at Lua o Palahemo also contains *P. hawaiiana*, along with the endangered anchialine pool shrimp *Vetericaris chaceorum* (Holthius 1973, pp. 12–19; Maciolek 1983, pp. 607–614; Brock 204, pp. 30–57). On Maui, *P. hawaiiana* occurs in two anchialine pools at Ahihi-Kinau NAR (Holthius 1973, pp. 12–19; Maciolek 1983, pp. 607–614; Brock 2004, pp. 30–57).

Like other anchialine pool shrimp species, *P. hawaiiana* inhabits extensive networks of water-filled interstitial spaces (cracks and crevices) leading to and from the actual pool, a trait which has precluded researchers from ascertaining accurate population size estimates (Holthius 1973, p. 36; Maciolek 1983, pp. 613–616). Often, surveys for many rare species of anchialine pool shrimp, including *P. hawaiiana*, involve a presence-absence survey approach in their respective habitat (often with the aid of baiting). Absence, and presumably extirpation, of shrimp species from suitable habitat is likely the best or only measure of species decline as population sizes are not easily determined (Holthius 1973, pp. 7–12; Maciolek 1983, pp. 613–616). Disappearance of the anchialine pool shrimp *Halocaridina rubra* from an anchialine pool at Honokohau Harbor (Hawaii Island) has been documented, as a result of the use of the pool for dumping of used oil, grease, and oil filters (Brock 2004, p. 14); however, to date, there is no documentation of extirpation of *Procaris hawaiiana* from the pools that it is known to occupy (Wada 2015, in litt.).

Habitat modification and destruction by human activities is a threat to *Procaris hawaiiana*. It is estimated that up to 90 percent of existing anchialine pools 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 another anchialine pool shrimp, *Halocaridina rubra*, from a pool adjacent to Honokohau Harbor on the island of Hawaii (Brock 2004, p. 16). 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 for trade for the aquarium hobby market is ongoing (Fuku-Bonsai 2015, in litt.). Collection 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. hawaiiana*. Nonnative fish (tilapia, *Oreochromis mossambica*) also outcompete native herbivorous species of shrimp that serve as a prey-base for *P. hawaiiana*, 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 NARs are provided some protection, these areas are remote and signage does not prevent human use and damage of the pools. The persistence of existing populations of *P. hawaiiana* is hampered by the small number of extant populations and the small geographic range of the known populations. The small populations of *P. hawaiiana* are at risk of extinction because of their increased vulnerability to loss of individuals from chance occurrences, habitat destruction, and the effects of invasive species; to demographic stochasticity; and to 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 may negatively impact the habitat and *P. hawaiiana* directly (Conry 2012, in litt.).

The remaining populations of *Procaris hawaiiana* and its habitat are at risk. The known individuals are restricted to a small area number of anchialine pools on Maui and Hawaii Island and 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; by water extraction; by predation by and competition with nonnative fish; and by collection for the aquarium trade. The small number of remaining populations may limit this species' ability to adapt to environmental changes. Because of these threats, we find that this species should be listed as endangered throughout all of its range, and, therefore, we find that it is unnecessary to analyze whether it is threatened or endangered or threatened in a significant portion of its range.

## Distinct Population Segment

### *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) to guide the implementation of the DPS provisions of the Act. 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. Below, we evaluate 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; Fig. 1). The geographic, and in some cases seasonal, separation of these breeding populations is widely recognized, with strong genetic differentiation between the two ocean basins and among individual populations (Friesen *et al.* 2007b, p. 1768; Smith *et al.* 2007, p. 768). Whether individual populations merit taxonomic separation remains unclear, and further study is needed (Friesen *et al.* 2007a, p. 18591; Smith *et al.* 2007, p. 770; reviewed in Howell 2011, 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 2011, 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.* 2007b, 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); 4,000mi (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) suggests there is 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.* 2007a, 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). No haplotypes are shared (1) Between Atlantic and Pacific populations; (2) among Japan, Hawaii, and Galapagos populations; or (3) between 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 differentiation from all other populations, and were most closely related to birds from Japan (Friesen *et al.* 2007, 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 *per se* 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.* 2007a, 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 (Fig. 1), 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.

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, 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.* 1982a, p. 716; Carey *et al.* 1982b, 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 conditions necessary for the species' persistence: relatively undisturbed habitat in areas least accessible to predators; in addition, adaptations unique in this species may be necessary for its 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 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 stressors affecting the other 48 species addressed in this proposed rule (summarized above; see also “Summary of Factors Affecting the 49 Species Proposed for Listing,” below).

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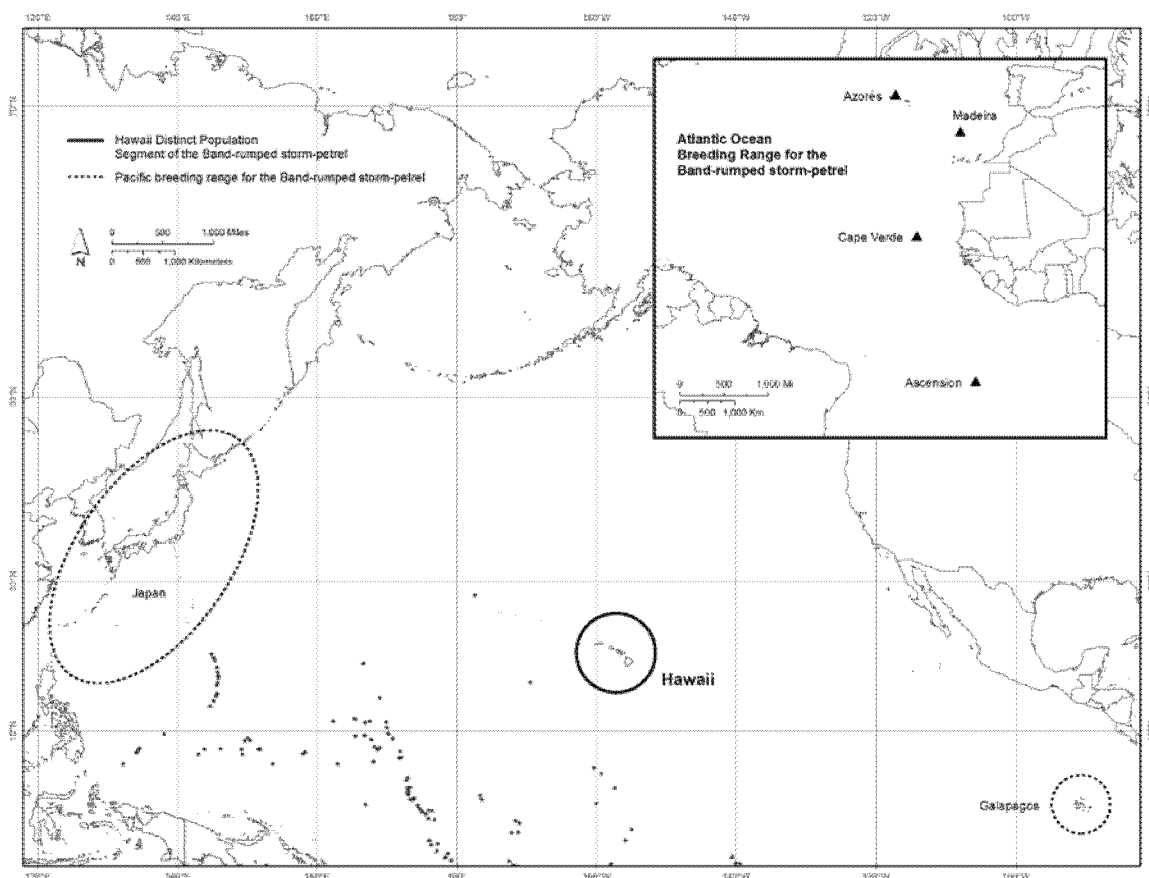


Figure 2. Location of the Hawaii Distinct Population Segment of the band-rumped storm-petrel and the two other breeding locations for the species in the Pacific Ocean.

Atlantic breeding locations also provided for context.

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**Summary of Factors Affecting the 49 Species Proposed for Listing**

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. 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 what factors might constitute threats to a species, we must look beyond the mere exposure of the species to the factor to evaluate whether the species responds to the factor in a way that causes actual impacts to the species. If there is exposure to a factor and the species responds negatively, the factor may be a threat, and, during the status review, we attempt to determine how significant a threat it is. The threat is significant 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. However, the identification of factors that could impact a species negatively may not be sufficient to warrant listing the species under the Act. The information must include evidence sufficient to show that these factors are

operative threats that act on the species to the point that the species meets the definition of an endangered or threatened species under the Act. That evidence is discussed below for each of the species proposed for listing in this rule.

If we determine that the level of threat posed to a species by one or more of the five listing factors is such that the species meets the definition of either endangered or threatened under section 3 of the Act, that species may then be proposed for listing. 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 proposed for listing in this

document are summarized in Table 3, and discussed in detail, below.

Each of the species proposed for listing in this proposed rule is adversely affected by the threats to the ecosystems on which it depends. There is information available on many of the threats that act on Hawaiian ecosystems, and for some ecosystems, there is a growing body of literature regarding these threats (e.g., nonnative ungulates and invasive plant species). The best available information on ecosystem threats affecting the species therein is discussed below. Table 3 identifies the threats to the ecosystems and the individual species within those ecosystems that are affected by those threats. Information on threats specific to certain species is also discussed where necessary and available; however, we acknowledge that we do not completely understand all the threats to each species. Scientific research directed toward each of these species is limited because of their rarity and the generally challenging logistics associated with conducting field work in Hawaii (e.g., areas are typically remote, difficult to survey in a comprehensive manner, and the target species are exceptionally uncommon).

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

(1) Foraging and trampling of native plants by nonnative ungulates, including feral pigs, goats, axis deer, black-tailed deer, mouflon, sheep, and cattle, which can result in severe erosion of watersheds. Foraging and trampling events destabilize soils that support native plant communities, bury or damage native plants, have adverse water quality effects due to runoff over exposed soils, and can negatively affect burrows and nesting areas used by the band-rumped storm-petrel.

(2) Disturbance of soils by feral pigs from rooting, which can create fertile seedbeds for nonnative plants.

(3) Increased nutrient availability and changes to nutrient cycling processes as a result of rooting by pigs in nitrogen-poor soils, which facilitates establishment of nonnative plants, as they are more adapted to nutrient-rich soils than native plants, and rooting activity creates open areas in forests allowing nonnative plants to completely replace native stands.

(4) Ungulate destruction of seeds and seedling of native plants, and facilitation of distribution of seeds of nonnative plants, promoting conversion of disturbed areas from native to nonnative vegetative communities.

(5) Damage by rat herbivory to plant propagules, seedlings, or native trees, which changes forest composition and structure.

(6) Feeding on or defoliation of native plants by nonnative invertebrates (e.g., slugs), which can reduce the geographic ranges of eight plant species (*Cyanea kauaulaensis*, *Deparia kaalaana*, *Labordia lorenciana*, *Phyllostegia brevidens*, *P. stachyoides*, *Ranunculus mauiensis*, *Schiedea diffusa* ssp. *diffusa*, and *S. pubescens*) because of damage or removal.

(7) Competition for food and nesting sites of the *Hylaeus* yellow-faced bees by nonnative wasps and bees.

(8) Predation by nonnative vertebrates such as fish, rats, cats, mongoose, and barn owls.

(9) Predation by nonnative invertebrates such as ants, wasps, and backswimmers.

(10) Water extraction leading to conversion of wetlands and surface fresh water resources, and changes to anchialine pools.

(11) Habitat modification and destruction by ungulates and fires, resulting in loss of forage plants used by *Hylaeus* for nectar and pollen.

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

Each of the above threats is discussed in more detail below, and summarized in Table 3.



TABLE 3—PRIMARY AND POTENTIAL FUTURE THREATS IDENTIFIED FOR EACH OF THE 49 HAWAIIAN ISLANDS SPECIES—Continued

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		
Yellow-faced bee ( <i>Hylaeus kuakea</i> )	LM		P, G	X	X	DR, HUR						A, W	X	LN, W, B, LHP	Ft.
Yellow-faced bee ( <i>Hylaeus longiceps</i> )	CO, LD	X	M, D	X	X	DR, HUR						A, W	X	LN, W, B, LHP	Ft.
Yellow-faced bee ( <i>Hylaeus mana</i> )	LM		P	X	X	DR, HUR						A, W	X	LN, W, B, LHP	Ft.

Factor A = Habitat Modification; Factor B = Overutilization; Factor C = Disease or Predation; Factor D = Inadequacy of Regulatory Mechanisms; Factor E = Other Species-Specific Threats; AP = Anchiaine 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); BS = Backswimmer; BTM = Black Tailed Deer; C = Cattle; CA = Cats; D = Axis Deer; FS = Fish; G = Goats; M = Mongoose; O = Barn Owls; P = Pigs; R = Rats; S = Slugs; SH = Sheep; TF = Tree Fall; W = Wasps (competition, predation).  
 DR = Drought; E = Erosion; F = Flooding; H = Human (fisheries, marine debris); HUR = Hurricanes; HY = Hybridization; L = Landslides; LHP = Loss of Host Plants; LJ = Lights; LN = Low Numbers; NR = No Regeneration; RF = Rockfalls; RU = Recreational Use (swimming, fishing, dumping trash and nonnative fish); SD = Sedimentation; ST = Structures; WE = Water Extraction; FV = Fortini Vulnerability analysis; Ft = Future threat.

*A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range*

The Hawaiian Islands are located over 2,000 miles (mi) (3,200 kilometers (km)) from the nearest continent. This isolation has allowed the few plants and animals that arrived by wind, water, or bird, to evolve into many highly 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 of the native species lost unneeded defenses against threats such as herbivory and competition with aggressive, weedy plant species typical of continental environments (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 sources (*e.g.*, Hawaiian yellow-faced bees) are particularly vulnerable to changes (from nonnative species, hurricanes, fire, and projected climate change) 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), largely impacting 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 2006). 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 the following species proposed for listing in this rule:

- On Oahu, the plants *Nothocestrum latifolium*, *Portulaca villosa*, and *Pseudognaphalium sandwicense* var. *molokaiense*, and the yellow-faced bees *Hylaeus anthracinus*, *H. assimulans*, *H. facilis*, and *H. longiceps*.
- On Molokai, the plants *Portulaca villosa*, *Pseudognaphalium sandwicense* var. *molokaiense*, and *Solanum nelsonii*; the orangeblack Hawaiian damselfly; and the yellow-faced bees *Hylaeus anthracinus*, *H. facilis*, *H. hiliaris*, and *H. longiceps*.
- On Maui, the plants *Nothocestrum latifolium*, *Portulaca villosa*, and *Solanum nelsonii*; and the yellow-faced bees *Hylaeus anthracinus*, *H. assimulans*, *H. facilis*, *H. hiliaris*, and *H. longiceps*.
- On Lanai, the plants *Nothocestrum latifolium*, *Portulaca villosa*, and *Pseudognaphalium sandwicense* var. *molokaiense*; the orangeblack Hawaiian damselfly; and the yellow-faced bees *Hylaeus anthracinus*, *H. assimulans*, *H. facilis*, *H. hiliaris*, and *H. longiceps*.
- On Hawaii Island, the orangeblack Hawaiian damselfly and the anchialine pool shrimp *Procaris hawaiiensis* (Daly and Magnacca 2003, pp. 55, 173; FWS Rare Taxon Database 2005, *in litt.*; HBMP 2007, *in litt.*; Magnacca 2007b, p. 188; IUCN 2007, *in litt.*; Kallstrom 2008, *in litt.*; MNTF 2010, *in litt.*; Duvall 2011, *in litt.*; 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 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 with a target completion date of 2015 (CWRM 2015, *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.

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 impacted anchialine pools on this island (Brock 2004, pp. 13–17) (see “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 a related anchialine pool shrimp *Halocaridina rubra* from a pool adjacent to Honokohau Harbor on Hawaii Island. Lua O Palahemo (where *Procaris hawaiiensis* occurs) on Hawaii Island is accessible to the public, and dumping has previously 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. hawaiiensis*; 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 impacted 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 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 impacted 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 proposed for listing in this rule (see Table 3).

#### Pigs (*Sus Scrofa*)

The destruction or modification of habitat by pigs currently affects five of the ecosystems (lowland dry, lowland mesic, lowland wet, montane wet, and montane mesic). 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, and 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 2006, p. 85). By the early 1900s, feral pigs were already recognized as a 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 impact 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 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 ac (0.1 ha)) of groundcover per week (Anderson *et al.* 2007, in litt.). Feral pigs are a major vector for promoting establishment and spread of competing invasive nonnative plant species, such as *Passiflora tarminiana* (banana poka) and *Psidium cattleianum* (strawberry guava), 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 impacts native plant communities by contributing to watershed degradation and by alteration of nutrient availability

for plants, as well as by directly damaging individual plants, and, in addition, impacts aquatic animals by contributing to 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 14 plants proposed for listing in this rule are at risk from erosion and landslides resulting from the activities of feral pigs: *Cylcosorus boydiae*, *Gardenia remyi*, *Joinvillea ascendens ssp. ascendens*, *Kadua fluviatilis*, *Kadua hauapuensis*, *Labordia lorenciana*, *Lepidium orbiculare*, *Ochrosia haleakalae*, *Phyllostegia brevidens*, *P. helleri*, *P. stachyoides*, *Ranunculus hawaiiensis*, *R. mauiensis*, and *Schiedea pubescens*. Thirty-one of the 39 plants (all except for *Cyanea kauaulaensis*, *Exocarpos menziesii*, *Festuca hawaiiensis*, *Hypolepis hawaiiensis* var. *mauiensis*, *Portulaca villosa*, *Pseudognaphalium sandwicense* var. *molokaiense*, *Sanicula sandwicensis*, and *Solanum nelsonii*) proposed for listing in this rule 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*) proposed for listing in this rule are at risk of habitat destruction and modification by feral pigs (see Table 3).

#### Goats (*Capra Hircus*)

Feral goats currently destroy and modify habitat in nine of the described ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane wet, montane mesic, montane dry, dry cliff, and wet cliff). Goats, native to the Middle East and India, were successfully introduced to the Hawaiian Islands in the late 1700s. Actions to control 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 impacted by ungulates beginning in 1793, with the 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; for over 50 years, 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 can be 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 following 12 plants proposed for listing in this rule are at risk from landslides or erosion caused by feral goats:

*Gardenia remyi*, *Joinvillea ascendens* ssp. *ascendens*, *Kadua fluviatilis*, *Labordia lorenciana*, *Ochrosia haleakalae*, *Phyllostegia helleri*, *P. stachyoides*, *Portulaca villosa*, *Pseudognaphalium sandwicense* var. *molokaiense*, *Ranunculus mauiensis*, *Sanicula sandwicensis*, and *Schiedea pubescens*; and the band-rumped storm-petrel. Twenty-two 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*, *Lepidium orbiculare*, *Phyllostegia brevidens*, *Portulaca villosa*, *Pritchardia bakeri*, *Ranunculus hawaiiensis*, *Schiedea diffusa* ssp. *diffusa*, *Sicyos macrophyllus*, *Solanum nelsonii*, *Stenogyne kaalae* ssp. *sherffii*, and *Wikstroemia skottsbergiana*), and the band-rumped storm-petrel, the orangeblack Hawaiian damselfly, and the yellow-faced bees *Hylaeus anthracinus*, *H. assimulans*, *H. facilis*, *H. hilaris*, and *H. kuakea* proposed for listing in this rule, are at risk of habitat destruction and modification by feral goats.

#### Axis Deer (*Axis Axis*)

Axis deer destroy and modify 8 of the 11 ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane

mesic, montane wet, montane dry, and dry cliff). 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 lower, more openly vegetated areas for browsing and grazing; however, 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, and promoting erosion by destabilizing substrate; creating gullies that convey water; and by dislodging stones from ledges that can cause rockfalls and landslides, directly damaging 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 at such high rates on Maui 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 invasive 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 managed as game animals on these three islands, the State does not permit their introduction to other Hawaiian Islands. Recently (2010-2011), there was an illegal introduction of axis deer 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 Land and Natural Resources—Division of Forestry and Wildlife (HDLNR-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 species proposed for listing in this rule are at risk from the activities of axis deer: *Gardenia remyi*, *Huperzia stemmerrmanniae*, *Joinvillea ascendens* ssp. *ascendens*, *Nothoecium latifolium*, *Phyllostegia stachyoides*, *Portulaca villosa*, *Pseudognaphalium sandwicense* var. *molokaiense*, *Ranunculus mauiensis*, *Schiedea pubescens*, and *Solanum nelsonii*, and 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). The black-tailed deer is one of nine subspecies of mule deer (Natural History Museum 2015, in litt.). On Kauai, black-tailed deer were first introduced in 1961, for the purpose of sport hunting (Tomich 1986, pp. 131–134). Currently, these deer are limited to 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 impact 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 in their hooves and feces. Black-tailed deer have been noted as a cause of habitat alteration in the Kauai ecosystems (NTBG 2007, in litt.; HBMP 2010). Four of the 39 plants proposed for listing in this rule (*Asplenium diellaciniatum*, *Nothoecstrum latifolium*, *Ranunculus mauianus*, and *Santalum involutum*) are at risk of habitat destruction and modification by black-tailed deer.

**Sheep (*Ovis aries*)**

Four of the described ecosystems on Hawaii Island (lowland wet, montane wet, montane dry, and wet cliff), are currently affected by habitat modification and destruction due to the activities of domestic 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). 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 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 plant and animal taxa (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). Five of the 39 plants, *Exocarpos menziesii*, *Festuca hawaiiensis*, *Nothoecstrum latifolium*, *Phyllostegia brevidens*, and *Portulaca villosa*, and the yellow-faced bee *Hylaeus anthracinus*, which are proposed for listing in this rule, are reported to be at risk of habitat destruction and modification by feral sheep (see Table 3).

**Mouflon Sheep (*Ovis gmelini musimon*)**

Mouflon sheep destroy and modify habitat in 7 of the 11 described ecosystems on Maui, Lanai, and Hawaii Island (coastal, lowland dry, lowland mesic, montane wet, montane mesic, montane dry, subalpine). Native to Asia Minor, mouflon sheep were introduced to the islands of Lanai and Hawaii in the 1950s as a managed 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 hunted as a game animal (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 enclosures on Hawaii Island constructed to protect rare species and habitat are only 4 ft (1.3 m) in height, as they are designed to exclude feral pigs, goats, and sheep; however, in actuality, a fence height of at least 6 ft (2 m) is necessary to exclude mouflon (Ikagawa 2011, in litt.). Seven of the 39 plant species (*Exocarpos menziesii*, *Festuca hawaiiensis*, *Nothoecstrum latifolium*, *Phyllostegia brevidens*, *Portulaca villosa*, *Ranunculus hawaiiensis*, and *Sicyos macrophyllus*); the yellow-faced bees *Hylaeus anthracinus*, *H. assimulans*, *H. facilis*, *H. hilaris*, and *H. longiceps*; and the band-rumped storm-petrel proposed for listing in this rule are at risk of destruction and modification of habitat resulting from the activities of mouflon sheep.

**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). 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.). Large areas of native forest were quickly converted to grassland through the combined logging of native koa and establishment of cattle ranches (Tomich 1986, p. 140; Cuddihy and Stone 1990, p. 47). 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 NWR (KMWP 2007, p. 55; USFWS 2010, pp. 3–15, 4–86). Nine of the 39 plant species (*Huperzia stemmermanniae*, *Ochrosia haleakalae*, *Phyllostegia brevidens*, *Portulaca villosa*, *Ranunculus hawaiiensis*, *R. mauiensis*, *Schiedea pubescens*, *Sicyos macrophyllus*, and *Solanum nelsonii*) and four of the yellow-faced bees (*Hylaeus anthracinus*, *H. assimulans*, *H. facilis*, and *H. hiliaris*) 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 (all except the anchialine pool shrimp *Procaris hawaiiensis*), which are proposed for listing in this rule, are at risk of habitat destruction and modification by feral ungulates including pigs, goats, axis deer, black-tailed deer, sheep, mouflon, and cattle (see Table 3). 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; 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 Modification and Destruction 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 (all but the anchialine pool ecosystem) 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, 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 (Scott *et al.* 1986, pp. 361–363; Cuddihy and Stone 1990, p. 73). We have compiled descriptions of 115 nonnative plant species reported to destroy and modify the habitat of, or outcompete, 44 of the 49 species proposed for listing in this rule (all except *Exocarpos menziesii*, *Huperzia stemmermanniae*, *Joinvillea ascendens* ssp. *ascendens*, the band-rumped storm-petrel, and the anchialine pool shrimp). Fourteen of these nonnative plants are included in the Hawaii Noxious Weed List (Hawaii Department of Agriculture HAR Title 4, Subtitle 6, Chapter 68).

Nonnative plants adversely impact 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 (*e.g.*, by fostering series of fires that burn successively farther into native habitat, destroying native plants and removing native plant habitat by altering microclimatic conditions to favor nonnative species), thus ultimately converting native-dominated plant communities to nonnative plant communities (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 often 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, mainly 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; there is little above-ground 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 44 species (36 plants, the orangeblack Hawaiian damselfly, and all 7 yellow-faced bees) proposed for listing in this rule, by modifying or destroying their habitat, by removing their native host plants, or by direct competition. Below, we have organized lists of the nonnative plants reported to negatively affect each of 10 of the 11 ecosystems (the anchialine pool ecosystem is not included). These lists include a total of 115 nonnative plant species with the specific negative effects they have on native ecosystems and the proposed species.

Nonnative Plants in the Coastal Ecosystem: Nonnative plants threatening the coastal ecosystem plants proposed for listing (*Portulaca villosa*, *Pseudognaphalium sandwicense* var. *molokaiense*, and *Solanum nelsonii*) and the coastal ecosystem animals proposed for listing (the orangeblack Hawaiian damselfly, and the yellow-faced bees *Hylaeus anthracinus*, *H. assimulans*, *H. facilis*, *H. hiliaris*, and *H. longiceps*), include the nonnative understory and subcanopy species *Asystasia gangetica* (Chinese violet), *Atriplex semibaccata*, *Conyza bonariensis* (hairy horseweed), *Kalanchoe pinnata* (air plant), *Lantana camara* (lantana), *Leucaena leucocephala* (koa haole), *Neonotonia wightii* (glycine), *Nicotiana glauca* (tree tobacco), *Pluchea carolinensis* (sourbush), *P. indica* (Indian fleabane), *Stachytarpheta* spp., and *Verbesina encelioides* (golden crown-beard) (DOFAW 2007, pp. 20–22, 54–58; HBMP 2010). Nonnative canopy species include *Acacia farnesiana* (klu) and *Prosopis pallida* (HBMP 2010). In addition, the nonnative grasses *Cenchrus ciliaris* (buffelgrass), *Chloris*

*barbata* (swollen fingergrass), *Cynodon dactylon* (Bermuda grass), *Digitaria insularis* (sourgrass), *Setaria verticillata* (bristly foxtail), *Urochloa maxima* (guinea grass), and *U. mutica* (California grass) negatively affect this ecosystem (HBMP 2010) (see “Specific Nonnative Plant Species Impacts,” below).

Nonnative Plants in the Lowland Dry Ecosystem: Nonnative plants threatening the lowland dry ecosystem plants proposed for listing (*Nothocestrum latifolium* and *Portulaca villosa*) and the lowland dry ecosystem animals proposed for listing (the orangeblack Hawaiian damselfly and the yellow-faced bees *Hylaeus anthracinus*, *H. assimulans*, *H. facilis*, *H. hiliaris*, and *H. longiceps*) include the nonnative understory and subcanopy species *Ageratina adenophora* (Maui pamakani), *Asystasia gangetica*, *Atriplex semibaccata*, *Conyza bonariensis*, *Lantana camara*, *Leonotis nepetifolia* (lion’s ear), *Leucaena leucocephala*, *Neonotia wightii*, *Nicotiana glauca*, *Passiflora foetida* (love-in-a-mist), *P. suberosa* (huehue haole), *Stachytarpheta* spp., and *Stapelia gigantea* (giant toad plant) (Perlman 2007, p. 3; HBMP 2010). Nonnative canopy species include *Acacia confusa* (Formosa koa), *A. farnesiana*, *Casuarina equisetifolia* (ironwood), *Chrysophyllum oliviforme* (satinleaf), *Grevillea robusta* (silk oak), *Prosopis pallida*, *Psidium guajava* (common guava), and *Schinus terebinthifolius* (Christmas berry) (Perlman 2007, p. 7; HBMP 2010). In addition, the nonnative grasses *Andropogon virginicus* (broomsedge), *Cenchrus ciliaris*, *C. setaceus* (fountain grass), *Chloris barbata*, *Cynodon dactylon*, *Digitaria insularis*, *Melinis minutiflora* (molasses grass), *M. repens* (natal redtop), and *Setaria verticillata* negatively affect this ecosystem (HBMP 2010) (see “Specific Nonnative Plant Species Impacts,” below).

Nonnative Plants in the Lowland Mesic Ecosystem: Nonnative plants threatening the lowland mesic ecosystem plants proposed for listing (*Deparia kaalaana*, *Gardenia remyi*, *Joinvillea ascendens* ssp. *ascendens*, *Kadua fluviatilis*, *K. haupeensis*, *Lepidium orbiculare*, *Microlepia strigosa* var. *mauiensis*, *Myrsine fosbergii*, *Nothocestrum latifolium*, *Ochrosia haleakalae*, *Pritchardia bakeri*, *Santalum involutum*, and *Sicyos lanceoloideus*) and the lowland mesic ecosystem animals proposed for listing (the orangeblack Hawaiian damselfly and the yellow-faced bees *Hylaeus facilis*, *H. kuakea*, and *H. mana*) include the nonnative understory and subcanopy species *Ageratina riparia*

(*Hamakua pamakani*), *Anemone hupehensis* var. *japonica* (Japanese anemone), *Ardisia elliptica* (shoebutton ardisia), *Asystasia gangetica*, *Blechnum appendiculatum* (no common name (NCN)), *Buddleja asiatica*, *Caesalpinia decapetala* (cat’s claw), *Cestrum diurnum* (day cestrum), *Clidemia hirta* (Koster’s curse), *Conyza bonariensis*, *Cordyline fruticosa* (ti, ki), *Cuphea carthagenensis*, *Cyclosorus dentatus*, *Delairea odorata* (German ivy), *Erigeron karvinskianus* (daisy fleabane), *Hedychium coronarium* (white ginger), *Kalanchoe pinnata* (air plant), *Lantana camara*, *Leptospermum scoparium* (tea tree), *Passiflora laurifolia* (yellow granadilla, water lemon), *P. suberosa*, *Rubus argutus* (prickly Florida blackberry), *R. rosifolius* (thimbleberry), *Sphaeropteris cooperi*, and *Stachytarpheta* spp. (TNC 1997, pp. 10, 15; HBMP 2010). Nonnative canopy species include *Acacia confusa*, *Aleurites moluccana* (kukui), *Casuarina equisetifolia*, *Chrysophyllum oliviforme*, *Cinchona pubescens* (quinine), *Coffea arabica* (coffee), *Falcataria moluccana* (albizia), *Ficus microcarpa* (Chinese banyan), *Fraxinus uhdei* (tropical ash), *Grevillea robusta*, *Morella faya* (firetree), *Omalanthus populifolius* (Queensland poplar), *Psidium cattleianum* (strawberry guava), *P. guajava*, *Ricinus communis* (castor bean), *Schefflera actinophylla* (octopus tree), *Schinus terebinthifolius*, *Syzygium cumini* (java plum), *S. jambos* (rose apple), *Tecoma stans* (yellow elder), and *Toona ciliata* (Australian red cedar). Additional threats are the nonnative grasses *Cynodon dactylon*, *Digitaria setigera*, *Ehrharta stipoides* (meadow rice grass), *Melinis minutiflora*, and *Paspalum conjugatum* (Hilo grass) (TNC 1997, p. 15; Motley 2005, p. 109; HBMP 2010) (see “Specific Nonnative Plant Species Impacts,” below).

Nonnative Plants in the Lowland Wet Ecosystem: Nonnative plants threatening the lowland wet ecosystem plants proposed for listing (*Cyanea kauaulaensis*, *Cyclosorus boydiae*, *Cyperus neokunthianus*, *Deparia kaalaana*, *Gardenia remyi*, *Kadua fluviatilis*, *Myrsine fosbergii*, *Ochrosia haleakalae*, *Phyllostegia brevidens*, *P. helleri*, *Santalum involutum*, *Schiedea diffusa* ssp. *diffusa*, *S. pubescens*, *Stenogyne kaalae* ssp. *sherffii*, and *Wikstroemia skottsbergiana*) include the nonnative understory and subcanopy species *Ageratina adenophora*, *A. riparia*, *Ageratum conyzoides*, *Angiopteris evecta*, *Blechnum appendiculatum*, *Buddleja asiatica*, *Cestrum diurnum*, *C. nocturnum* (night cestrum), *Clidemia hirta*, *Conyza*

*bonariensis*, *Cordyline fruticosa*, *Cuphea carthagenensis*, *Cyclosorus dentatus*, *Drymaria cordata* (chickweed), *Erechtites valerianifolia* (fireweed), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum* (kahili ginger), *Juncus planifolius* (bog rush), *Leptospermum scoparium* (tea tree), *Passiflora edulis* (passion fruit), *P. foetida*, *P. suberosa*, *Persicaria punctata* (water smartweed), *Pterolepis glomerata* (NCN), *Rubus argutus*, *R. rosifolius*, *Sphaeropteris cooperi*, *Tibouchina herbacea* (glorybush), and *Youngia japonica* (oriental hawkbeard); and the nonnative canopy species *Ardisia elliptica*, *Cinnamomum burmannii* (padang cassia), *Coffea arabica*, *Cryptomeria japonica* (tsugi pine), *Eucalyptus* spp., *Falcataria moluccana*, *Heliocarpus popayanensis* (moholo), *Miconia calvescens* (miconia), *Morella faya*, *Pimenta dioica* (allspice), *Psidium cattleianum*, *P. guajava*, *Schefflera actinophylla*, *Schinus terebinthifolius*, and *Syzygium jambos* (TNC 1997, p. 10; HBMP 2010). Nonnative grasses that negatively impact the lowland wet ecosystem include *Axonopus fissifolius* (narrow-leaved carpetgrass), *Cortaderia jubata* (pampas grass), *Ehrharta stipoides*, *Melinis minutiflora*, *Oplismenus hirtellus* (basketgrass), *Paspalum conjugatum*, *Sacciolepis indica* (glenwood grass), *Urochloa maxima*, and *U. mutica* (TNC 1997, p. 10; Erickson and Puttock 2006, p. 270) (see “Specific Nonnative Plant Species Impacts,” below).

Nonnative Plants in the Montane Wet Ecosystem: Nonnative plants threatening the montane wet ecosystem plants proposed for listing (*Calamagrostis expansa*, *Cyclosorus boydiae*, *Cyrtandra hematos*, *Dryopteris glabra* var. *pusilla*, *Hypolepis hawaiiensis* var. *mauiensis*, *Microlepia strigosa* var. *mauiensis*, *Myrsine fosbergii*, *Phyllostegia brevidens*, *P. helleri*, *P. stachyoides*, *Ranunculus mauiensis*, *Schiedea diffusa* ssp. *diffusa*, *S. pubescens*, and *Sicyos macrophyllus*) include the nonnative understory and subcanopy species *Ageratina adenophora*, *A. riparia*, *Ageratum conyzoides* (maile honohono), *Anemone hupehensis* var. *japonica*, *Blechnum appendiculatum*, *Buddleja asiatica*, *Cestrum nocturnum*, *Clidemia hirta*, *Cyclosorus dentatus*, *Drymaria cordata*, *Erechtites valerianifolia*, *Erigeron karvinskianus*, *Hedychium gardnerianum*, *Hypochaeris radicata* (hairy cat’s ear), *Juncus effusus*, *J. ensifolius*, *J. planifolius*, *Lantana camara*, *Lapsana communis* (nipplewort), *Persicaria punctata*,

*Rubus argutus*, *R. ellipticus* (yellow Himalayan raspberry), *R. rosifolius*, *Sphaeropteris cooperi*, *Tibouchina herbacea*, *Ulex europaeus* (gorse), and *Youngia japonica*, and the nonnative canopy species *Cinnamomum burmannii*, *Cryptomeria japonica*, *Eucalyptus* spp., *Morella faya*, *Psidium cattleianum*, and *Schinus terebinthifolius* (HBMP 2010). Nonnative grasses that negatively impact the montane wet ecosystem include *Anthoxanthum odoratum* (sweet vernalgrass), *Axonopus fissifolius*, *Cortaderia jubata*, *Ehrharta stipoides*, *Holcus lanatus* (common velvet grass), *Melinis minutiflora*, *Paspalum conjugatum*, *Sacciolepis indica* (glenwood grass), and *Setaria palmifolia* (palmgrass) (see “Specific Nonnative Plant Species Impacts,” below).

Nonnative Plants in the Montane Mesic Ecosystem: Nonnative plants threatening the montane mesic ecosystem plants proposed for listing (*Asplenium diellaciniatum*, *Labordia lorenciana*, *Microlepia strigosa* var. *mauiensis*, *Ochrosia haleakalae*, *Phyllostegia stachyoides*, *Ranunculus hawaiiensis*, *R. mauiensis*, *Sanicula sandwicensis*, *Schiedea pubescens*, *Sicyos lanceoloideus*, *S. macrophyllus*) include the nonnative understory and subcanopy species *Ageratina adenophora*, *Buddleja asiatica*, *Clidemia hirta*, *Cotoneaster pannosus*, *Cyclosorus dentatus*, *Delairea odorata*, *Epilobium ciliatum* (willow herb), *Lantana camara*, *Leptospermum scoparium*, *Passiflora edulis*, *P. tarminiana*, *Rubus argutus*, *R. rosifolius*, and *Ulex europaeus* (Leeward Haleakala Watershed Partnership (LHWP) 2006, p. 25; HBMP 2010; TNCH 2009, 14 pp.); and the nonnative canopy species *Cinchona pubescens*, *Fraxinus uhdei*, *Morella faya*, *Pinus* spp., *Psidium cattleianum*, and *Schinus terebinthifolius*. Nonnative grasses that negatively impact the montane mesic ecosystem include *Andropogon virginicus*, *Cenchrus setaceus*, *Cortaderia jubata*, *Cynodon dactylon*, *Ehrharta stipoides*, *Holcus lanatus*, *Melinis minutiflora*, *Paspalum conjugatum*, and *Setaria palmifolia* (HBMP 2010) (see “Specific Nonnative Plant Species Impacts,” below).

Nonnative Plants in the Montane Dry Ecosystem: Nonnative plants threatening the montane dry ecosystem plants proposed for listing (*Festuca hawaiiensis*, *Portulaca villosa*, *Ranunculus hawaiiensis*, *R. mauiensis*, *Sanicula sandwicensis*, and *Sicyos macrophyllus*) include the nonnative understory and subcanopy species *Clidemia hirta*, *Cotoneaster pannosus*,

*Heterotheca grandiflora* (telegraph weed), *Rubus argutus*, and *Senecio madagascariensis*, and the nonnative canopy species *Grevillea robusta*, *Psidium cattleianum*, and *Schinus terebinthifolius* (HBMP 2010). Nonnative grasses such as *Cenchrus setaceus* and *Melinis minutiflora* negatively impact the montane dry ecosystem (see “Specific Nonnative Plant Species Impacts,” below).

Nonnative Plants in the Subalpine Ecosystem: Nonnative plants threatening the subalpine ecosystem plants proposed for listing (*Ranunculus hawaiiensis* and *Sanicula sandwicensis*) include the nonnative understory and subcanopy species *Ageratina adenophora*, *Cotoneaster pannosus*, *Epilobium billardierianum* ssp. *cinereum* (willow herb), *E. ciliatum*, *Hypochoeris radicata*, *Lapsana communis*, *Passiflora tarminiana*, and *Rubus argutus*, and the nonnative canopy species *Pinus* spp. Nonnative grasses such as *Anthoxanthum odoratum*, *Cenchrus setaceus*, *Cynodon dactylon*, *Dactylis glomerata* (cocksfoot), and *Holcus lanatus* negatively impact the montane dry ecosystem (see “Specific Nonnative Plant Species Impacts,” below).

Nonnative Plants in the Dry Cliff Ecosystem: Nonnative plants threatening the dry cliff ecosystem plants proposed for listing (*Nothoctrum latifolium*, *Ochrosia haleakalae*, and *Sicyos lanceoloideus*) and the dry cliff ecosystem animal, the band-rumped storm-petrel, include the nonnative understory and subcanopy species *Ageratina adenophora*, *A. riparia*, *Blechnum appendiculatum*, *Clidemia hirta*, *Erigeron karvinskianus*, *Hypochoeris radicata*, *Kalanchoe pinnata*, *Lantana camara*, *Lapsana communis*, *Leucaena leucocephala*, *Lythrum maritimum* (loosestrife), *Passiflora suberosa*, *Pluchea carolinensis*, *Prunella vulgaris*, and *Rubus rosifolius*, and the nonnative canopy species *Acacia confusa*, *Casuarina equisetifolia*, *Grevillea robusta*, *Melia azedarach* (chinaberry), *Psidium cattleianum*, *P. guajava*, *Schinus terebinthifolius*, *Sphaeropteris cooperi*, *Syzygium cumini*, *Tecoma stans*, and *Toona ciliata* (HBMP 2010). Nonnative grasses that negatively impact the dry cliff ecosystem include *Andropogon virginicus*, *Cenchrus setaceus*, *Dactylis glomerata*, *Digitaria insularis*, *Ehrharta stipoides*, *Holcus lanatus*, *Melinis minutiflora*, and *Urochloa maxima* (HBMP 2010) (see “Specific Nonnative Plant Species Impacts,” below).

Nonnative Plants in the Wet Cliff Ecosystem: Nonnative plants

threatening the wet cliff ecosystem plants proposed for listing (*Phyllostegia brevidens*, *P. helleri*, *Ranunculus mauiensis*, and *Schiedea pubescens*) and the wet cliff ecosystem animal, the band-rumped storm-petrel, include the nonnative understory and subcanopy species *Ageratina adenophora*, *Blechnum appendiculatum*, *Clidemia hirta*, *Erchites valerianifolia*, *Erigeron karvinskianus*, *Hedychium gardnerianum*, *Juncus effusus*, *Passiflora suberosa*, *Pterolepis glomerata*, *Rubus argutus*, *R. rosifolius*, and *Tibouchina herbacea*, and the nonnative canopy species *Ardisia elliptica*, *Buddleja asiatica*, *Heliocarpus popayanensis*, *Psidium cattleianum*, *P. guajava*, *Schinus terebinthifolius*, and *Toona ciliata* (HBMP 2010). Nonnative grasses that negatively impact the wet cliff ecosystem include *Axonopus fissifolius*, *Ehrharta stipoides*, *Melinis minutiflora*, *Oplismenus hirtellus*, *Paspalum conjugatum*, and *Setaria palmifolia* (HBMP 2010) (see “Specific Nonnative Plant Species Impacts,” below).

Specific Nonnative Plant Species Impacts: Destruction and modification of habitat, and competition, by nonnative plants represent ongoing threats to 45 species (36 plants, the band-rumped storm-petrel, the orangeblack Hawaiian damselfly, and all 7 yellow-faced bees) proposed for listing in this rule throughout their ranges. Nonnative plants adversely affect microhabitat by modifying availability of light and nutrient cycling processes, and by altering soil-water regimes. Some nonnative plants may release chemicals that inhibit growth of other plants. They also alter fire regimes leading to incursions of fire-tolerant, nonnative plant species in native habitat. These competitive advantages allow nonnative plants to convert native-dominated plant communities to nonnative plant communities (Cuddihy and Stone 1990, p. 74; Vitousek 1992, pp. 33–35).

The Hawaii Weed Risk Assessment (HWRA) is cited in many of the descriptions below. This assessment was created as a research collaboration between the University of Hawaii and the U.S. Forest Service for use in Hawaii and other high Pacific islands (*i.e.*, volcanic in origin, as opposed to low-lying atolls), and is an adaptation of the Australian/New Zealand Weed Risk Assessment protocol developed in the 1990s (Denslow and Daehler 2004, p. 1). The Australian/New Zealand protocol was developed to screen plants proposed for introduction into those countries, while the Hawaii-Pacific Weed Risk Assessment (HWRA) was developed to evaluate species already

used in landscaping, gardening, and forestry, and is also used to predict whether or not a nonnative plant species is likely to become invasive. Not all nonnative plant species present in Hawaii have been assessed, and information on propensity for invasiveness is lacking from some of the following descriptions. When known, we describe specific negative impacts of individual nonnative plants that threaten 45 of the 49 species proposed for listing.

- *Acacia confusa* (Formosa koa) is a tree introduced to Hawaii from Taiwan and the Philippine Islands in 1915 by the Board of Agriculture and Forestry and the Hawaiian Sugar Planter's Association for use as a windbreak; it is naturalized on all the main islands except Niihau (Geesink *et al.* 1999, p. 641). This species forms monotypic stands at lower elevations that prevent establishment of native plants. Seeds present in the ground germinate profusely after fire, allowing it to outcompete native plants (Pacific Islands Ecosystems at Risk (PIER) 2008). This species occurs in lowland dry, lowland mesic, and dry cliff habitats on all the main islands except Niihau (Geesink 1999, p. 641).

- *Acacia farnesiana* (klu) is a shrub to 13 ft (4 m) tall, native to the Neotropics, and formerly cultivated in Hawaii for an attempted perfume industry. This species is thorny and forms dense thickets, and regenerates quickly after fire. The seeds are dispersed by ungulates that eat the pods (PIER 2011). It is now naturalized (*i.e.*, initially introduced from another area, and now reproducing in the wild) in coastal and lowland dry areas on all of the main Hawaiian Islands except Niihau (Geesink *et al.* 1999, p. 641). According to the HWRA for *A. farnesiana*, this species has a high risk of invasiveness or a high risk of becoming a serious pest (PIER 2011).

- *Ageratina adenophora* (Maui pamakani) is native to tropical America, and has naturalized in lowland to subalpine, dry to wet forest, including cliffs, on the islands of Kauai, Oahu, Molokai, Lanai, and Maui (Wagner *et al.* 1999, pp. 254–255; Wagner *et al.* 2012, p. 9). This shrub is 3 to 5 ft (1 to 1.5 m) tall with trailing branches that root on contact with the soil. It forms dense mats, which prevent regeneration of native plants (Anderson *et al.* 1992, p. 315). It is considered a harmful weed in agriculture, especially in rangeland, because it often displaces more desirable vegetation or native species, and is fatally toxic to horses and most livestock. The eupatorium gall fly, *Procecidochares utilis*, was introduced

to Hawaii in 1944 for control of Maui pamakani, with some success in suppression of some infestations, but not those in higher rainfall areas (Bess and Haramoto 1959, p. 248; Bess and Haramoto 1972, pp. 166, 175).

- *Ageratina riparia* (Hamakua pamakani) is a subshrub native to Mexico and the West Indies that spreads from a creeping rootstock (Wagner *et al.* 1999, p. 255). This species forms dense mats that prevent regeneration of native plants (Davis *et al.* 1992, p. 427), and is naturalized in dry cliffs, lowland mesic, lowland wet, and montane wet forest on Kauai, Oahu, Molokai, Lanai, and Maui (Wagner *et al.* 1999, p. 255; Wagner *et al.* 2012, p. 9).

- *Ageratum conyzoides* (maile honohono) is a perennial herb native to Central and South America and now widespread on all the main Hawaiian Islands (Wagner *et al.* 1999, pp. 254–255). This species invades lowland and montane wet areas, tolerates shade, and can outcompete and displace native plants. It produces many thousands of seeds that spread by wind and water, with over half the seeds germinating shortly after they are shed (PIER 2007).

- *Aleurites moluccana* (kukui) is a spreading, tall tree (66 ft; 20 m), native to Malesia, and considered a Polynesian introduction to Hawaii. It is now a significant component of the lowland mesic valley vegetation from sea level to 2,300 ft (700 m) on all the main islands (Wagner *et al.* 1999, p. 598). According to the HWRA, this species has a high risk of invasiveness or a high risk of becoming a serious pest (PIER 2008). This species tolerates a wide range of soil conditions and forms dense thickets, shading out other plants (Wagner *et al.* 1999, p. 598).

- *Andropogon virginicus* (broomsedge) is a perennial bunch grass native to northeastern America and naturalized on Kauai, Oahu, Molokai, Maui, and Hawaii Island (Wagner *et al.* 2012, p. 88). It occurs along roadsides and in disturbed dry to mesic forest and shrubland, and cliffs (O'Connor 1999, p. 1497). Seeds are easily distributed by wind, clothing, vehicles, and animals (Smith 1989, pp. 60–69). This species can outcompete and displace native plants, and may release allelopathic substances that prevent the establishment of other plants (Rice 1972, pp. i, 752–755). This species is fire-adapted, and has become dominant in areas subjected to natural or human-caused fires (Mueller-Dombois 1972, pp. 1–2), and is included in the Hawaii State Noxious Weed List (HAR Title 4, Subtitle 6, Chapter 68).

- *Anemone hupehensis* var. *japonica* (Japanese anemone), an herbaceous

perennial, is native to China and is naturalized and locally common in open, wet areas along roadsides and in lowland mesic and montane wet forest on Hawaii Island (Duncan 1999, p. 1087). This species has wind-distributed seeds, spreads by suckers, and resists grazing because of toxic chemicals that induce vomiting when ingested. According to the HWRA, this species has a high risk of invasiveness or a high risk of becoming a pest species (PIER 2011).

- *Angiopteris evecta* (mule's foot fern) is native throughout much of the South Pacific, including Australia and New Guinea, and is naturalized on Kauai, Oahu, Molokai, Maui, Lanai, and Hawaii Island (Palmer 2003, p. 49; Wagner *et al.* 2012, p. 103). Rhizomes form a massive trunk, and fronds may grow up to 23 ft (7 m) long and 10 ft (3 m) wide, allowing this species to form dense stands and displace and shade out native plants in lowland wet forest (Global Invasive Species Database (GISD) 2011; Palmer 2003, pp. 48–49). It has become the dominant understory plant in some valleys on Oahu.

- *Anthoxanthum odoratum* (sweet vernalgrass) is a perennial bunchgrass native to Eurasia and now naturalized on Kauai, Oahu, Molokai, Maui, and Hawaii Island, in pastures, disturbed areas in montane wet forest, and sometimes subalpine shrubland (O'Connor 1999, p. 1498; Wagner *et al.* 2012, p. 88). This grass forms extensive ground cover, crowding out and preventing reestablishment of native plants (PIER 2008).

- *Ardisia elliptica* (shoebuttan ardisia) is a branched shrub native to Sri Lanka that is now naturalized on Kauai, Oahu, Maui, and Hawaii Island (Wagner *et al.* 1999, pp. 932–933; Wagner *et al.* 2012, p. 53). This species is shade-tolerant and can rapidly form dense, monotypic stands, preventing establishment of native species (Global Invasive Species Database (GISD) 2005). Its fruit are attractive to birds, which then spread the seeds over the landscape. According to the HWRA, this species has a high risk of invasiveness or a high risk of becoming a serious pest (PIER 2008). This species occurs in lowland mesic and wet forest, and on wet cliffs (Wagner *et al.* 1999, p. 933).

- *Asystasia gangetica* (Chinese violet) is a perennial herb native to India, Malay Peninsula, and Africa (Wagner *et al.* 1999, p. 168). This species can grow over shrubs and smother all vegetation in the herbaceous layer, covering native plants and preventing their establishment (Smith 1985, p. 185). According to the HWRA, this species has a high risk of invasiveness or a high

risk of becoming a serious pest (PIER 2009). This species occurs in all low-elevation coastal, dry and mesic habitats on Midway Atoll, and all the main Hawaiian Islands (Wagner *et al.* 1999, p. 168; Wagner *et al.* 2012, p. 3).

- *Atriplex semibaccata* (Australian saltbush) is a drought- and saline-tolerant, low-growing shrub, native to Australia, which forms dense spreading mats and displaces native plants. It was introduced to Hawaii in 1895 as an experimental forage grass for cattle; it is now naturalized in coastal and lowland dry to seasonally wet areas on all the main Hawaiian Islands (Wagner *et al.* 1999, p. 535). The seeds are attractive to fruit eaters, which may contribute to its dispersal (California Invasive Plant Council 2006, in litt.).

- *Axonopus fissifolius* (carpetgrass) is a pasture grass that forms dense mats with tall foliage. This species does well in soils with low nitrogen levels, and can outcompete native plants in wet forests and bogs, an impact exacerbated by drought (Olaa Kilauea Partnership 2007, p. 3). The species is not subject to any major diseases or insect pests, and recovers quickly from fire. Seeds are readily spread by water, vehicles, and grazing animals (O'Connor 1999, pp. 1500–1502; Cook *et al.* 2005, p. 4). This species occurs in lowland and montane wet pastures, cliffs, wet forests, and bogs on all the main islands except Kahoolawe and Niihau (O'Connor 1999, p. 1502; Wagner *et al.* 2012, p. 88).

- *Blechnum appendiculatum* (NCN) is a fern with fronds to 23 in (60 cm) long. This species occurs on all the main islands, and forms large colonies in closed canopy lowland and montane wet forest, especially on rocky substrate or cliffs, outcompeting and displacing native species (Palmer 2003, pp. 79–81).

- *Buddleja asiatica* (dog tail) is a shrub or small tree native to Pakistan, India, China, Taiwan, Malesia, and the Mariana Islands, and is naturalized on Kauai, Maui, Oahu, Lanai, and Hawaii Island (Wagner *et al.* 1999, p. 415; Wagner *et al.* 2012, p. 20). This species can tolerate a wide range of lowland and montane mesic and wet habitats, and forms dense thickets, rapidly spreading into forest and lava and cinder substrate areas, displacing native vegetation (Wagner *et al.* 1999, p. 415; PIER 2011).

- *Caesalpinia decapetala* (cat's claw), a prickly climber or shrub, native to tropical Asia, is naturalized on all the main Hawaiian Islands except Kahoolawe (Geesink *et al.* 1999, p. 647). This sprawling, noxious shrub forms large, impenetrable thickets; is used as a fence plant for ranches (Geesink *et al.* 1999, p. 647); and is a pest in lowland mesic habitat (Smith 1985, p. 187).

Seeds are dispersed by rodents, birds, and human activities (Smith 1985, p. 187). According to the HWRA, this species has a high risk of invasiveness or a high risk of becoming a serious pest (PIER 2013).

- *Casuarina equisetifolia* (ironwood), native to Australia, is a tall tree (66 ft; 20 m) and is naturalized in the Northwest Hawaiian Islands on Kure, Midway Atoll, Pearl and Hermes, Lisianski, Laysan, French Frigate Shoals, and all of the main Hawaiian Islands (Wagner *et al.* 1999, pp. 528–529; Cronk and Fuller 2001, p. 144 in PIER 2011). This species is a pioneer plant, salt-resistant, that forms monotypic stands in lowland dry and mesic areas and cliffs, under which little else grows (PIER 2011). This species spreads by root suckers, and the roots and needle litter may exude a chemical that kills or inhibits the growth of other plants. Ironwood is fire-resistant, and the seeds are wind- and water-dispersed, further contributing to its competitive advantage over native species (Staples and Herbst 2005, p. 229).

- *Cenchrus ciliaris* (buffelgrass), native to Africa and tropical Asia, is naturalized on Midway Atoll and all the main islands except Niihau (O'Connor 1999, p. 1512; Wagner *et al.* 2012, p. 90). This fire-adapted grass provides fuel for fires and recovers quickly after fire, rapidly increasing its cover because it can reproduce through vegetative fragmentation and is readily dispersed by animals or other vectors. These attributes allow it to displace native plants and alter fire regimes (PIER 2007). This species occurs in coastal and lowland dry areas (O'Connor 1999, p. 1512).

- *Cenchrus setaceus* (formerly known as *Pennisetum setaceum*; fountain grass), a densely tufted grass, is an aggressive colonizer that outcompetes most native species. Native to northern Africa, *C. setaceus* is naturalized on Kauai, Oahu, Maui, Lanai, Kahoolawe, and Hawaii Island (O'Connor 1999, p. 1581; Wagner *et al.* 2012, p. 99). This fire-adapted grass burns swiftly and hot, causing extensive damage to the surrounding habitat (O'Connor 1999, p. 1581). In Hawaii, this species occurs in lowland and montane, mesic to dry, and subalpine, open areas, cliffs, barren lava flows, and cinder fields (O'Connor 1999, p. 1581). This species is included on the Hawaii State Noxious Weed list as *Pennisetum setaceum* (HAR Title 4, Subtitle 6, Chapter 68).

- *Cestrum diurnum* (day cestrum), a shrub up to 7 ft (2 m) tall, is native to the West Indies, and cultivated for its fragrant flowers. It is naturalized on

Kauai, Oahu, and Molokai (Symon 1999, p. 1254). This species invades lowland mesic and wet areas, forming dense thickets. Seeds are dispersed by birds; however, the seeds are poisonous to humans and other mammals (Florida Exotic Pest Plant Council (FEPC) 2011).

- *Cestrum nocturnum* (night cestrum), a shrub or small tree native to the Antilles and Central America, was cultivated in Hawaii prior to 1871, and is naturalized on Kauai, Oahu, Maui, and Lanai (Symon 1999, pp. 1254–1255; Wagner *et al.* 2012, p. 70). It forms dense, impenetrable thickets in lowland and montane wet forest and open areas. According to the HWRA, this species has a high risk of invasiveness or a high risk of becoming a serious pest (PIER 2010).

- *Chloris barbata* (swollen fingergrass), native to Central and South America and the West Indies, is widely naturalized on Kure Atoll, Midway Atoll, and all the main Hawaiian islands (O'Connor 1999, p. 1514; Wagner *et al.* 2012, p. 90). This species developed resistance to Group C1/5 herbicides in Hawaii in 1987, and infests roadsides and sugarcane plantations (WeedScience.com 2009; HBMP 2010). According to the HWRA, this species has a high risk of invasiveness or a high risk of becoming a serious pest (PIER 2008) because of its ability to outcompete native species. It occurs in coastal and lowland dry, disturbed areas, roadsides, vacant lots, and pastures (O'Connor 1999, p. 1514).

- *Chrysophyllum oliviforme* (satinleaf) is a small tree native to Florida, the West Indies, and Central America, and is naturalized on Kauai, Niihau, Oahu, Maui, and Hawaii Island (Pennington 1999, p. 1231; Wagner *et al.* 2012, p. 69; PIER 2009). Birds disperse the fleshy fruit and the species becomes a dominant component in native forest (Pennington 1999, p. 1231; Maui Land and Pineapple Company 2002, pp. 20, A1–A4). According to the HWRA, this species has a high risk of invasiveness or a high risk of becoming a serious pest (PIER 2006). This species has been documented in lowland dry and mesic forest in Hawaii.

- *Cinchona pubescens* (quinine) is a densely-canopied tree up to 33 ft (10 m) tall. It is native to Central and South America, and it is widely cultivated for quinine (Wagner *et al.* 1999, p. 1120). A small plantation was started on Maui in 1868, and this species was also planted by State foresters on Oahu, Maui, and Hawaii Island between 1928 and 1947. Currently, the only naturalized populations are reported from Maui and Hawaii Island (Wagner *et al.* 1999, p. 1120). It reproduces with wind-

dispersed seeds and also vegetatively by suckering, resulting in displacement of native lowland and montane mesic forest (GISD 2011; PIER 2013).

- *Cinnamomum burmannii* (padang cassia), a tree native to Indonesia, is cultivated and now naturalized on Kauai, Oahu, Maui, Lanai, and Hawaii Island (van der Werff 1999, p. 846; Wagner *et al.* 2012, p. 48). Seeds are bird-dispersed (Starr *et al.* 2003). On Maui, this species is included in the weed control program at Puu Kukui Preserve, as it becomes a dominant component of lowland and montane wet forest habitat (Maui Land and Pineapple Company (MLP) 2002, p. 20).

- *Clidemia hirta* (Koster's curse) is a noxious shrub in the Melastomataceae family that forms a dense understory, shades out native plants and prevents their regeneration, and is considered a significant nonnative plant threat (Wagner *et al.* 1985, p. 41; Smith 1989, p. 64; Almeda 1999, p. 906). *Clidemia hirta* is native to the Neotropics, and is naturalized on all the main islands except Kahoolawe and Niihau (Almeda 1999, p. 906; Wagner *et al.* 2012, p. 51). All plants in the Melastomataceae family are included in the Hawaii State Noxious Weed List (HAR Title 4, Subtitle 6, Chapter 68) because of their high germination rates, rapid growth, early maturity, ability of fragments to root, possible asexual reproduction, and efficient seed dispersal (especially by birds that are attracted by the plants' copious production of berries) (Smith 1985, p. 194; University of Florida Herbarium 2006; <http://www.ctahr.hawaii.edu/invweed/weedsHI.html>). These characteristics enable the plants to be aggressive and successful competitors in Hawaiian lowland and montane, dry, mesic, and wet ecosystems.

- *Coffea arabica* (Arabian coffee), a shrub or tree to 17 ft (5 m) tall, native to Ethiopia, is widely cultivated in Hawaii as a commercial crop. It was naturalized in Hawaii by the mid-1800s in mesic to wet sites, usually in valleys or along streambeds on all the main islands except Niihau (Wagner *et al.* 1999, pp. 1120–1121). This species is shade-tolerant, and can form dense stands in the forest understory, displacing and shading out lowland mesic and lowland wet native vegetation. The seeds are dispersed by birds and rats (PIER 2008).

- *Conyza bonariensis* (hairy horseweed) is an annual herb common in urban and nonurban areas in Hawaii. It occurs from coastal and lowland dry areas to lowland mesic and lowland wet forest, on Kure Atoll, Midway Atoll, Laysan, French Frigate Shoals, and all of

the main Hawaiian Islands, where it outcompetes and displaces native vegetation (Wagner *et al.* 1999, p. 288).

- *Cordyline fruticosa* (ki, ti), a shrub to 12 ft (4 m) tall, is considered a Polynesian introduction to Hawaii. It was extensively cultivated and occurs in lowland mesic and wet valleys and forest and is naturalized on all the main islands except Kahoolawe (Wagner *et al.* 1999, pp. 1348–1350). It can become a dominant element of the understory (Department of Land and Natural Resources (DLNR) 1989).

- *Cortaderia jubata* (pampas grass), a large, clump-forming, perennial grass native to the northern Andes, was first reported in 1987 in Hawaii from the slopes of Haleakala on east Maui, where it had escaped cultivation (Wagner *et al.* 2012, p. 91; PIER 2013). This species is a serious pest in California, New Zealand, and South Africa, and is included in the Hawaii State Noxious Weed List (Chimera *et al.* 1999, p. 3; HAR Title 4, Subtitle 6, Chapter 68). Pampas grass has razor-sharp leaves, produces abundant seed, and spreads readily, allowing it to outcompete native species in the lowland wet, montane wet, and montane mesic ecosystems (Staples and Herbst 2005, p. 744).

- *Cotoneaster pannosus* (silver-leaf cotoneaster) is a shrub native to China that is cultivated in Hawaii (Volcano on Hawaii Island and Kula, Maui) (Wagner *et al.* 1999, p. 1100; Wagner *et al.* 2012, p. 61). Previously thought to be contained, this species has escaped and become a threat to native montane mesic, montane dry, and subalpine ecosystems on Maui and Hawaii Island (Oppenheimer 2010, in litt.). The attractive, bird-dispersed fruits, aggressive root systems, and tendency to shade out and smother native plants contribute to the invasiveness of this species (PIER 2010).

- *Cryptomeria japonica* (Japanese cedar, tsugi) is a pyramidal evergreen tree native to China and Japan. This tree grows to 60 ft (18m) and has dense foliage (North Carolina State University 2006; University of Connecticut 2006). Its life-history traits of small seed mass, short juvenile period, and short intervals between large seed crops contribute to its invasiveness (Richardson and Rejmanek 2004, p. 321). This species is also highly flammable and is not recommended for landscaping in fire-prone areas (Scripps Ranch Fire Safe Council 2006, in litt.). It occurs in lowland wet and montane wet areas of Maui and Hawaii Island (Wagner *et al.* 2012, p. 107; Smithsonian Institution Online Herbarium Database 2015, in litt.).

- *Cuphea carthagenensis* (tarweed) is an annual or short-lived perennial herb native to South America and naturalized in lowland mesic to wet areas on Kauai, Oahu, Molokai, Maui, Lanai, and Hawaii Island (Wagner *et al.* 1999, p. 866; Wagner *et al.* 2012, p. 49). This species forms dense, shrubby mats that displace and prevent the establishment of native plants (Hawaii National Park 1959, p. 7; Wagner *et al.* 1999, p. 866).

- *Cyclosorus dentatus* (previously *Christella dentata*) (NCN) is a medium-sized fern widely distributed in the tropics and subtropics of the Old World, now widespread as a weed in the Americas. In Hawaii, this species is most common in disturbed lowland and montane mesic and wet habitats on all the main Hawaiian Islands (Wagner *et al.* 2012, p. 103). This fern hybridizes with the endemic *Cyclosorus cyatheoides*, forming extensive numbers of the sterile hybrid (Palmer 2003, pp. 88–90).

- *Cynodon dactylon* (Bermuda grass, manienie) is a strongly rhizomatous or stoloniferous grass native to tropical Africa (O'Connor 1999, p. 1520). Introduced to Hawaii in 1935, it is widely cultivated and naturalized on Kure, Midway, Pearl and Hermes atolls, Laysan, French Frigate Shoals, and all of the main Hawaiian Islands except Niihau (O'Connor 1999, p. 1520; Wagner *et al.* 2012, p. 91). This grass occurs in rocky or sandy sites in dry and mesic areas, from coastal to alpine habitats, and forms a solid mat where seepage may be present. *Cynodon dactylon* outcompetes native species as it readily roots at the nodes, covering an area of up to 26 sq ft (2.5 sq m) within 150 days, with culms up to 4 ft (130 cm) long (PIER 2013). According to the HWRA, this species has a high risk of invasiveness or a high risk of becoming a serious pest (PIER 2013).

- *Dactylis glomerata* (cocksfoot), a tufted, perennial grass native to Europe, is widely cultivated and now naturalized in Hawaii. It is abundant in pastures and along trails and roadsides on Kauai, Oahu, Molokai, Maui, and Hawaii (O'Connor 1999, p. 1521). This species establishes in disturbed sites in dry cliff to subalpine habitat, and forms dense mats that suppress growth of native grasses and herbaceous plants (PIER 2010).

- *Delairea odorata* (formerly known as *Senecio mikanioides*, German ivy), a rapidly growing perennial vine, native to South Africa, is naturalized on Maui and Hawaii Island (Wagner *et al.* 1999, p. 356; Staples and Herbst 2005, p. 169; Benitez *et al.* 2008, p. 38; Wagner *et al.* 2012, p. 16). This bushy vine covers and suppresses growth and germination of



native species by rooting at leaf nodes and carpeting other plants and the ground. It can also grow in forest canopy, where it smothers and kills native trees in lowland and montane mesic areas (Benitez *et al.* 2008, p. 38; PIER 2012; Weeds of Blue Mountains Bushland 2011, in litt.).

- *Digitaria insularis* (sourgrass) is a densely tufted, perennial grass up to 5 ft (150 cm) tall. It is native to the Neotropics, and is naturalized on Midway Atoll and all the main Hawaiian islands (O'Connor 1999, p. 1531; Wagner *et al.* 2012, p. 92). This grass forms dense mats that crowd out native species (Motooka *et al.* 2003, in litt.) in disturbed coastal, lowland dry and cliff habitats (O'Connor 1999, p. 1531).

- *Digitaria setigera* (kukaepuaa, itchy crabgrass), an annual 3-ft tall (80 cm) grass, is native to tropical Asia from India to Sri Lanka, and the Pacific Islands. It is naturalized on all of the main Hawaiian Islands except Kahoolawe in lowland mesic forest, fields and pastures, and along roadsides (O'Connor 1999, pp. 1531–1532). This species rapidly spreads through runners and prolific seeding.

- *Drymaria cordata* (chickweed) is a straggling herb naturalized in shaded moist areas on Kauai, Oahu, Molokai, Maui, Lanai, and Hawaii Island (Wagner *et al.* 1999, p. 505; Wagner *et al.* 2012, p. 26). This species is known to invade plantation crops such as tea and coffee, as well as pastures, lawns, gardens, riverbanks, ditches, and sandbars in rivers, displacing or preventing the establishment of native plants in lowland wet and montane wet habitats (PIER 2010).

- *Ehrharta stipoides* (meadow ricegrass), a grass native to Australia, New Zealand, and the Philippines, is naturalized on all the main Hawaiian Islands except Lanai (O'Connor 1999, p. 1536; Wagner *et al.* 2012, p. 93). This species creates thick mats and its bristled seeds are easily dispersed, preventing the establishment of native plants in lowland mesic, lowland wet, montane wet, montane mesic, dry cliff, and wet cliff habitats (U.S. Army Garrison 2006, p. 2–1–20; O'Connor 1999, p. 1536).

- *Epilobium billardierianum* ssp. *cinereum* (willow herb), a (native to Australia, New Zealand, and Chatham Islands) and *E. ciliatum* (native to North America, Japan, Asia, Mexico, and South America) are perennial herbs naturalized in open forest and disturbed grassland, and especially on open lava, pastures, and along roadsides on Kauai, Oahu, Maui, and Hawaii Island (Wagner *et al.* 1999, p. 995; Wagner *et al.* 2012,

p. 56). These species are dominant components of subalpine areas on Maui and in wet forest on Hawaii Island, Maui, and Kauai, growing to 5 ft (2 m) in height, and outcompeting native plant species (Anderson *et al.* 1992, p. 328). Seeds are wind-dispersed; rapid germination and spread are not effectively controlled by herbicides (Oregon State, 2015, in litt.). These species are self-compatible and also can reproduce from leafy rosettes from the stem base (Wagner *et al.* 1999, p. 995; New England Wildflower Society, in litt.). *Epilobium* spp. invade montane mesic, montane wet, montane dry, and subalpine forest on Maui, Kauai, and Hawaii Island (Wagner *et al.* 1999, p. 995; Wagner *et al.* 2012, p. 56).

- *Erechtites valerianifolia* (fireweed) is a tall (8 ft, 2.5 m), widely distributed annual herb that produces thousands of wind-dispersed seeds, and outcompetes native plants (Wagner *et al.* 1999, p. 314). Native to Mexico and South America, this species is naturalized in disturbed lowland wet, montane wet, and wet cliff habitats on all of the main islands except Niihau (Wagner *et al.* 2012, p. 11).

- *Erigeron karvinskianus* (daisy fleabane), an annual or perennial herb native to Central and South America and the Neotropics, reproduces and spreads rapidly to form dense mats by stem layering and regrowth from broken roots. This species crowds out and displaces native ground-level plants (Weeds of Blue Mountains Bushland 2006), and occurs in lowland to montane, mesic to wet habitats on Kauai, Oahu, Molokai, Maui, and Hawaii Island (Wagner *et al.* 1999, p. 315; Wagner *et al.* 2012, p. 12).

- *Eucalyptus* spp. are tall trees or shrubs, and almost all of the more than 600 species are native to Australia (Chippendale 1999, pp. 948–959). In an attempt to protect Hawaii's watersheds in the early 20th century, over 90 *Eucalyptus* species and thousands of individuals were planted by Hawaii State foresters on all the main islands except Niihau and Kahoolawe (Cuddihy and Stone 1990, p. 51; Chippendale 1999, p. 949; Wagner *et al.* 2012, pp. 53–54). Approximately 30 species are reported to be spreading beyond the forestry plantings. Three species species in particular, *Eucalyptus grandis* (flooded gum), *E. paniculata* (gray ironbark), and *E. saligna* (Sydney blue gum), were the principal species used in reforestation efforts and greatly threaten native habitat in Hawaii (Chippendale 1999, p. 958). *Eucalyptus* are quick-growing, reach up to 180 ft (55 m) in height, reproduce from wind-dispersed seeds, thereby outcompeting and

replacing native forest species in lowland wet and montane wet habitats (PIER 2011). According to the HWRA for *Eucalyptus*, these species have a high risk of invasiveness or a high risk of becoming a pest species (PIER 2011).

- *Falcataria moluccana* (albizia), a tree up to 130 ft (40 m) tall, is native to the Moluccas, New Guinea, New Britain, and the Solomon Islands. This species was widely planted in Hawaii for reforestation and is naturalized in lowland mesic to lowland wet areas on all the main Hawaiian islands except Kahoolawe and Niihau (Geesink *et al.* 1999, p. 690; Wagner *et al.* 2012, p. 41). Its rapid growth habit enables it to outcompete and shade out native trees, and its high-nitrogen leaf litter alters nutrient dynamics in the soil, allowing nonnative plant species to flourish (GISD 2011, in litt.). The roots are shallow and the wood is brittle, and falling branches are a hazard to humans, animals, and other vegetation (State of Hawaii 2013, in litt. (S.C.R. No. 74)).

- *Ficus microcarpa* (Chinese banyan) is a very large, spreading tree native to Ceylon, India, China, Ryuku Islands, Australia, and New Caledonia, and is naturalized on Midway Atoll and all the main Hawaiian islands except Kahoolawe and Niihau (Wagner *et al.* 1999, pp. 924–926; Wagner *et al.* 2012, p. 52). This epiphytic species has large branches with numerous aerial roots that form columnar stems, eventually strangling its host, and can shade out native plants with its broad canopy. Seeds are spread by birds (Motooka *et al.* 2003, in litt.). This species occurs in lowland mesic habitat in Hawaii (Wagner *et al.* 1999, pp. 924–926).

- *Fraxinus uhdei* (tropical ash) is a tree to 80 ft (24 m) tall, native to central and southern Mexico. In Hawaii, between 1924 and 1960, over 700,000 trees were planted by State foresters on all the main islands (except Kahoolawe and Niihau) (Wagner *et al.* 1999, p. 991). Tropical ash is now naturalized in lowland mesic and montane mesic habitat, and is currently considered a serious threat to the mesic native *Acacia-Metrosideros* (koa-ohia) forest at Waikamoi on east Maui (TNCH 2006, p. A5). This species reproduces by wind-dispersed seed and spreads rapidly along watercourses and forms dense, monotypic stands, crowding out and replacing native plants (Holt 1992, pp. 525–535).

- *Grevillea robusta* (silk oak) is a large (100 ft, 30 m) evergreen tree native to Australia (Wagner *et al.* 1999, p. 1086; PIER 2013). Over two million trees were planted in Hawaii between 1919 and 1959, in an effort to reduce erosion and to provide timber (Motooka

*et al.* 2003, in litt.). This species is an aggressive, drought-tolerant tree, with the ability to establish in little to no soil, and forms dense, monotypic stands (Santos *et al.* 1992, p. 342). The leaves produce an allelopathic substance that inhibits the establishment of other plants (Smith 1985, p. 191). This species occurs in lowland to montane, dry to mesic forest and open areas on all the main Hawaiian Islands except Kahoolawe (Wagner *et al.* 1999, p. 1086; Wagner *et al.* 2012, p. 61).

- *Hedychium coronarium* (white ginger) is an herbaceous perennial up to 7 ft (2 m) tall, native to southwestern China and the Himalayas (Nagata 1999, p. 1622). White ginger is naturalized in lowland mesic forest on Oahu, Molokai, Lanai, Maui, and Hawaii Island (Nagata 1999, p. 1622). This species is shade tolerant but can grow in full sun (Csurhes and Hannan-Jones 2008, p. 7). Similar to *H. gardnerianum*, the creeping growth habit of *H. coronarium* overwhelms native plants, and is difficult to control due to new growth from rhizomes (GISD 2011).

- *Hedychium gardnerianum* (kahili ginger) is native to India (Nagata 1999, p. 1623). This showy ginger was introduced to Hawaii for ornamental purposes, and was first collected outside of cultivation in 1954 at Hawaii Volcanoes National Park, and is now naturalized in lowland wet and montane wet areas on Kauai, Oahu, Maui, Lanai, and Hawaii Island (Nagata 1999, p. 1623; Wester 1992, pp. 99–154; Wagner *et al.* 2012, p. 102). Kahili ginger grows over 3 ft (1 m) tall in open light environments; however, it will readily grow in full shade beneath forest canopy (Smith 1985, pp. 191–192). It forms vast, dense colonies, displacing other plant species, and reproduces by rhizomes. The conspicuous fleshy red seeds are dispersed by fruit-eating birds. Studies show that ginger reduces the amount of nitrogen in the native *Metrosideros* forest canopy in Hawaii (Asner and Vitousek 2005, in litt.). This species may also block stream edges, altering water flow (GISD 2007).

- *Heliocarpus popayanensis* (moho) is a nearly 100-ft (30-m) tall tree native to Mexico and Argentina. This species was planted extensively in Hawaii by foresters beginning in 1941, and has since escaped into lowland wet forest and cliffs on Kauai, Oahu, Lanai, and Hawaii Island (Wagner *et al.* 1999, p. 1292; Wagner *et al.* 2012, p. 72). The seeds are wind-dispersed, and this species is becoming a dominant feature in some forest areas on Oahu (Smith 1998). It grows rapidly, and spreads readily in disturbed forest where it can

outcompete native vegetation (Motooka *et al.* 2003, in litt.).

- *Heterotheca grandiflora* (telegraph weed) is an annual or biennial herb native to California and Mexico and now common from lowland to subalpine habitats of all the main Hawaiian Islands except Niihau (Wagner *et al.* 1999, p. 326; Wagner *et al.* 2012, p. 13). This species is an opportunistic colonizer that grows quickly, forms dense stands, and has been observed to inhibit recruitment of native plants in montane dry areas (Csurhes 2009, p. 2; PIER 2011).

- *Holcus lanatus* (common velvetgrass), native to Europe, is naturalized in Hawaii from montane to subalpine habitat, and occurs on all the main islands except Kahoolawe and Niihau (O'Connor 1999, p. 1551; Wagner *et al.* 2012, p. 95). It is an aggressive plant, growing rapidly from basal shoots or its prolific seed, and can become a dominant element of the vegetation if not controlled (Smith 1985, p. 192). Allelopathy may also play a role in the dominance of this species over other grasses (Remison and Snaydon *in* Pitcher and Russo 2005, p. 2).

- *Hypochoeris radicata* (hairy cat's ear) is a perennial herb up to 2 ft (0.6 m) tall, native to Eurasia. In Hawaii, it is naturalized in montane wet to dry cliff and subalpine sites on all the main islands (Wagner *et al.* 1999, p. 327; Wagner *et al.* 2012, p. 13). This species has a deep, succulent taproot favored by feral pigs, which dig up large areas searching for the roots (Smith 1985, p. 192). Seeds are produced in large numbers and dispersed by wind. It regenerates rapidly from the crown of the taproot after fire (Smith 1985, p. 192). These attributes contribute to its ability to outcompete native plants.

- *Juncus effusus* (Japanese mat rush) is a perennial herb widely distributed in temperate regions and naturalized in Hawaii in montane ponds, streams, and open boggy sites on Oahu, Molokai, Maui, and Hawaii Island (Coffey 1999, p. 1453; Wagner *et al.* 2012, p. 84). It was brought to Hawaii as a source of matting material, but grew too slowly to be of commercial value (Coffey 1999, p. 1453). This plant spreads by seeds and rhizomes, and forms dense mats that crowd out native plants (U.S. Department of Agriculture-Agricultural Research Division-National Genetic Resources Program (USDA-ARS-NGRP) 2011).

- *Juncus ensifolius* (dagger-leaved rush), a perennial herb native to the western United States, is naturalized in Hawaii and occurs in standing water of marshy montane wet areas on Maui and Hawaii Island (Coffey 1999, p. 1453;

Wagner *et al.* 2012, p. 84). This weedy colonizer can tolerate environmental stress and outcompete native species (Pojar and MacKinnon 1994, in litt.).

- *Juncus planifolius* (bog rush), a perennial herb native to South America, New Zealand, and Australia, is naturalized on Kauai, Oahu, Molokai, Maui, Lanai, and Hawaii Island, in moist, open, disturbed margins of lowland and montane wet forests and in bogs (Coffey 1999, pp. 1453–1454; Wagner *et al.* 2012, p. 84). This species forms dense mats and displaces native plants by preventing establishment of native seedlings (Medeiros *et al.* 1991, pp. 22–23).

- *Kalanchoe pinnata* (air plant), a perennial herb, is widely established in many tropical and subtropical areas. In Hawaii, it was naturalized prior to 1871, and is abundant in low-elevation coastal, dry, and mesic areas on all the main islands except Niihau and Kahoolawe (Wagner *et al.* 1999, p. 568). It can reproduce by vegetatively at indentations along the leaf margin, usually after the leaf has broken off the plant and is lying on the ground, from which a new plant can take root (Motooka *et al.* 2003, in litt.). This species forms dense stands that prevent reproduction of native plants (Motooka *et al.* 2003, in litt.; Randall 2007-Global Compendium of Weeds Database).

- *Lantana camara* (lantana), a malodorous, branched shrub up to 6 ft (3 m) tall, was brought to Hawaii as an ornamental plant and is now naturalized on Midway Atoll and all the main Hawaiian Islands. This species forms dense stands that prevent establishment of native plants (Davis *et al.* 1992, p. 412; Wagner *et al.* 1999, p. 1320; Motooka *et al.* 2003, in litt.). Its berries are attractive to birds, which spread it to new areas (Davis *et al.* 1992, p. 412). This species occurs in almost all habitat types, from coastal, dry to mesic, lowland to montane forest and shrubland.

- *Lapsana communis* (nipplewort) is an annual herb (to 5 ft, 1.5 m) native to Eurasia, and is naturalized in montane wet forest, dry cliff, and alpine habitat (3,200 m) on Maui and Hawaii Island (Wagner *et al.* 1999, p. 331). It is identified as an agricultural weed and an invasive species in Hawaii (USDA-NRCS 2011).

- *Leonotis nepetifolia* (lion's ear) is a coarse, annual herb (to 8 ft, 2.5 m), native to tropical Africa, and is naturalized on all the main Hawaiian islands except Kahoolawe and Niihau (Wagner *et al.* 1999, p. 803; Wagner *et al.* 2012, p. 46). It forms dense thickets that displace native plants, especially in lowland dry habitat (Wagner *et al.* 1999,

p. 803). According to the HWRA, this species has a high risk of invasiveness or a high risk of becoming a serious pest (PIER 2006).

- *Leptospermum scoparium* (tea tree) is a shrub or small tree (7 to 16 ft (2 to 5 m)) native to New Zealand and Australia, and now naturalized on Kauai, Oahu, Maui, and Lanai (Wagner *et al.* 1999, p. 963; Wagner *et al.* 2012, p. 55). It forms thickets that crowd out other plants, and has allelopathic properties that prevent the growth of native plants (Smith 1985, p. 193). This species occurs in disturbed lowland to montane, mesic to wet forest habitat (Wagner *et al.* 1999, p. 963).

- *Leucaena leucocephala* (koa haole), a shrub (30 ft (9 m)) native to the Neotropics, is now naturalized on all of the main Hawaiian Islands and Midway Atoll. It is an aggressive, nitrogen-fixing competitor that often becomes the dominant component of vegetation in coastal and lowland dry areas (Geesink *et al.* 1999, pp. 679–680).

- *Lythrum maritimum* (loosestrife), native to Peru, is a many-branched shrub occurring in drier open areas and cliffs on all of the main Hawaiian islands except Kahoolawe and Niihau (Wagner *et al.* 1999, p. 868; Wagner *et al.* 2012, p. 49). It was collected by botanists as early as 1794, suggesting it may be indigenous to the Hawaiian Islands; however, *L. maritimum* is identified as an invasive species in Hawaii (Stone *et al.* 1992, p. 104; USDA–NRCS 2011).

- *Melia azedarach* (chinaberry) is a deciduous tree (to 65 ft (20 m)) native to southwestern Asia that is invading forests, fence lines, and disturbed areas on all of the main Hawaiian islands except Kahoolawe (Wagner *et al.* 1999, p. 918; Wagner *et al.* 2012, p. 52). Its fast growth and rapidly spreading thickets make it a significant pest plant by shading out and displacing native vegetation (University of Florida 2008). Feral pigs and fruit-eating birds further distribute the seeds (Stone 1985, pp. 194–195). According to the HWRA, this species has a high risk of invasiveness or a high risk of becoming a serious pest (PIER 2008). This species occurs in dry, open habitats and cliffs (Wagner *et al.* 1999, p. 918).

- *Melinis minutiflora* (molasses grass), native to Africa, is naturalized on all the main Hawaiian islands except Niihau (O'Connor 1999, p. 1562). *Melinis minutiflora* is a spreading, perennial grass up to 3 ft (1 m) tall that forms dense mats from root runners, crowding out and preventing establishment of native plants. These mats can fuel more intense fires and dense stands can contribute to recurrent

fires, with rapid expansion into adjacent burned areas (Cuddihy and Stone 1990, p. 89; O'Connor 1999, p. 1562; PIER 2013). This species occurs in almost all habitats, from dry to wet, lowland to montane (O'Connor 1999, p. 1562).

- *Melinis repens* (natal redtop), a perennial grass (1 to 3 ft (0.3 to 1 m)) native to Africa, is now naturalized on Midway Atoll and all of the main Hawaiian islands (O'Connor 1999, p. 1588; Wagner *et al.* 2012, p. 99). This species invades disturbed, dry areas from coastal regions to subalpine forest (O'Connor 1999, p. 1588). Dense stands of natal redtop can contribute to recurrent fires (Desert Museum 2011).

- *Miconia calvescens* (miconia or velvet tree), a tree up to 50 ft (15 m) tall, native to tropical America, first appeared on Oahu and the island of Hawaii as an introduced garden plant and subsequently escaped from cultivation (Almeda 1999, p. 903; Staples and Herbst 2005, p. 397). This species is now also found on Kauai and Maui (Wagner and Herbst 2003, p. 34; Wagner *et al.* 2012, p. 51). This species is remarkable for its 2- to 3-ft (70 cm) long, dark purple leaves (Staples and Herbst 2005, p. 397). It tolerates and reproduces in dense shade in lowland wet habitats, eventually shading out all other plants to form a monoculture. A single mature plant produces millions of seeds per year, which are spread by birds, ungulates, and humans (Motooka *et al.* 2003, in litt.). According to the HWRA assessment, miconia has a high risk of invasiveness or a high risk of becoming a serious pest (PIER 2010). This species, as well as all plants in the Melastoma family, are included on the Hawaii State Noxious Weed list (HAR Title 4, Subtitle 6, Chapter 68).

- *Morella faya* (firetree) is an evergreen shrub or small tree (26 ft (8 m)) native to the Canary Islands, Madeira, and the Azores, and naturalized on Kauai, Oahu, Maui, Lanai, and Hawaii Island (Wagner *et al.* 1999, p. 931; Wagner *et al.* 2012, p. 53). This species forms monotypic stands, is a nitrogen-fixer, and alters the successional ecosystems in areas that it invades by displacing native vegetation through competition. It is a prolific fruit producer (average of 400,000 fruits per tree per year), and these fruit are spread by birds and feral pigs (Vitousek 1990, pp. 8–9; Wagner *et al.* 1999, p. 931; PIER 2008). This species is included in the Hawaii State Noxious Weed List (HAR Title 4, Subtitle 6, Chapter 68), and is reported from lowland to montane mesic and wet forest habitat (PIER 2008).

- *Neonotonia wightii* (previously *Glycine wightii*; glycine), a twining herb

native to Central and South America, is naturalized on all the main Hawaiian islands except Niihau (Geesink *et al.* 1999, p. 674; Wagner *et al.* 2012, p. 39). It was brought to Hawaii for cultivation as a fodder plant. This species forms dense patches in coastal and lowland dry areas, and covers and outcompetes other plants (Geesink *et al.* 1999, p. 674; PIER 2010).

- *Nicotiana glauca* (tree tobacco), a shrub or spindly tree, is native to Argentina, and naturalized on all the main Hawaiian islands except Kauai and Niihau (Symon 1999, pp. 1261–1263; Wagner *et al.* 2012, p. 71). A drought-resistant plant, it occurs in lowland, open, arid, disturbed sites, and forms dense stands that crowd out native species and prevent their regeneration (Symon 1999, pp. 1261–1263; HBMP 2010; PIER 2011).

According to the HWRA assessment, this species has a high risk of invasiveness or a high risk of becoming a serious pest (PIER 2011).

- *Omalanthus populifolius* (Queensland poplar) is a large shrub (20 ft (6 m)) native to Australia that is now naturalized on Maui and Hawaii Island (Starr *et al.* 2003, in litt.). Based on information from its native range, infestations in Hawaii could invade lowland mesic forest. As a pioneer species, it is considered a potential pest plant in South Africa (Starr *et al.* 2003, in litt.). Bird-dispersed seeds germinate quickly when exposed to direct sunlight, but also have a long dormancy period, providing a long-lived seed bank (Hornsby Shire Council 2015, in litt.).

- *Oplismenus hirtellus* (basketgrass) is a perennial grass common through the tropics and now naturalized on all of the main Hawaiian Islands except Kahoolawe and Niihau (O'Connor 1999, p. 1565; Wagner *et al.* 2012, pp. 96–97). This species forms a dense ground cover, is sometimes climbing, and roots at the nodes, enabling its rapid spread. It also has sticky seeds that attach to animals and birds that results in its spread to new areas (O'Connor 1999, p. 1565; Johnson 2005, in litt.). This species displaces native plants on forest floors and trail sides, and occurs in lowland wet forest and cliffs (Motooka *et al.* 2003, in litt.; O'Connor 1999, p. 1565).

- *Paspalum conjugatum* (Hilo grass) is a perennial grass native to the Neotropics, up to 2 ft (0.6 m) tall, and occurs in lowland mesic and wet habitats, forming a dense ground cover. It occurs on all the main Hawaiian islands except Kahoolawe and Niihau (O'Connor 1999, pp. 1575–1576). Its small hairy seeds are easily transported on humans and animals, or are carried

by the wind through native vegetation, where it establishes and displaces native plants (University of Hawaii Botany Department 1998; Cuddihy and Stone 1990, p. 83; Motoooka *et al.* 2003, in litt.; PIER 2008).

- *Passiflora edulis* (passion fruit), native to South America, is a vigorous vine that can reach up to 50 ft (15 m) in length. This species is widely cultivated for its fruit juice, and is naturalized in lowland to montane mesic areas on all the main Hawaiian islands except Kahoolawe and Niihau (Escobar 1999, p. 1010; Wagner *et al.* 2012, p. 57). Seeds are dispersed by feral pigs, and this vine overgrows and smothers forest canopy. Rooting and trampling by feral pigs in search of its fruit disrupts topsoil, causing erosion, and may also destroy native plant seedlings (GISD 2012).

- *Passiflora foetida* (love-in-a-mist) is a vine with glandular hairs that give the plant a fetid odor. This species, native to American tropics and subtropics, is naturalized on all the main Hawaiian islands except Kahoolawe, and grows over and covers vegetation that prevents or delays establishment of native species (Escobar 1999, p. 1011; Wagner *et al.* 2012, p. 57). Its fruit are eaten and spread by birds (Escobar 1999, p. 1011; GISD 2006). This species occurs in lowland dry and wet habitat (Escobar 1999, p. 1011).

- *Passiflora laurifolia* (yellow granadilla, water lemon) is a vine native to the West Indies, Guianas, and South America, where it is widely cultivated (Escobar 1999, p. 1011). In Hawaii, it widely scattered in mostly inaccessible lowland mesic to wet habitat, and can grow over and smother vegetation (Escobar 1999, p. 1011; Starr *et al.* 2003, in litt.).

- *Passiflora suberosa* (huehue haole), a vine, has many-seeded purple fruits that are dispersed widely by birds. This species is native to the American subtropics and the West Indies, and naturalized on Kauai, Oahu, Maui, Lanai, and Hawaii Island (Escobar 1999, p. 1014; Wagner *et al.* 2012, p. 57). This vine grows over and smothers ground cover, shrubs, and small trees, sometimes reaching the upper canopy layer of the forest (Smith 1985, pp. 191–192). *Passiflora suberosa* occurs in lowland grassland, shrubland, open dry to wet forest, and exposed cliff habitats (Escobar 1999, p. 1014).

- *Passiflora tarminiana* (banana poka), a vine native to South America, is widely cultivated for its fruit (Escobar 1999, pp. 1007–1014). First introduced to Hawaii in the 1920s, it is now a serious pest in montane mesic and subalpine forest on Kauai, Maui, and

Hawaii Island, where it overgrows and smothers the forest canopy (Escobar 1999, p. 1012; Wagner *et al.* 2012, p. 57). Seeds are readily dispersed by humans, birds, and feral pigs (La Rosa 1992, pp. 281–282). Fallen fruit encourage rooting and trampling by pigs, resulting in destruction of native habitat (Diong 1982, pp. 157–158). Field releases of biocontrol agents have not been successful to date (PIER 2010). This species is included on the Hawaii State Noxious Weed list (HAR Title 4, Subtitle 6, Chapter 68).

- *Persicaria punctata* (previously *Polygonum punctatum*, water smartweed), a rhizomatous perennial herb native to North America, South America, and the West Indies, is a naturalized aquatic species found along streambeds, running or standing water, in lowland and montane wet habitat on Hawaii Island (Wagner *et al.* 1999, p. 1064; Wagner *et al.* 2012, p. 59). This species is fast-growing and has long-lived seeds and allelopathic properties (Gutsher 2007, in litt.). Loh and Tunison (1998, p. 5) found that in pig-disturbed sites, *P. punctata* expanded from 25 percent cover to 63 percent cover within 2 years. The combination of these attributes allows this species to form dense patches that inhibit establishment of native plants.

- *Pimenta dioica* (allspice), native to Mexico, Central America, Cuba, and Jamaica, is a tree (60 ft (18 m)) with sticky, grape-like seeds that are spread by birds. Widely cultivated, this species was introduced to Hawaii in 1885, and is naturalized on Kauai and Maui (Staples and Herbst 2005, p. 427; Wagner *et al.* 2012, p. 53). According to the HWRA, this species has a high risk of invasiveness or a high risk of becoming a serious pest (PIER 2008). This tree forms dense thickets and tolerates a wide range of soil types, and can outcompete native plants, and is naturalized in lowland wet forest.

- *Pinus* spp. (pine tree) are tall, evergreen trees or shrubs native to all continents and to some oceanic islands, but are not native to any of the Hawaiian Islands. *Pinus caribaea* var. *hondurensis*, *P. elliotii*, *P. patula*, *P. pinaster*, *P. radiata*, and *P. taeda* are naturalized on Molokai, Lanai, and Maui (Little and Skolmen 1989, pp. 56–60; Oppenheimer 2003, pp. 18–19; PIER 2011; Wagner *et al.* 2012, p. 107). *Pinus* species were primarily planted by Hawaii State foresters for reforestation and erosion control (Little and Skolmen 1989, pp. 56–60; Oppenheimer 2003, pp. 18–19; PIER 2010). *Pinus* species are known to establish readily; create dense stands that shade out native plants and prevent regeneration; outcompete native

plants for soil, water, and nutrients; change soil chemistry; promote growth of weed seeds dropped by perching birds; and be highly flammable (Oppenheimer 2010, in litt.; PIER 2010). On east Maui, *Pinus* species are a threat to higher elevation habitat because they invade pastures and native montane mesic and subalpine shrublands, and have contributed to wildfires in the area (Oppenheimer 2002, pp. 19–23; Oppenheimer 2010, in litt.).

- *Pluchea carolinensis* (sourbush) is native to Mexico, the West Indies, and South America (Wagner *et al.* 1999, p. 351; Wagner *et al.* 2012, p. 16). This 3 to 6 ft (1 to 2 m) tall, fast-growing shrub forms thickets in lowland dry habitats and can tolerate saline conditions. This species is widespread in Hawaii from coastal to lowland areas and is adapted to a wide variety of soils and sites on Kure Atoll, Midway Atoll, French Frigate Shoals, and all the main islands (Wagner *et al.* 1999, p. 351). The seeds are wind-dispersed (Francis 2004, in litt.). It quickly invades burned areas. These adaptive characteristics increase its ability to outcompete native plants. Some biological control agents have been introduced but have not been effective (U.H. Botany Department, [http://www.botany.hawaii.edu/faculty/cw\\_smith/plu\\_sym.htm](http://www.botany.hawaii.edu/faculty/cw_smith/plu_sym.htm)).

- *Pluchea indica* (Indian fleabane) is native to southern Asia, and is naturalized on Midway Atoll, Laysan Island, and all the main Hawaiian Islands (Wagner *et al.* 1999, p. 351; Wagner *et al.* 2012, p. 16). These 6 ft (2 m) tall, fast-growing shrubs form thickets in dry habitats and are widespread in Hawaii in coastal areas. The seeds are wind-dispersed (Francis 2006). It quickly invades burned areas, and can regenerate from basal shoots. These traits increase its competitive abilities over native plants (Wagner *et al.* 1999, p. 351).

- *Prosopis pallida* (kiawe, mesquite) is a tree up to 66 ft (20 m) tall. Native to Peru, Columbia, and Ecuador, it was introduced to Hawaii in 1828, and its seed pods were used as fodder for ranch animals. This species is now a dominant component of the vegetation in lowland, dry, disturbed sites, and it is well-adapted to dry habitats on Midway Atoll and all the main Hawaiian Islands (Geesink *et al.* 1999, pp. 692–693; Wagner *et al.* 2012, p. 41). It overshadows other vegetation and has deep tap roots that significantly reduce available water for native dryland plants. This species fixes nitrogen and can outcompete native plants (Geesink *et al.* 1999, pp. 692–693; PIER 2011).

- *Prunella vulgaris* (common selfheal) is a perennial herb in the mint family.

This species, native to North and Central America, Europe, and Asia, is naturalized in drier areas (including cliffs) on the islands of Molokai, Maui, and Hawaii (Wagner *et al.* 1999, pp. 828–829). It can root from stem nodes (PIER 2010). This species is reported as an invasive species in Hawaii (USDA–NRCS 2011).

- *Psidium cattleianum* (strawberry guava) is a tall shrub or tree (20 ft (6 m)) that forms dense stands in which few other plants can grow, displacing native vegetation through competition. Native to the Neotropics, *P. cattleianum* is naturalized on all the main Hawaiian islands except Kahoolawe and Niihau (Wagner *et al.* 1999, p. 971). The fruit is eaten by pigs and birds that disperse the seeds throughout the forest (Smith 1985, p. 200; Wagner *et al.* 1985, p. 24). This species occurs in lowland to montane, mesic to wet habitats (Wagner *et al.* 1999, p. 971).

- *Psidium guajava* (common guava) is a shrub or tree (32 ft (10 m)) that forms dense stands, excluding native species. Native to the Neotropics, *P. guajava* is naturalized on all the main Hawaiian islands except Kahoolawe and Niihau (Wagner *et al.* 1999, p. 972). Seeds are spread by pigs and birds, and it also regenerates from underground parts by suckering (Wagner *et al.* 1999, p. 972). These traits allow this species to outcompete native vegetation in lowland to montane dry, mesic, and wet habitats.

- *Pterolepis glomerata* (NCN) is an herb or subshrub in the Melastomataceae family. Native to South America, *P. glomerata* is naturalized on Kauai, Oahu, Molokai, and Hawaii Island (Almeda 1999, p. 912–913; Wagner *et al.* 2012, p. 52). This species has rapid growth, early maturity to fruiting, a high germination rate, possible asexual reproduction, the ability of fragments to root, and seed dispersal by birds (University of Florida Herbarium 2006). These attributes allow it to displace native vegetation through competition. All plants in the Melastomataceae family are included in the Hawaii State Noxious Weed List (HAR Title 4, Subtitle 6, Chapter 68). It is a pest in lowland wet habitat and along trail margins and cliffs (Almeda 1999, p. 912–913).

- *Ricinus communis* (castor bean), a shrub or small tree native to Africa, is naturalized in lowland mesic habitat on all the main Hawaiian Islands (Wagner *et al.* 1999, p. 629). This fast-growing species forms thickets, reaches 33 ft (10 m) in height, and shades and crowds out native plants, preventing their regeneration. Its toxic seeds are spread mainly by human activities (PIER 2012).

According to the HWRA assessment, this species has a high risk of becoming invasiveness or a high risk of becoming a serious pest (PIER 2012).

- *Rubus argutus* (prickly Florida blackberry) is a thorny shrub with long, arching stems that reproduces both vegetatively and by seed. Native to the continental United States, *R. argutus* is naturalized on Kauai, Oahu, Molokai, Maui, and Hawaii Island (Wagner *et al.* 1999, p. 1107; Wagner *et al.* 2012, p. 62). It readily sprouts from underground runners, and is quickly spread by frugivorous birds, displacing native vegetation through competition (Tunison 1991, p. 2; Wagner *et al.* 1999, p. 1107; U.S. Army 2006, pp. 2–1–21, 2–1–22). This species is included in the Hawaii State Noxious Weed List (HAR Title 4, Subtitle 6, Chapter 68). It occurs in almost all areas, from lowland to subalpine, dry to wet habitats.

- *Rubus ellipticus* (yellow Himalayan raspberry), native to India, is a prickly, climbing shrub, now naturalized on Hawaii Island in montane wet areas; an infestation on Oahu was removed (Wagner *et al.* 1999, pp. 1107–1108; Wagner *et al.* 2012, p. 62). It occurs in montane wet areas in the Volcano and Laupahoehoe areas (Motooka *et al.* 2003, in litt.). Its long, arching stems form impenetrable thickets, and cover and smother smaller native plants. Seeds are dispersed by frugivorous birds and other animals. The plants spread locally by underground shoots that also allow it to regenerate rapidly after fire (PIER 2012).

- *Rubus rosifolius* (thimbleberry) is an erect to trailing shrub that forms dense thickets and outcompetes native plant species. Native to India, southeastern Asia, the Philippines, and Indonesia, *R. rosifolius* is naturalized on Kauai, Maui, and Hawaii Island (Wagner *et al.* 1999, p. 1110). It readily reproduces from roots left in the ground, and seeds are spread by birds and animals (GISD 2008; PIER 2008). This species occurs in lowland to montane mesic and wet habitats (Wagner *et al.* 1999, p. 1110).

- *Sacciolepis indica* (glenwood grass) is an annual grass that invades disturbed and open areas, and prevents the establishment of native plants. Native to the Paleotropics, *S. indica* is naturalized on all the main Hawaiian islands except Kahoolawe and Niihau (O'Connor 1999, p. 1589; Wagner *et al.* 2012, p. 99). The seeds are dispersed by sticking to animal fur (Motooka *et al.* 2003, in litt.; PIER 2011). This species occurs from lowland to montane elevations in open, wet areas such as grasslands, ridge crests, openings in wet

forest, and along trails (O'Connor 1999, p. 1589).

- *Schefflera actinophylla* (octopus tree) is a tree (50 ft (15 m)) native to Australia and New Guinea, and now naturalized on all the main Hawaiian islands except Kahoolawe and Niihau (Lowry II 1999, p. 232; Wagner *et al.* 2012, p. 7). This species is shade-tolerant and can spread into undisturbed forest, forming dense thickets in lowland mesic and wet habitats (Lowry II 1999, p. 232). *Schefflera actinophylla* grows epiphytically, strangling host trees, and its numerous seeds are readily dispersed by birds (PIER 2008).

- *Schinus terebinthifolius* (Christmas berry or Brazilian pepper) is a shrub or tree up to 50 ft (15 m) tall that forms dense thickets (Wagner *et al.* 1999, p. 198). Its red berries are attractive to, and are spread by, birds (Smith 1989, p. 63). *Schinus* seedlings grow very slowly and can survive in dense shade, exhibiting vigorous growth when the canopy is opened after a disturbance (Brazilian Pepper Task Force 1997). Because of these attributes, *S. terebinthifolius* is able to displace native vegetation through competition (Wagner *et al.* 1999, p. 198). This species (native to Brazil) occurs in lowland to montane, dry to wet habitats on Midway Atoll and all of the main Hawaiian islands except Kahoolawe and Niihau (Wagner *et al.* 1999, p. 198).

- *Senecio madagascariensis* (fireweed), native to Madagascar and South Africa, is an annual or short-lived perennial herb with showy yellow flowers, and is poisonous to grazing animals (PIER 2010). It is naturalized in disturbed areas and in pastures, in lowland to montane, dry to mesic areas on all the main Hawaiian islands except Niihau (Wagner *et al.* 2012, p. 16). This species occurs in a wide range of soils, and its seeds are spread by wind, birds, animals, and humans, and can also be spread as a contaminant in agricultural products and machinery. It spreads locally by rooting from nodes (PIER 2010). According to the HWRA, for this species, there is a high risk of invasiveness or a high risk of it becoming a pest species (PIER 2010).

- *Setaria palmifolia* (palmgrass), native to tropical Asia, was first collected on Hawaii Island in 1903, and is now also naturalized on Oahu, Lanai, and Maui (O'Connor 1999, p. 1592; Wagner *et al.* 2012, p. 100). A large-leaved, perennial grass, this species reaches almost 7 ft (2 m) in height, and shades and crowds out native vegetation. Palmgrass is resistant to fire and recovers quickly after being burned (Cuddihy and Stone 1990, p. 83). This

species occurs from lowland to montane elevations in mesic to wet areas.

- *Setaria verticillata* (bristly foxtail), a tufted annual grass native to Europe, with culms up to 3 ft (1 m) tall, is naturalized on Kure, Midway, and Pearl and Hermes atolls; French Frigate Shoals; Nihoa; and all the main Hawaiian Islands (O'Connor 1999, p. 1593; HBMP 2010). The sticky seed heads are readily moved by animals and human activity (PIER 2008). This species outcompetes native plants in coastal and lowland dry areas.

- *Sphaeropteris cooperi* (previously *Cyathea cooperi*; Australian tree fern) is a large tree fern, 13 ft (4 m) tall, with individual fronds extending over 13 ft (4 m) (Palmer 2003, pp. 243–244). It is native to Australia and was introduced to Hawaii for use in landscaping, and now naturalized on Kauai, Oahu, Maui, Lanai, and Hawaii Island (Medeiros *et al.* 1992, p. 27; Wagner *et al.* 2012, p. 106). It can achieve high densities in lowland and montane Hawaiian forests, growing over 1 ft (0.3 m) per year (Jones and Clemesha 1976, p. 56), displacing native plant species. Understory disturbance by pigs facilitates the establishment of this tree fern (Medeiros *et al.* 1992, p. 30). It has been known to spread over 7 mi (12 km) through windblown dispersal of spores from plant nurseries (Medeiros *et al.* 1992, p. 29). This species has been documented in mesic and wet forest and in forest openings in wet areas.

- *Stachytarpheta* spp. are native to Cuba, Mexico, South America, West Indies, and tropical Asia. There are four known species naturalized in Hawaii: *Stachytarpheta australis* (on Kauai, Oahu, Maui, Lanai, and Hawaii Island), *S. cayennensis* (on all the main islands except Kahoolawe and Niihau), *S. jamaicensis* (on Midway Atoll, and all the main islands except Kahoolawe and Niihau), and *S. mutabilis* (on Kauai) (Wagner *et al.* 1999, pp. 1321–1324). These annual or perennial herbs or subshrubs occur in coastal, lowland dry, and mesic areas, and form dense stands (PIER 2011–2013, in litt.). Used intentionally as ornamental plants, seeds are dispersed by vehicles, by movement of soils from gardens, and by rainwater. *Stachytarpheta jamaicensis* is declared a noxious weed in Australia. According to the HWRA assessment, *S. cayennensis* and *S. mutabilis* are species with a high risk of invasiveness or a high risk of becoming serious pests (PIER 2011–2013, in litt.).

- *Stapelia gigantea* (giant toad plant) is a succulent, cactus-like plant native to tropical Africa and Mozambique, and is naturalized on Oahu, Molokai, and Maui in lowland dry forest and open

areas (Wagner *et al.* 1999, p. 241; Wagner *et al.* 2012, p. 8). This species outcompetes native plants for space and water.

- *Syzygium cumini* (java plum), a 66 ft- (20 m-) tall tree native to India, Ceylon, and Malesia, is widely cultivated and now naturalized in Hawaii in lowland mesic and dry cliff habitat on all the main islands except Kahoolawe and Niihau (Wagner *et al.* 1999, p. 975). It forms dense cover, excluding all other species, and prevents the reestablishment of native forest plants. The large, black fruit is dispersed by frugivorous birds and feral pigs (PIER 2008).

- *Syzygium jambos* (rose apple), a 50 ft (15 m) tall tree, brought to Hawaii from Rio de Janeiro in 1825, is naturalized on all the main Hawaiian islands except Kahoolawe and Niihau (Wagner *et al.* 1999, p. 975). Fruit are dispersed by birds, humans, and possibly feral pigs. This tree is particularly detrimental to native ecosystems because it does not need disturbance to become established, and can germinate and thrive in shade, eventually overtopping and replacing native canopy trees (U.S. Army Garrison 2006, p. 2–1–23). This species occurs in lowland mesic to wet sites, primarily in valleys (Wagner *et al.* 1999, p. 975).

- *Tecoma stans* (yellow elder) is a shrub or small tree (32 ft (10 m)) that forms dense stands that inhibit regeneration of native species. Native to Northern and Central America, Argentina, and the West Indies, *T. stans* is naturalized on Oahu, Maui, and Hawaii Island (Wagner *et al.* 1999, p. 389). Its seeds are wind-dispersed (PIER 2008). This species occurs in lowland mesic to dry cliff habitat (Wagner *et al.* 1999, p. 389).

- *Tibouchina herbacea* (glorybush), an herb or shrub up to 3 ft (1 m) tall, is native to southern Brazil, Uruguay, and Paraguay. In Hawaii, it is naturalized and abundant in lowland to montane wet forest and cliffs on Molokai, Lanai, Maui, and Hawaii Island (Almeda 1999, p. 915; Wagner *et al.* 2012, p. 52). This species forms dense thickets, crowding out all other plants, and inhibiting regeneration of native plants (Motooka *et al.* 2003, in litt.). All members of the Melastomataceae family are included in the Hawaii State Noxious Weed List (HAR Title 4, Subtitle 6, Chapter 68).

- *Toona ciliata* (Australian red cedar) is a fast-growing, almost 100 ft (30 m) tall tree, with wind-dispersed seeds and an open, spreading crown that overtops and displaces native forest (Wagner *et al.* 1999, p. 920; Koala Native Plants 2005). This species, native to India,

southeastern Asia, and Australia, occurs in lowland mesic to cliff habitat on all the main Hawaiian islands except Kahoolawe and Niihau (Wagner *et al.* 1999, p. 920; Wagner *et al.* 2012, p. 52).

- *Ulex europaeus* (gorse), a woody legume up to 12 ft (4 m) tall and covered with spines, is native to Western Europe and is now naturalized in montane wet and mesic habitat on Molokai, Maui, and Hawaii Island (Geesink 1999, pp. 715–716; Wagner *et al.* 2012, p. 43). It is cultivated and a hedge and fodder plant, and was inadvertently introduced to Hawaii before 1910, with the establishment of the wool industry (Tulang 1992, pp. 577–583; Geesink 1999, pp. 715–716). Gorse produces numerous seeds, which are widely spread by explosive opening of the pods (Mallinson 2011, in litt.). It can rapidly form extensive, dense and impenetrable infestations, and outcompetes native plants, preventing their establishment. Dense patches can also pose a fire hazard (Mallinson 2011, in litt.). Over 20,000 ac (8,100 ha) are infested by gorse on the island of Hawaii, and over 15,000 ac (6,100 ha) are infested on Maui (Tulang 1992, pp. 577–583). Gorse is included on the Hawaii State Noxious Weed List (HAR Title 4, Subtitle 6, Chapter 68).

- *Urochloa maxima* (previously *Panicum maximum*, guinea grass), native to Africa, is cultivated as an important forage grass throughout the tropics and is naturalized on Midway (Sand Island) and all the main Hawaiian Islands (Davidse 1999, p. 1569; Wagner *et al.* 2012, p. 97). This tall grass (10 ft (3 m)) produces profuse seeds that are spread by wind, birds, and water. It is strongly allelopathic and can form dense stands that exclude native species (PIER 2007). It regenerates rapidly from underground rhizomes after a fire (PIER 2007). This species has been documented in open, coastal areas, cliffs, and open areas of lowland wet forest (PIER 2007).

- *Urochloa mutica* (previously *Brachiaria mutica*, California grass) is a sprawling perennial grass with culms up to 20 ft (6 m) long. Native to Africa, it is now pantropical, and naturalized in Hawaii on Midway Atoll and all the main islands except Kahoolawe and Niihau (O'Connor 1999, p. 1504; PIER 2012; Wagner *et al.* 2012, p. 89). This species forms dense floating mats in open water, and monotypic stands along streams, ditches, and roadsides in wet habitat. It has mild allelopathic activity, outcompetes native species, and prevents their reestablishment (Chou and Young 1975 in PIER 2012). This grass is also fire-adapted, and dead leaves provide a high fuel load.

According to the HWRA assessment, *U. mutica* has a high risk of invasiveness or a high risk of becoming a serious pest (PIER 2012).

- *Verbesina encelioides* (golden crown-beard) is a tap-rooted, annual herb native to Mexico and the southwestern United States (Wagner *et al.* 1999, p. 372). This plant has a number of traits that allow it to outcompete native plants, including tolerance of a wide range of growing conditions, rapid growth, allelopathic effects on other plants, and high seed production and dispersal with high germination rates. In addition, it is poisonous to livestock (Shluker 2002, pp. 3–4, 7–8). *Verbesina* has become a widespread and aggressive weed on both Midway Atoll and Kure Atoll, where it interferes with seabird nesting and inhibits native plant growth (Shluker 2002, pp. 3–4, 8). This species has been documented in coastal habitat on Kure Atoll, Midway Atoll, Pearl and Hermes, and all of the main Hawaiian Islands except for Niihau (Wagner *et al.* 1999, p. 372; Wagner *et al.* 2012, p. 16).

- *Youngia japonica* (oriental hawkbeard), an annual herb 3 ft (1 m) tall and native to southeastern Asia, is now a pantropical weed (Wagner *et al.* 1999, p. 377). In Hawaii, this species occurs on all the main islands except Kahoolawe and Niihau. *Youngia japonica* can invade intact lowland and montane native wet forest, where it displaces native species (Wagner *et al.* 1999, p. 377).

#### Habitat Destruction and Modification by Fire

Six of the 11 ecosystems (coastal, lowland dry, lowland mesic, montane mesic, montane dry, and subalpine) 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 pasturands 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 these native species, as well as the 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 noted that “no regeneration of native canopy is occurring within the Puuwaawaa burn area” (Takeuchi 1991, p. 2). 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 impacted rare or endangered species and their habitat 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; several of these alone burned more than 5,000 ac (2,023 ha) (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 TNC's Kamakou Preserve, and encroached on Onini Gulch, Kalamaula, and Kawela (Hamilton 2009, *in litt.*). Species proposed for listing in this rule at risk of wildfire on Molokai include the plants *Nothoecstrum latifolium*, *Portulaca villosa*, *Ranunculus mauiensis*, and *Schiedea pubescens*, *Solanum nelsonii*; the orangeblack Hawaiian damselfly; 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 proposed for listing in this

rule at risk of wildfire on Lanai include the plants *Exocarpos menziesii*, *Nothoecstrum latifolium*, and *Portulaca villosa*, the orangeblack Hawaiian damselfly, and 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, habitat for several endangered plants. On east Maui, in 2007, a fire consumed over 600 ac (240 ha), increasing invasion of the area by nonnative *Pinus* spp. (Pacific Disaster Center 2007, in litt.; The Maui News 2011, in litt.). Species proposed for listing in this rule at risk of wildfire on west and east Maui include the plants *Festuca hawaiiensis*, *Nothoecstrum latifolium*, *Ochrosia haleakalae*, *Phyllostegia stachyoides*, *Portulaca villosa*, *Ranunculus mauiensis*, *Sanicula sandwicensis*, *Schiedea pubescens* and *Solanum nelsonii*; and the animals, the orangeblack Hawaiian damselfly; 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 impacted rare or endangered species. Between 2004 and 2005, wildfires burned more than 360 ac (146 ha) in Honouliuli Preserve, home to more than 90 rare and endangered plants and animals (TNC 2005, in litt.). In 2006, a fire at Kaena Point State Park burned 60 ac (24 ha), and encroached on endangered plants in Makuu Military Training Area. In 2007, there was a significant fire at Kaukonahua that crossed 12 gulches, eventually encompassing 5,655 ac (2,289 ha) and negatively impacted eight endangered plant species and their habitat (*Abutilon sandwicense*, *Bonamia menziesii*, *Colubrina oppositifolia*, *Eugenia koolauensis*, *Euphorbia haeleleana*, *Hibiscus brackenridgei* ssp. *mokuleianus*, *Nototrichium humile*, and *Schiedea hookeri*) (U.S. Army Garrison 2007, 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 used as a food source by cattle and goats. The grass was observed to generate blades over 2 feet in length only 2 weeks following the fire (U.S. Army Garrison 2007, 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 impacted 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, burning more than 1,000 ac (400 ha) (KHON 2014, in litt.). The Makakilo fire took over two 2 weeks to contain. Species proposed for listing in this rule at risk of wildfire on Oahu include the plants *Joinvillea ascendens* ssp. *ascendens*, *Nothoecstrum latifolium*, *Portulaca villosa*, 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 threatened and endangered plants in the adjacent Kula Natural Area Reserve 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 proposed for listing in this rule at risk of wildfire on Kauai include the plants *Joinvillea ascendens* ssp. *ascendens*, *Labordia lorenciana*, *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 sq mi (500 sq km) of the leeward areas (Fire Science Brief 2009, in litt.). In the past 50 years, on the leeward side of Hawaii Island, three wildfires encompassed a total of 30,000 ac (12,140 ha) (Fire Science Brief 2009, in litt.). These wildfires traveled great distances, from 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 (Joint Fire Science Program (JFSP) 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 been previously 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 proposed for listing in this rule at risk of wildfire on Hawaii Island include the plants *Exocarpos menziesii*, *Festuca hawaiiensis*, *Ochrosia haleakalae*, *Phyllostegia stacyoides*, *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 15 plant species (*Exocarpos menziesii*, *Festuca hawaiiensis*, *Joinvillea ascendens* ssp. *ascendens*, *Labordia lorenciana*, *Nothoecstrum latifolium*, *Ochrosia haleakalae*, *Phyllostegia stacyoides*, *Portulaca villosa*, *Ranunculus mauiensis*, *Sanicula sandwicensis*, *Santalum involutum*, *Schiedea pubescens*, *Sicyos lanceoloideus*, *S. macrophyllus*, and *Solanum nelsonii*), and eight animal species (the orangeblack Hawaiian damselfly, and the yellow-faced bees *Hylaeus anthracinus*, *H. assimulans*, *H. facilis*, *H. hilaris*, *H. kuakea*, *H. longiceps*, and *H. mana*) because these species or their habitat are located in or near areas that were burned previously, or in areas considered at risk 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) are at risk of habitat destruction and modification by hurricanes. Hurricanes exacerbate the impacts from other threats such as habitat modification and destruction by ungulates and competition with nonnative plants. By destroying native vegetation, hurricanes open the forest canopy, thus modifying the availability of light, and create disturbed areas conducive to invasion by nonnative pest species (see “Specific Nonnative Plant Species Impacts,” above) (Asner and Goldstein 1997, p. 148; Harrington *et al.* 1997, pp. 539–540). In addition, hurricanes adversely impact 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 1993, 88 pp.). Because many Hawaiian plant and animal species persist in low numbers and in restricted ranges, natural disasters such as hurricanes can be particularly devastating to the species (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 (mph) (160 kmh, 87 knots), 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 nonnative plants into native forest (Kitayama and Mueller-Dombois 1995, p. 671). Hurricanes therefore have the potential to exacerbate the threat of competition with 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 (1993, pp. 86–87) documented the extirpation of the scarlet Kauai damselfly (*Megalagrion vagabundum*, a species related to *M. xanthomelas* included in this listing proposal), from the entire Hanakapiai Stream system on the island of Kauai as a result of the impacts of Hurricane Iniki. Damage by future hurricanes could further impact the remaining native-plant dominated habitat areas that support 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, below).

In summary, hurricanes can 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, (*Hylaeus anthracinus*, *H. assimulans*, *H. facilis*, *H. hiliaris*, *H. kuakea*, *H. longiceps*, and *H. mana*.)

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

Habitat destruction and modification by landslides, rockfalls, treefall, flooding, erosion, and drought affect all 11 ecosystems (singly or in combination). Landslides, rockfalls, treefall, flooding, and erosion destabilize substrates, damage and destroy individual plants, and alter hydrological patterns resulting in changes to native plant and animal communities. In the open sea near Hawaii, rainfall averages 25 to 30 in (630 to 760 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 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 3).

These events have the potential to 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.

Landslides, rockfalls, treefall, flooding, and erosion are threats to 20 plant species (*Cyanea kauaulaensis*, *Cyclosorus boydiae*, *Deparia kaalaana*, *Gardenia remyi*, *Joinvillea ascendens* ssp. *ascendens*, *Kadua fluviatilis*, *K. haupuensis*, *Labordia lorenciana*, *Lepidium orbiculare*, *Ochrosia haleakalae*, *Phyllostegia brevidens*, *P. helleri*, *P. stachyoides*, *Portulaca villosa*, *Pseudognaphalium sandwicense* var. *molokaiense*, *Ranunculus hawaiiensis*, *R. mauiensis*, *Sanicula sandwicensis*, *Schiedea pubescens*, and *Solanum nelsonii*), and the band-rumped storm-petrel, and the orangeblack Hawaiian damselfly. Destabilization of cliff habitat could lead to additional landslides and alteration of hydrological patterns, affecting the availability of soil moisture. Landslides can also modify and destroy 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 lead to extirpation of the species by direct destruction. Monitoring data presented by the PEPP program 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 could be impacted by flooding if most individuals are carried out of suitable habitat or into areas occupied by nonnative fish.

Drought has been reported to be a threat to nine plants (*Deparia kaalaana*, *Huperzia stemmermanniae*, *Phyllostegia stachyoides*, *Ranunculus hawaiiensis*, *R. mauiensis*, *Sanicula sandwicensis*, *Schiedea pubescens*, *Sicyos lanceoloides*, and *Solanum nelsonii*), the orangeblack Hawaiian damselfly, and all seven yellow-faced bees proposed for listing in this rule

(Magnacca 2007b, 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) 2009a and 2009b; HDLNR 2009, pp. 1–6; 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 2009a and 2009b). Desiccation of these water sources directly reduces or eliminates habitat suitable for the larval stage of the orangeblack Hawaiian damselfly to grow and mature, as well as reduces habitat for the damselfly's adult stage to hunt prey. Drought leads to increases in the number of forest and brush fires, leading to a reduction of native plant cover over streams and ponds used by the orangeblack Hawaiian damselfly (Giambelluca *et al.* 1991, p. v; D'Antonio and Vitousek 1992, pp. 77–79). Recent episodes of drought have also 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 “C. Disease or Predation,” below) (Waring 1996, in litt; Nishibayashi 2001, in litt.). Drought events have the potential to 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.

#### 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, called 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 utilized 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* (*Brachiaria mutica*, California grass). This sprawling, perennial grass was first observed on Oahu in 1924, and now occurs on all the main Hawaiian 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, pp. 291, 301–303). Many of these aquifers are the sources of springs, which contribute flow to streams. The draining of these aquifers may cause springs to become dry (Stearns and Vaksvik 1935, pp. 380, 388). Most remaining streams that are not already diverted have been, and continue to be, 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.

#### Habitat Destruction and Modification by Climate Change

Climate change may have impacts to the habitat of the 49 species. Discussion of these impacts is included in our complete discussion of climate change in the section “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 proposed rule is occurring throughout the entire range of each of the species. These impacts include the effects of introduced ungulates, nonnative plants, fire, hurricanes, landslides, rockfalls, treefall, flooding, erosion, drought, water extraction, and the direct or cumulative effects of climate change.

The threat of habitat destruction and modification by agriculture and urban development is an ongoing threat to four plant species (*Nothoecstrum latifolium*, *Portulaca villosa*, *Pseudognaphalium sandwicensium* var. *molokaiense*, and *Solanum nelsonii*); the orangeblack Hawaiian damselfly; the anchialine pool shrimp *Procaris hawaiiiana*; and the yellow-faced bees *Hylaeus anthracinus*,

*H. assimulans*, *H. facilis*, *H. hilaris*, and *H. longiceps*, as the conversion of terrestrial and aquatic habitats for urban use modifies or permanently removes habitat, the host plants, and aquatic features required by these species for their life-history needs.

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 the 37 of the 39 plants (all except for *Cyanea kauaulaensis* and *Hypolepis hawaiiensis* var. *mauiensis*), and 9 of the 10 animal species (all except for the anchialine pool shrimp), that are proposed for listing in this rule that occur in these 10 ecosystems (see Table 3) because ungulates: (1) Directly impact the species by trampling and grazing; (2) increase soil disturbance and erosion; (3) create open, disturbed areas conducive to nonnative plant invasion and establishment 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 affects the aquatic and anchialine pool habitats.

Habitat destruction and modification by nonnative plants represents an ongoing threat to 36 of the 39 plant species (all except for *Exocarpos menziesii*, *Huperzia stemmermanniae*, and *Joinvillea ascendens* ssp. *ascendens*), the orangeblack Hawaiian damselfly, and all seven yellow-faced bee species addressed in this proposed rule because they: (1) Adversely impact 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; and (5) outcompete, and possibly directly inhibit (through allelopathy) the growth of, native plant species. Each of these threats can convert native-dominated plant communities to nonnative plant communities (Cuddihy and Stone 1990, p. 74; Vitousek 1992, pp. 33–35). This conversion has negative impacts on 44 of the 49 species addressed here.

The threat of habitat destruction and modification by fire to 15 plant species (*Exocarpos menziesii*, *Festuca hawaiiensis*, *Joinvillea ascendens* ssp. *ascendens*, *Labordia lorenciana*, *Nothoecstrum latifolium*, *Ochrosia haleakalae*, *Phyllostegia stachyoides*, *Portulaca villosa*, *Ranunculus mauiensis*, *Sanicula sandwicensis*, *Santalum involutum*, *Schiedea*

*pubescens*, *Sicyos lanceoloideus*, *S. macrophyllus*, and *Solanum nelsonii*), the orangeblack Hawaiian damselfly, and all seven yellow-faced bee species in this proposed rule is ongoing because fires occur frequently, and damage and destroy native vegetation, including dormant seeds, seedlings, and juvenile and adult plants, and host plants. Many nonnative invasive plants, particularly fire-tolerant grasses, create more destructive fires, invade burned areas, and can outcompete 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 23 species depend.

Habitat destruction and modification by natural disasters such as hurricanes represent a threat to the plant *Pritchardia bakeri*, the band-rumped storm-petrel, the orangeblack Hawaiian damselfly, and all seven yellow-faced bee species addressed in this proposed rule. 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,” above, provides additional information related to canopy gaps, light availability, and the establishment of nonnative plant species. In addition, hurricanes can alter and directly damage streams and wetlands used by the orangeblack Hawaiian damselfly (Polhemus 1993, pp. 86–87). The impacts from hurricanes can be particularly devastating to 10 species addressed in this proposed rule 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 the species that persist as one or several small, isolated populations.

Landslides, rockfalls, treefall, flooding, and erosion adversely impact 20 plant species (*Cyanea kauaulaensis*, *Cyclosorus boydiae*, *Deparia kaalaana*, *Gardenia remyi*, *Joinvillea ascendens* ssp. *ascendens*, *Kadua fluviatilis*, *K. haupuensis*, *Labordia lorenciana*, *Lepidium orbiculare*, *Ochrosia haleakalae*, *Phyllostegia brevidens*, *P. helleri*, *P. stachyoides*, *Portulaca villosa*, *Pseudognaphalium sandwicense* var. *molokaiense*, *Ranunculus hawaiiensis*, *R. mauiensis*, *Sanicula sandwicensis*, and *Schiedea pubescens*, and *Solanum nelsonii*), and the band-rumped storm-petrel, and the orangeblack Hawaiian

damselfly, which are proposed for listing in this rule, by destabilizing substrates, damaging and killing individuals, and altering hydrological patterns. These impacts result in habitat destruction or modification, and changes to native plant and animal communities. Drought threatens five nine plant species (*Deparia kaalaana*, *Huperzia stemmermanniae*, *Phyllostegia stachyoides*, *Ranunculus hawaiiensis*, *R. mauiensis*, *Sanicula sandwicensis*, *Schiedea pubescens*, *Sicyos lanceoloideus*, and *Solanum nelsonii*), and the orangeblack Hawaiian damselfly, and all seven yellow-faced bee species addressed in this proposed rule, directly or by desiccation of streams and ponds, and the host plants upon which all seven yellow-faced bees depend.

Conversion of wetland and other aquatic habitat (*i.e.*, water extraction) for agriculture and urban development is an ongoing threat that is expected to continue into the future, and affects the orangeblack Hawaiian damselfly by removing habitat required for hunting and breeding. Water extraction impacts 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, negatively impacting the damselfly naiads by causing physiological stress. Loss of stream-course habitat affects *Cyclosorus boydiae* because this is the only habitat where this riparian species occurs. Water extraction may affect the delicate balance of the anchialine pool ecosystem, including salinity and biota, affecting habitat of the anchialine pool shrimp, *Procaris hawaiiana*.

#### *B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes*

We are not aware of any threats to 48 of the 49 species addressed in this proposed rule that would be attributed to overutilization for commercial, recreational, scientific, or educational purposes.

#### *Anchialine Pool Shrimp*

The Service has become aware of companies and private collectors using anchialine pool shrimp and related shrimp species for commercial sales of self-contained aquariums (Ecosphere Associates 2015, in litt.). One company located in Hawaii, Fuku Bonsai, has been using Hawaiian anchialine pool species for the aquarium hobby market for many years; however, they state they will soon be discontinuing sale of “micro-lobsters” (Fuku-Bonsai 2015, in

litt.). For commercial purposes, a Native Invertebrate Research and Collecting permit issued by DLNR-Division of Forestry and Wildlife is required to collect anchialine pool shrimp. 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 is prohibited in State Natural Area Reserves (NARs) but not in State Parks or City and County property where some anchialine pools occur. Overcollection by the aquarium hobby market is a potential threat to the anchialine pool shrimp *Procaris hawaiiiana*. Collection is prohibited in the Ahihi-Kinau (Maui) and Manuka (Hawaii Island) NARs, but is not expressly prohibited at Lua O Palahemo (Hawaii Island). There is no regulatory protection of these shrimp at the remaining five anchialine pools outside of Manuka NAR that are known to contain *P. hawaiiiana*. We consider overcollection of this anchialine pool shrimp, *P. hawaiiiana*, to be an ongoing threat, because it can occur at any time.

#### C. Disease or Predation

##### Disease

We are not aware of any threats to the 49 species addressed in this proposed rule that would be attributable to disease.

##### 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 any native ants or conifers, has very few families of birds, and has only had two species of native 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. As 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 antipredator mechanisms against mammals or invertebrates 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), grazing and browsing by introduced ungulates are a threat to the following 26 plant species in this proposal (see Table 3): *Asplenium diellaciniatum* (black-tailed deer); *Calamagrostis expansa* (pigs), *Cyclosorus boydiae* (pigs), *Exocarpos menziesii* (goats, sheep, mouflon), *Festuca hawaiiensis* (goats, sheep), *Gardenia remyi* (pigs, goats, deer), *Huperzia stemmermanniae* (cattle), *Joinvillea ascendens* ssp. *ascendens* (pigs, goats, deer), *Kadua fluviatilis* (pigs, goats), *Labordia lorenciana* (goats), *Microlepia strigosa* var. *mauiensis* (pigs), *Myrsine fosbergii* (pigs, goats), *Nothoecstrum latifolium* (pigs, goats, deer, black-tailed deer, sheep, mouflon), *Ochrosia haleakalae* (cattle), *Phyllostegia brevidens* (pigs, sheep), *P. stachyoides* (pigs, goats), *Portulaca villosa* (deer, mouflon), *Pseudognaphalium sandwicense* var. *molokaiense* (deer), *Ranunculus hawaiiensis* (pigs, cattle, mouflon), *R. mauiensis* (pigs, goats, deer, black-tailed deer, cattle), *Sanicula sandwicensis* (goats), *Santalum involutum* (black-tailed deer), *Schiedea pubescens* (deer, cattle), *Sicyos lanceoloideus* (goats), *S. macrophyllus* (mouflon, cattle), and *Solanum nelsonii* (deer, cattle).

##### Feral Pigs

We have direct evidence of ungulate damage to some of the plant species proposed for listing in this rule, 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 plant 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); *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); *Nothoecstrum 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 hawaiiensis* 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, p. 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 in this proposal; 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*, 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 proposed for listing in this rule: *Exocarpos menziesii* on Hawaii Island (NTBG Herbarium Database 2014, in litt.), *Festuca hawaiiensis* on Hawaii Island (USFWS Rare Plant database 2010, in litt.), *Gardenia remyi* on Kauai (PEPP 2011, p. 114; PEPP 2013, p. 107; Kishida 2011, in litt.), *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), *Nothoecstrum latifolium* on Maui (HBMP 2010), *Phyllostegia stachyoides* on Molokai (HBMP 2010), *Portulaca*

*villosa* on Hawaii Island (PEPP 2012, p. 140), *Ranunculus mauiensis* on Kauai and on Maui (PEPP 2011, p. 161; PEPP 2012, p. 144; PEPP 2013, pp. 177–178; PEPP 2014, p. 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, feral goats may also damage or destroy native host plants of the yellow-faced bees *Hylaeus anthracinus*, *H. assimulans*, *H. facilis*, *H. hilaris*, and *H. kuakea*.

#### 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* (nau), and Swedberg and Walker (1978, in Anderson 2003, pp. 124–25) reported that the native plants *Osteomeles anthyllidifolia* (uulei) and *Leptecophylla tameiameia* (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 particular

threat to the following plant species proposed for listing in this rule: *Gardenia remyi* on Molokai (HBMP 2010), *Huperzia stemmermanniae* on Maui (HBMP 2010), *Joinvillea ascendens* ssp. *ascendens* on Maui (PEPP 2014, pp. 108–109), *Nothoecstrum latifolium* on Lanai (PEPP 2012, p. 129), *Phyllostegia stachyoides* on Molokai (HBMP 2010), *Portulaca villosa* on Lanai (HBMP 2010), *Pseudognaphalium sandwicense* var. *molokaiense* on Molokai (Wood 2005, 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 habitat of the orangeblack Hawaiian damselfly and 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 strawberry guava (*Psidium cattleianum*) and thimbleberry (*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 poses a threat to the Kauai plant species *Asplenium diellaciniatum*, *Nothoecstrum latifolium*, *Ranunculus mauiensis*, and *Santalum involutum* proposed for listing here.

#### 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, in litt.). 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), *Sanicula sandwicensis*, and *Silene hawaiiensis*, as well as 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 particular threat to the following plant species proposed for listing in this rule: *Exocarpos menziesii* on Lanai and 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.); *Nothoecstrum latifolium* on Lanai (PEPP 2012, p. 129); *Phyllostegia brevidens* on Hawaii Island (PEPP 2014, p. 136); *Portulaca villosa* on Lanai (HBMP 2010); *Ranunculus hawaiiensis* on Hawaii Island (HBMP 2010); and *Sicyos macrophyllus* on Hawaii Island (HBMP 2010). As feral sheep and mouflon occur in all of the described ecosystems except for the anchialine pool ecosystem, the data from studies, cited above, suggest that herbivory by feral sheep and mouflon likely also pose a threat to the yellow-faced bees on Lanai (*Hylaeus anthracinus*, *H. assimulans*, *H. facilis*, *H. hilaris*, and *H. longiceps*), by eating their host plants.

#### 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 particular threat to the following plant species proposed for listing: *Huperzia stemmermanniae* on Maui and Hawaii Island (Medeiros *et al.* 1996, p. 96); *Ochrosia haleakalae* on Maui (HBMP 2010); *Phyllostegia brevidens* on Hawaii Island (PEPP 2011, p. 144); *Ranunculus hawaiiensis* 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 2005, 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). As feral cattle occur in six of the described

ecosystems (lowland dry, lowland mesic, lowland wet, montane wet, montane mesic, and subalpine) on Molokai, Maui, and Hawaii Island, the results from the studies cited above, in addition to direct observations from field biologists, suggest that grazing by feral cattle can directly damage or destroy these plants.

#### Blackbuck

The blackbuck antelope (*Antelope cervicapra*) is a 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). While the possible habitat effects from the blackbuck antelope are unknown at this time, we consider this ungulate a potential threat to native plant species, including six plants that are known from dry areas on Molokai, and are proposed for listing in this rule (*Gardenia remyi*, *Nothoecstrum latifolium*, *Portulaca villosa*, *Pseudognaphalium sandwicense* var. *molokaiense*, *Ranunculus mauiensis*, and *Solanum nelsonii*). The blackbuck antelope may potentially threaten the yellow-faced bees *Hylaeus anthracinus*, *H. facilis*, *H. hilaris*, and *H. longiceps* proposed for listing in this rule by consuming their native host plants on Molokai.

#### 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 seven of the described ecosystems (coastal, lowland mesic, lowland wet, montane wet, montane mesic, montane dry, and wet cliff), and predation by rats threatens 18 of the plants proposed for listing in this rule (*Calamagrostis expansa* (Maui and Hawaii Island; HBMP 2010), *Cyanea kauaulaensis* (Maui; PEPP 2012, pp. 71–72; PEPP 2014, p. 73), *Gardenia remyi* (Kauai; NTBG 2004), *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), *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 hawaiiensis* (Maui, Hawaii Island; HBMP 2010), *R. 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, Maui; Wood 2010, 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 the band-rumped storm-petrel (Lehua, Niihau, Kauai, Maui, and Hawaii Island; Pyle and Pyle 2009, in litt.), proposed for listing in this rule.

Rat Impacts on Plants: Rats impact 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, seriously affecting vigor and regeneration (Abe and Umeno 2011, pp. 27–39; Nelson 2012, in litt.). 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 as 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 an ongoing threat to all the Hawaiian *Pritchardia* palms, including *P. bakeri* proposed for listing in this rule, 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 (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). As rats occur in seven of the described ecosystems, the results from the studies cited above, 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, p. 20–21). Evidence from the islands of Hawaii and Maui show that the Hawaiian petrel, which 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 could further decrease the numbers and populations of the band-rumped storm-petrel, and 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 birds. Between 1996 and 1998, 10 percent of nest failures of the endangered forest bird, the puaiohi (small Kauai thrush, *Myadestes palmeri*), on Kauai were attributed to owls (Snetsinger *et al.* 1994, p. 47; Snetsinger *et al.* 2005, pp. 72, 79). In the Galapagos, the short-eared owl (*Asio flammeus galapagoensis*), a close relative of the pueo, is the primary predator of juvenile and adult band-rumped storm-petrels, and took more storm-petrels than other seabirds in some months. Predation by owls (*Asio flammeus galapagoensis*) was greatest during the cold season and on non-breeders, which spend more time on the ground prospecting for nesting sites (Harris 1969 in Slotterback 2002, in litt.). Some predation avoidance behavior by band-rumped storm-petrels has been observed: Their nocturnal activity (feeding chicks only at night) and burrow-nesting habitat limit predation by gulls and frigatebirds, and non-reproductive birds decrease their activity (measured by fewer birds in flight and fewer vocalizations) around the period of the full moon to avoid predation (Bretagnolle 1990 in Slotterback 2002, in litt.); however, it is uncertain how effective this behavior is against predation by owls.

### 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; Medina *et al.* 2011, pp. 3505–3507; Duffy and Capece 2012, pp. 176–177). 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 are not adapted to predation by these animals (Nogales *et al.* 2013, p. 804; Ziegler 2002, p. 243; Scott *et al.* 1986, p. 363; Ainley *et al.* 1997, p. 24; Hess and Banko 2006, in litt.). 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 2012, in litt.; Hess *et al.* 2008, pp. 11, 14). Causes of predation are better studied for the Hawaiian petrel, which is much larger in size but has nesting characteristics similar to those of the band-rumped storm-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 (Simon 1984, p. 1073). The band-rumped storm petrel is small in size, 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 three 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 there are established populations 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*), the Hawaiian duck (koloa, *Anas wyvilliana*), the Hawaiian coot (alae keokeo, *Fulica alai*), the Hawaiian stilt (aeo, *Himantopus mexicanus knudseni*), the Hawaiian gallinule (ula, *Gallinula chloropus sandvicensis*), the Hawaiian petrel, and the Newell's shearwater. Bird extinctions in other areas are attributed to mongooses, 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 are found in habitat that would have been unsuitable for it within its natural range, and they have no predators and few communicable diseases or parasites. Because mongooses occur in all three 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 Damsel

Predation by nonnative fishes on the orangeblack Hawaiian damselfly is a significant threat. Similar to the aquatic insects, Hawaii has a depauperate freshwater fish fauna, with only five

native species comprised of 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; McPeck 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; McPeck 1990b, p. 1722). The introduction of nonnative fishes has been implicated in the extirpation of a species related to the orangeblack Hawaiian damselfly, the 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). Over 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 1993, 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 (*M. oceanicum*), the endangered crimson Hawaiian



damsselfly (*M. leptodemas*), and the endangered blackline Hawaiian damsselfly (*M. nigrohamatum nigrolineatum*). Currently, these damsselfies 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 damsselfies evolved with few, if any, predatory fishes and exposed behavior of most of the fully aquatic species, including the orangeblack Hawaiian damsselfly, makes them particularly vulnerable to predation by nonnative fish.

#### Nonnative Fish Impacts on the Anchialine Pool Shrimp

In Hawaii, the introduction of nonnative fishes, including bait-fish, into anchialine pools may have been a major contributor to the decline of native shrimp. 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 in “E. Other Natural or Manmade Factors Affecting Their Continued Existence,” below.

#### Introduced Invertebrates

##### Slugs

Herbivory by nonnative slugs is reported to adversely impact 8 of the 39 plant species (*Cyanea kauaulaensis* (Maui); *Deparia kaalaana* (Kauai, Maui, Hawaii Island), *Labordia lorenciana* (Kauai), *Phyllostegia brevidens* (Maui), *P. stachyoides* (Molokai, Maui), *Ranunculus mauiensis* (Maui), *Schiedea diffusa* ssp. *diffusa* (Maui), and *S. pubescens* (Maui); see Table 3) proposed for listing in this rule, through mechanical damage, destruction of plant parts, and mortality (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, p. 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 enclosures without slugs. As slugs are reported in 5 of the 11 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, suggest that slugs can directly damage or destroy native plants.

##### Backswimmers

Predation by nonnative backswimmers (Heteroptera: Notonectidae) poses a threat to the orangeblack Hawaiian damsselfly. 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 damsselfly naiads (Borror *et al.* 1989, p. 296; Zalom 1978, p. 617). Backswimmers (several species) were introduced in recent times. *Buena pallipes* (NCN) has been recorded from Hawaii Island, Oahu, Maui, and Kauai (Zimmerman 1948a, 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 damsselfly 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). The mere presence of backswimmers in the water can cause naiads to stop foraging, reducing their growth, development, and survival (Heads 1986, pp. 375–376). Because of these attributes, predation by backswimmers poses a threat to the orangeblack Hawaiian damsselfly.

##### Ants

At least 47 species of ants are known to be introduced and established in the Hawaiian Islands (Hawaii Ants 2008, 11

pp.). No native ants 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 (Krushelnicky *et al.* 2005, pp. 6–7). Some ant species may impact yellow-faced bee species indirectly as well, by consuming seeds of native 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 pollination (Krushelnicky 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). 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 (Krushelnicky *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-elevation (less than 2,000 ft (600 m)) in rocky areas of moderate rainfall (less than 100 in (250 cm) annually) (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, p. 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 Tokelau Atolls (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 proposed for listing in this rule. *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 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, *Solenopsis geminata* 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 in 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 impact 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 proposal directly 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 proposed for listing in this rule 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 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 an 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 hawaiiiana*, or the seven yellow-faced bees proposed for listing in this rule.

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, backswimmers, ants, and wasps) to pose an ongoing threat to 33 of the 39 plant species and to all 10 animal species proposed for listing throughout their ranges (see Table 3) for the following reasons:

(1) Observations and reports have documented that pigs, goats, axis deer,

black-tailed deer, sheep, mouflon, and cattle browse 26 of the 39 plant species (see Table 3), in addition to other studies demonstrating the negative impacts of ungulate browsing on native plant species of the islands. Browsing by blackbuck antelope is currently a potential threat to plants that occur in the dry areas of Molokai, including the host plants for the yellow-faced bees.

(2) Nonnative rats and slugs cause mechanical damage to plants and destruction of plant parts (branches, flowers, fruits, and seeds), and are considered a threat to 20 of the 39 plant species proposed for listing (see Table 3).

(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 an ongoing threat.

(4) Barn owls and cats have established populations in the wild on all the main Hawaiian islands, and mongooses have established populations on all the main islands except for Kauai. Predation by these animals is an ongoing threat to the band-rumped storm-petrel.

(5) The absence of Hawaiian damselflies (including the orangeblack Hawaiian damselfly) in streams 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 Hawaiian damselflies from these habitats. Accordingly, predation by nonnative fishes is an ongoing threat to the orangeblack Hawaiian damselfly.

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

(7) Herbivory (leading to damage, destruction of reproductive parts, and mortality of seedlings) by slugs, is a known threat to 10 of the 39 plant species proposed for listing.

(8) The presence of backswimmers in aquatic habitat can cause damselfly naiads, including those of the orangeblack Hawaiian damselfly, to stop foraging, reducing their growth, development, and survivability. In addition, backswimmers can directly feed on damselfly naiads, posing a significant threat to the orangeblack Hawaiian damselfly.

(9) 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. In addition, negative impacts to native Hawaiian plants on Molokai from grazing and browsing by blackbuck antelope are likely should this nonnative ungulate increase in numbers and range on the island. The effects of the combined threats suggest the need for immediate implementation of recovery and conservation methodologies.

#### *D. The Inadequacy of Existing Regulatory Mechanisms*

Currently, there are no existing Federal, State, or local laws, treaties, or regulations that specifically conserve or protect 48 of the 49 species (except the band-rumped storm-petrel, as discussed below) proposed for listing, or adequately address the threats to all 49 species described in this proposed rule. There are a few small programs and organizations that conduct vegetation monitoring, and nonnative species and predator control, but these activities are not regulatory, and continuation of conservation efforts, or funding for them, is not guaranteed. Hawaii's Plant Extinction Prevention Program (PEPP) is a multi-agency (Federal, State, and private) program that identifies and supports the "rarest of the rare" Hawaiian plant species in need of immediate conservation efforts. The goal of PEPP is to prevent the extinction of plants species that have fewer than 50 individuals remaining in the wild in the Hawaiian Islands and Guam and the Commonwealth of the Northern Mariana Islands (GPEPP). Partnerships such as the Hawaii Invasive Species Council (HISC) and the Coordinating Group on Alien Pest Species (CGAPS) were formed in 2002 and 1995, respectively, but their conservation actions are also limited, as discussed below. The capacity of Federal and State agencies and their nongovernmental partners in Hawaii to mitigate the effects of nonnative species, such as ungulates and weeds, is limited due to the large number of taxa currently causing damage (CGAPS 2009). Many invasive nonnative plants established in the Hawaiian Islands have currently limited but expanding ranges and are of concern. Resources available to reduce the spread of these species and counter their negative effects are limited. Control efforts are largely focused on a

few invasive species that cause significant economic or environmental damage to public and private lands. Comprehensive control of an array of nonnative species and management to reduce disturbance regimes that favor them remains 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 ungulates and predators, plants, and invertebrates are ongoing and expected to continue into the future.

The Hawaiian population of band-rumped storm-petrel is currently protected under Federal law by the Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703 *et seq.*). 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 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. The Hawaiian population of the band-rumped storm-petrel is listed by the State of Hawaii as an endangered species under Hawaii State Endangered Species Act (Hawaii ESA) (HRS 195D-4(a)), which also prohibits take, possession, sale, transport, or export of adults, eggs, or young, except as authorized by law, license, or permit, but like the MBTA, the Hawaii ESA affords no protection of habitat.

#### Terrestrial Habitat and Feral Ungulates

Nonnative ungulates pose a major ongoing threat to 37 of the 39 plant species, and 9 of the 10 animals species (all except the anchialine pool shrimp, *Procaris hawaiana*) through destruction and modification of terrestrial habitat, and through direct predation of 26 of the 39 plant species (see "A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range" and "C. Disease and

Predation,” above; and Table 3). The State of Hawaii provides game mammal (feral pigs and goats; axis deer; black-tailed deer; and sheep, mouflon, and mouflon-sheep hybrids) hunting opportunities on 91 State-designated public hunting areas (within 45 units) on all the main Hawaiian Islands except Kahoolawe and Niihau (HAR 2003, 13–123, rev 2010; HDLNR 2009, pp. 25–30); however, there are private hunting opportunities on Niihau (Niihau Safaris Inc. 2015, in litt.). The State’s management objectives for game animals range from maximizing public hunting opportunities (e.g., “sustained yield”) in some areas to removal by State staff or their designees in other areas (HAR 2003, 13–123 rev 2010; HDLNR 2009, pp. 25–30). Thirty of the 39 plant species, the band-rumped storm-petrel, the orangeblack Hawaiian damselfly, and three yellow-faced bees (*Hylaeus assimulans*, *H. facilis*, and *H. longiceps*) have populations in areas where terrestrial habitat may be manipulated for game enhancement and game populations are maintained at certain levels for public hunting (Holmes and Joyce 2009, 4 pp.; HAR 2003, 13–123, rev 2010; 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 37 of the 39 plant species, the band-rumped storm-petrel, the orangeblack Hawaiian damselfly, or the seven yellow-faced bees on all the main Hawaiian islands (except Kahoolawe) (see Table 3). After an incident in 2012 of inter-island transport of axis deer to Hawaii Island, which until that time had been free of axis deer, a bill was enacted to prohibit inter-island transportation and possession of wild or feral deer under Hawaii Revised Statute Title 12, 183D–52 (2014), but there are no other regulations designed to address habitat protection from ungulates, including game mammals.

#### Aquatic Habitat

Existing regulations are inadequate to maintain stream flow, springs, ponds, and seeps year-round for the different life stages of the orangeblack Hawaiian damselfly, proposed for listing in this rule. 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 were adopted (State Water Code, HRS 174C–71, and HAR Title 13, Ch 169–44–49). The State of Hawaii considers all natural flowing surface water (streams, springs, and seeps) as State property (HRS 174C), and the HDLNR has management responsibility for the aquatic organisms in these waters (HRS Annotated 1988, Title 12; 1992 Cumulative Supplement). Accordingly, damselfly populations (including the orangeblack Hawaiian damselfly) in all natural flowing surface waters are under jurisdiction of the State of Hawaii, regardless of property ownership.

The State of Hawaii manages the use of surface and ground water resources through the Commission on Water Resource Management (Water Commission), as mandated by the 1987 State Water Code (HRS 174 and HAR Title 13, Ch 168 and 169). Because of the complexity of establishing instream flow standards (IFS) for approximately 376 perennial streams, the Water Commission established interim IFS at status quo levels in 1987 (Commission of Water Resource Management (CWRM) 2009). In the Waiahole Ditch Combined Contested Hearing on Oahu (1997–2006), the Hawaii Supreme Court determined that status quo interim IFS were not adequate, and required the Water Commission to reassess the IFS for Waiahole Ditch and other streams statewide (Case No. CCH–OA95–1; Maui Now.com, in litt.). The Water 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; CWRM 2014, in litt.).

In the Hawaii Stream Assessment Report (DLNR 1990), prepared in coordination with the National Park Service (NPS), the Water Commission identified high-quality rivers or streams (and portions thereof) that may be placed within a Wild and Scenic River system. This report ranked 70 out of 176 streams analyzed as outstanding high-quality habitat, and recommended that streams meeting certain criteria be protected from further development (DLNR 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, for damselflies. 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 these permits, the COE does not typically

establish IFS as a matter of policy (U.S. Army 1985, RGL 85–6).

There are no existing regulatory mechanisms that specifically protect Hawaii’s anchialine pools (habitat for the anchialine pool shrimp, *Procaris hawaiiiana*, and the orangeblack Hawaiian damselfly); however, 2 anchialine pools on Maui and 12 anchialine pools on Hawaii Island are located within State Natural Area Reserves (NARs) (Ahihi-Kinau and Manuka, respectively). Designation as a State NAR prohibits the removal of any native organism and the disturbance of pools (HAR 13–209–4). The State NARs were created to preserve and protect samples of Hawaii’s ecosystems and geological formations, and are actively managed and monitored. Though signs are posted at NARs to notify the public that pools are off-limits to bathers and other activities, the State NARs have no funding for proper enforcement of those restrictions.

Because there are currently no Federal, State, or local laws, treaties, or regulations that specifically or effectively conserve or protect the anchialine pool shrimp and the orangeblack Hawaiian damselfly, or adequately address inadequate maintenance and protection of instream flow, springs, seeps, and anchialine pools for the anchialine pool shrimp and the orangeblack Hawaiian damselfly habitat, these threats are ongoing and are expected to continue into the future.

#### Introduction of Nonnative Species

Under statutory authorities provided by Chapter 183D, HRS, 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 islands 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.” As discussed in “Habitat Destruction and Modification by Introduced Ungulates,” and “Terrestrial Habitat and Feral Ungulates,” above, a bill was enacted to prohibit inter-island transportation and possession of wild or feral deer under Hawaii Revised Statute Title 12, 183D–

52 (2014), but no other game mammals are regulated by this statute.

Currently, four agencies are responsible for inspection of goods arriving in Hawaii (CGAPS 2009). The Hawaii Department of Agriculture (HDOA) inspects domestic cargo and vessels and focuses on nonnative pest species of concern to Hawaii, especially insects or plant diseases not yet known to be present in the State. The U.S. 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. CBP focuses on a wide range of quarantine issues involving non-propagative plant materials, wooden packing materials, timber, and products; internationally regulated commercial species under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); and federally listed noxious plants and seeds, soil, and pests of concern to the greater United States, such as pests to mainland U.S. forests and agriculture. The U.S. 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 handles other related matters, but focuses on pests of wide concern across the United States (HDOA 2009, in litt.). The Service inspects arriving wildlife products, enforces the injurious wildlife provisions of the Lacey Act (18 U.S.C. 42; 16 U.S.C. 3371 *et seq.*), and prosecutes CITES violations.

The State of Hawaii's unique biosecurity needs are not recognized by Federal import regulations, as these regulations are based on species considered threats to the mainland United States, and not those species that could become threats to native Hawaiian species (Hawaii Legislative Reference Bureau (HLRB) 2002; USDA—APHIS—PPQ 2010; CGAPS 2009). Interstate commerce provides the pathway for new species to enter Hawaii. Pest species may be intercepted, but are not always acted on by Federal agents because these species are not regulated under Federal mandates. Hence, Federal protection against pest species of concern to Hawaii historically has been inadequate. It is possible for the USDA to grant Hawaii protective exemptions under the "Special Local Needs Rule," when clear and comprehensive arguments for both agricultural and conservation issues are provided; however, this exemption

procedure operates on a case-by-case basis and is extremely time-consuming to satisfy. Therefore, there is only minimal protection against a large diversity of nonnative species that arrive and may negatively impact Hawaii.

Inadequate staffing, facilities, and equipment for Federal and State inspectors devoted to invasive species interdiction are critical biosecurity gaps (HLRB 2002; USDA—APHIS—PPQ 2010; CGAPS 2009). In recognition of the gaps, State laws have recently been passed that allow the HDOA to collect fees for quarantine inspection of freight entering Hawaii (*e.g.*, Act 36 (2011) HRS 150A–5.3). Legislation enacted in 2011 (H.B. 1568) requires commercial harbors to provide biosecurity and inspection facilities to facilitate the movement of cargo through ports. This enactment is a significant step toward optimizing biosecurity capacity in the State; however, only time will determine the its effectiveness of this Act (Act 201(11)). From a Federal perspective, there is a need to ensure all civilian and military port and airport operations and construction are in compliance with the Act 201 (11) State of Hawaii's laws.

In 1995, a partnership, Coordinating Group on Alien Pest Species (CGAPS), comprised primarily of managers from every major Federal, State, county, and private agency and organization involved in invasive species work in Hawaii, was formed in an effort to influence 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 State 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; HRS 194–2(a)). Some of the recent priorities for the HISC include interagency efforts to control nonnative species such as the plants *Miconia calvescens* (miconia) and *Cortaderia* sp. (pampas grass), coqui frogs (*Eleutherodactylus coqui*), the coconut rhinoceros beetle (*Oryctes rhinoceros*) (HISC 2013, in litt.; OISC 2015, in litt.), and ants (HISC 2009;

HISC 2015, <http://dlnr.hawaii.gov/hisc>). Budget cuts beginning in 2009 severely restricted State funding support of HISC, resulting in a serious setback of conservation efforts (HISC 2009; HISC 2015, <http://dlnr.hawaii.gov/hisc/projects/funding>). As an example of current and future challenges, a strain of the plant rust *Puccinia psidii*, also referred to as ohia rust, was first noticed affecting stands of rose apple and the native *Metrosideros* (ohia) seedlings (both in the plant family Myrtaceae) in nurseries in 2005. *Metrosideros* spp. are a dominant component of native forests in Hawaii, providing watershed protection and wildlife habitat. The Hawaii Board of Agriculture recommended a quarantine rule be passed against the introduction of all new strains of ohia rust (mostly through transmission on Myrtaceae species used in the horticulture trade), to prevent destruction of ohia forests and the danger to agriculture and horticulture industries (Environment Hawaii 2015, pp. 1, 8–9). However, this rule currently remains in draft form and under review (HDOA 2015, <http://hdoa.hawaii.gov/meetings-reports/proposedar>, accessed April 9, 2015).

#### Nonnative Aquatic Species

Existing State and Federal regulatory mechanisms do not adequately prevent the introduction of nonnative species to Hawaii via inter-State and international mechanisms, or intra-State movement of nonnative species between islands and watersheds in Hawaii. The importation of non-domestic animals, including aquatic species, is regulated by a permit system (HAR 4–71) managed through the HHDOA. The HDOA's Board of Agriculture maintains lists of non-domestic 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.*, pet and resale trade, retail sales, and food consumption), or institutions. However, Hawaii's Division of Aquatic Resources recognizes that unwanted nonnative species, both aquatic and terrestrial, are still entering the State and moving between islands (DLNR 2003, p. 2–12).

The Division of Aquatic Resources (DAR), within the State's DLNR, manages Hawaii's aquatic resources (HDAR 2015, in litt.), and is responsible for conserving, protecting, and enhancing the State's renewable resources of aquatic life and habitat (HDLNR 2003, p. 3–13). The release of live nonnative fish or other live

nonnative aquatic life into any waters of the State is prohibited (HRS 187A–6.5). The DAR has the authority to seize, confiscate, or destroy as a public nuisance; any fish or other aquatic life found in any State waters whose importation is prohibited or restricted pursuant to rules of the HDOA (HRS 187A–2, HRS 187A–6.5). State (HAR 71C) and Federal regulations (Executive Order (E.O.) 13112, 1999 and 2005) are in place to prevent the unauthorized entry of nonnative aquatic animals such as fish and amphibians; however, their intentional or inadvertent introduction and movement between islands and between watersheds continues (HDAR 2003, pp. 2–12–2–14). There is insufficient agency capacity to adequately enforce such regulations or to provide for sufficient inspection services and monitoring, although this priority need is recognized (Cravalho 2009, in litt.).

#### Nonnative Vertebrate Species

The State of Hawaii's laws prohibit the importation of all animals unless they are specifically placed on a list of allowable species (HLRB 2002; CGAPS 2010). The importation and interstate transport of invasive vertebrates is federally regulated by the Service under the Lacey Act as "injurious wildlife" (Fowler *et al.* 2007, pp. 353–359; 18 U.S.C. 42 *et seq.*–43 2006); the current list of vertebrates considered as "injurious wildlife" is provided at 50 CFR part 16. This law also prohibits importation of species listed as endangered or threatened from other areas, or species from within protected areas such as parks or forest reserves. The law in its current form prohibits importation of a limited number of taxa (USFWS 2012, 50 CFR part 16) including fruit bats, mongoose, European rabbits and hares, wild dogs, rats or mice, raccoon dogs, brushtail possum (New Zealand species), starlings, house sparrows, mynas, dioch, Java sparrows, red whiskered bulbuls, walking catfish, mitten crabs, zebra mussels, snakehead family taxa, four species of carp, salmonids, brown tree snakes, and pythons. In 2008, the Lacey Act was expanded to include prohibition of importation of "any plant that was illegally harvested," such as illegally logged woods (USFWS 2012, 50 CFR 16). Mongoose, rabbits, rats, mice, house sparrows, mynas, Java sparrows, red whiskered bulbuls are already established in Hawaii, and are difficult and costly to control, or are not controlled at all. Additionally, a species may 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). The continued spread of injurious species nationwide indicates the limited effectiveness of this regulation in preventing vertebrate introductions into the State (Fowler *et al.* 2007, p. 357). 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.).

As a recent example in Hawaii, an opossum (*Didelphis virginiana*) was found in a trap set for feral cats near Sand Island, Oahu, in July 2015. Opossums are not included on the Lacey Act's list of prohibited species injurious wildlife. Opossums, native to North America, occupy a variety of habitat such as stream areas, forests, and agricultural lands (Oregon Department of Fish and Wildlife 2015, in litt.). They are omnivores and scavengers, and eat a wide variety of food items including insects, small vertebrates, bird eggs, slugs and snails, snakes, and fruits and berries (Claremont College 2015, in litt.). Opossums are known to hitchhike in shipping containers, and have been found previously in containers on Oahu in 2005 and 2011 (Star Advertiser 2015, in litt.). If opossums were to establish wild populations in Hawaii, their predation on ground-nesting seabirds could negatively impact species such as the band-rumped storm-petrel.

#### Nonnative Invertebrate Species

It is likely that the introduction of most nonnative invertebrate pests to the State has been and continues to be accidental and incidental to other intentional and permitted activities. The prevention and control of introduction of nonnative invertebrates to Hawaii is the responsibility of Hawaii State government and Federal agencies, and is voluntarily addressed by a few private organizations as well. Even though these agencies have regulations and some controls in place, as discussed in "Introduction of Nonnative Species" and "Nonnative Aquatic Species," above, the introduction and movement of nonnative invertebrate pest species between islands and from one watershed to the next continues. By the early 1990s, an average of 20 new alien invertebrate species was introduced to Hawaii per year, an increase of 25 percent over the previous totals between 1930 and 1970 (TNCH 1992, p. 8). As an example, the threat of introduction of nonnative invertebrate species is evidenced by the 2013 discovery of the 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, + maps). The coconut rhinoceros beetle is considered one of the most damaging insects to coconut and African oil palm in southern and Southeast Asia, as well as the western Pacific Islands, and has the potential to devastate populations of native and nonnative palm species in Hawaii (Giblin-Davis 2001 in HISC 2014, in litt.). While a rapid response team headed by HDOA (with USDA, University of Hawaii, U.S. Navy, and other partners; 2014) has set up pheromone traps island-wide, and capture and range delineation efforts are ongoing, along with funding for support services to capture and control the CRB for fiscal year 2015 (HISC 2014, in litt.), existing regulatory mechanisms did not prevent its introduction into Hawaii. Existing regulatory mechanisms, such as HRS 187A–6.5 and HAR 71C (regarding release of nonnative aquatic species), and H.B. 1568 (pertaining to the State law to enforce biosecurity measures), therefore appear inadequate to prevent introductions of nonnative invertebrates. Efforts to ameliorate the threat of the beetle continue, but whether those efforts will be effective in controlling or eliminating this threat is unknown at this time.

#### Nonnative Plant Species

The State of Hawaii allows the 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; regulated crops include 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. The State Noxious Weed list (HAR 4–68) and USDA–APHIS–PPQ's Restricted Plants List restrict 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) includes few of the many globally known invasive plants, and plants in general do not require a weed risk assessment prior to importation from international ports. The USDA–APHIS–PPQ is in the process of finalizing rules to include a weed risk assessment for newly imported plants. Although the State has

general guidelines for the importation of plants, and regulations are in place regarding the plant crops mentioned above, the intentional or inadvertent introduction of nonnative plants outside the regulatory process and movement of species between islands and from one watershed to the next continues, and represents a threat to native flora and fauna for the reasons mentioned above. In addition, government funding is inadequate to provide for sufficient inspection services and monitoring. One study concluded that the plant importation laws virtually ensure new invasive plants will be introduced via the nursery and ornamental trade, and that outreach efforts cannot keep up with the multitude of new invasive plants being distributed (Martin 2007, in litt.). The author states the only effective method to address this issue is to use public outreach to encourage consumers to purchase and use only noninvasive or native plants in landscaping (Martin 2007, in litt.).

On the basis of the above information, existing State and Federal regulatory mechanisms are not preventing the introduction of nonnative species into Hawaii via interstate and international pathways, or via intrastate movement of nonnative species between islands and watersheds. Therefore, State and Federal regulatory mechanisms do not adequately protect the 49 species, or their habitats, addressed in this rule 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. Habitat-altering nonnative plant species (Factor A) and predation by nonnative animal species (Factor C) pose major ongoing threats to all 49 species addressed in this rule. Thirty-seven of the 39 plant species, the orangeblack Hawaiian damselfly, and the yellow-faced bees (*Hylaeus anthracinus*, *H. assimulans*, *H. facilis*, *H. hiliaris*, and *H. longiceps*) experience the threat of habitat destruction and modification by nonnative plants (Factor A), and 26 of the 39 plants, and all 10 animals, experience the threat of predation and herbivory by nonnative animals (Factor C). Therefore, we conclude the existing regulatory mechanisms discussed above are

inadequate to sufficiently reduce these threats to these species.

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

Other factors threatening 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 above.

#### 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 ocean prey (Telfer *et al.* 1987, p. 412). Artificial lights can cause confusion, exhaustion, and possible collision with structures, followed by fallout. The seabirds are then either too exhausted to fly or seriously injured, and, once grounded, 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 between species and age classes and according to the influence of season, lunar phase, and weather conditions. Young birds are more likely 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 young, 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.). However, 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, but any loss in such a small population is significant.

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 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 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 very site-dependent (Travers *et al.* 2014, pp. 19, 29–37; Service 2015, in litt., Slide 21). 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; Croxall *et al.* 2012, p. 24). Seabirds are caught in most types of fishing gear, notably in nets and on long-lines, where they suffer mortality by drowning. Seabirds attending fishing vessels also come into contact with and consume deep-water fish they would not normally have access to, 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, we believe they can have the same effects as have been shown for other seabirds. In addition, pollution of the open ocean by plastics and other marine debris that can be mistaken for food by band-rumped storm-petrels may 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. 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).

#### 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. Rubble 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), could more drastically affect water quality and result 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 may be degrading the health of Hawaiian anchialine pool systems in which the anchialine pool shrimp, *Procaris hawaiiiana*, 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; however, due to its remote location, is not monitored regularly by State agency staff. The release of mosquito fish (*Gambusia affinis*) and tilapia (*Tilapia mossambica*) 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 hypogean (subterranean) shrimp species disappeared (Brock 2004, p. iii). Nonnative fishes 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 fishes prey on and exclude native hypogean 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, which prey on and exclude the herbivorous aquatic animals upon which *Procaris hawaiiiana* feed. 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, and we expect that this activity continues (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 and 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 by species endemic to single islands that face numerous threats such as those described in this proposal (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 may exhibit reduced levels of genetic variability, which can diminish 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 in this proposal like *Myrsine fosbergii* of which some individuals are functionally dioecious (staminate (male) and pistillate (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 impacted 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 even more 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*, and *Nothocestrum latifolium* 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 two individuals of *Phyllostegia brevidens*. *Kadua haupuensis*, *Phyllostegia brevidens*, 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 hawaiiana*), 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 breeding season, could cause reproductive failure and the mortality of a significant percentage of the extant 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 5 of 8 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 that 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, fire, droughts, floods, and hurricanes; predation by nonnative fish and backswimmers; 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 hawaiiana*, 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. hawaiiana* include: Habitat destruction and modification by agriculture and urban development; commercial trade; dumping of nonnative fish and trash into anchialine pools; and water extraction. The effects of these threats are compounded by the low number of individuals and populations of *P. hawaiiana*.

We consider the seven Hawaiian yellow-faced bees vulnerable to extinction due to impacts associated with low numbers of individuals and populations. The 7 yellow-faced bee species currently occur in only 22 locations (with some overlap) on 6 main Hawaiian Islands, and are likely more vulnerable to habitat change and stochastic events due to low numbers and occurrences (Daly and Magnacca 2003, p. 3; Magnacca 2007a, 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, 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 *Microlepidia strigosa* var. *mauiensis* because it may lead to extinction of the original genotypically distinct variety, as noted by biologists’ observations of the Oahu occurrences (Kawelo 2009, in litt.). Only 15 to 20 individuals on Oahu express the true phenotype of the variety (Ching 2011, 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: *Cyrtandra hematos*, *Gardenia remyi*, *Joinvillea ascendens* ssp. *ascendens*, *Labordia lorenciana*, *Lepidium orbiculare*, and *Nothoestrum latifolium* (see “Low Numbers of Individuals and Populations,” “Plants,” above), proposed for listing in this rule. 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 2010, 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 2007b, 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 may exclude *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 2007b, 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 “C. Disease or Predation,” above). Lach (2008, p. 155) observed that *Hylaeus* bees that regularly collect pollen from flowers of the native tree *Metrosideros polymorpha* were entirely absent from trees with flowers visited by the big-headed ant (*Pheidole megacephala*), while visits by the European honey bee were not affected. As a result, Lach (2008, p. 155) concluded that the European honey bee may have a competitive advantage over *Hylaeus* species, as 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 2007b, p. 188; Magnacca and King 2013, pp. 19–22). While it has been suggested these nonnative bees may impact native *Hylaeus* bees through competition for pollen base on their similar size and flower preferences, there is no information that demonstrates these nonnative bees forage on *Hylaeus* host plants (Magnacca 2007b, p. 188; Magnacca and King 2013, pp. 19–22). It has also been suggested parasitoid wasps may compete for nectar with native *Hylaeus* species; however, information demonstrating nonnative parasitoid wasps forage on the same host plants as *H. anthracinus*, *H. assimulans*, *H. facilis*, *H. hilaris*, *H.*

*kuakea*, *H. longiceps*, and *H. mana* is unavailable (Daly and Magnacca 2003, p. 10).

#### 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 are a threat to yellow-faced bees, by outcompeting 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 Factors A and C). 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) can increase the intensity, extent, and frequency of fire, converting native shrubland and forest to land dominated by nonnative grasses; and (3) may cause the loss of the native host plants upon which the yellow-faced bees depend (Factor A). Drought, fire, and water extraction may lead to loss of host plants within the known ranges of populations of yellow-faced bees, and are discussed in “A. The Present or Threatened Destruction, Modification, or Curtailed of Its Habitat or Range,” above.

#### Climate Change

Our analyses under the Act include consideration of ongoing and projected changes in climate. The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). “Climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2013, p. 1450). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (*e.g.*, temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2013, p. 1450). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (*e.g.*, habitat fragmentation) (IPCC 2007, pp. 8–14, 18–19). In our analyses, we use our expert judgment to weigh relevant information, including

uncertainty, in our consideration of various aspects of climate change.

Climate change will be a particular challenge for the conservation of biodiversity because the introduction and interaction of additional stressors may push species beyond their ability to survive (Lovejoy *et al.* 2005, pp. 325–326). The synergistic implications of climate change and habitat fragmentation are the most threatening facets of climate change for biodiversity (Hannah *et al.* 2005, p. 4). The magnitude and intensity of the impacts of global climate change and increasing temperatures on native Hawaiian ecosystems are the subjects of active research.

The average ambient air temperature (at sea level) is projected to increase globally by about 4.1 degrees Fahrenheit (°F) (2.3 °Celsius (C)) with a range of 2.7 °F to 6.7 °F (1.5 °C to 3.7 °C) by 2100 worldwide (IPCC 2007, in litt.). These changes would increase the monthly average temperature of the Hawaiian Islands from the current value of 74 °F (23.3 °C) to between 77 °F to 86 °F (25 °C to 30 °C). Temperature has been rising over the last 100 years, with the greatest increase occurring after 1975 (Alexander *et al.* 2006, pp. 1–22; Giambelluca *et al.* 2008, p. 1). 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 the 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).

The forecast of changes in precipitation is highly uncertain because it depends, in part, on how the El Niño-La Niña weather cycle (a disruption of the ocean atmospheric system in the tropical Pacific having important global consequences for weather and climate) might change (State of Hawaii 1998, pp. 2–10). However, over the past 100 years, the Hawaiian Islands have experienced an annual decline in precipitation of just over 9 percent (US–NSTC 2008, p. 61) and a steady decline of about 15 percent over the last 15 to 20 years (Chu and Chen 2005, pp. 4802–4803; Diaz *et al.* 2006, pp. 1–3). 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). Stream-gauge data provide 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). 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 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 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). 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 Hawaiian plants,” above; Table 3), 28 of the 39 plant species in this proposal were included in the recent analysis of the vulnerability of Hawaiian plants to climate change conducted by Fortini *et al.* (2013, 134 pp.). All 28 species scored as moderately to highly 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 threatened or endangered, 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 other 11 plant species proposed for listing 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, likely to be substantively altered by climate change.

In summary, based on the best available information, we conclude that changes in environmental conditions that result from projected climate change are likely to negatively affect all 49 species we are proposing to list as endangered in this rule. 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 49 species, thus exacerbating current threats to these species. The probability of a species going extinct as a result of these effects increases when its range is restricted, its habitat decreases, and its abundance declines (IPCC 2014, pp. 14–15). These 49 species all persist with small population sizes and highly restricted or fragmented ranges. They thus face increased risk from stochastic events such as hurricanes, which can extinguish an important proportion of the remaining individuals, and from environmental changes because these species may lack ecological or genetic adaptive capacity (Fortini *et al.* 2013, pp. 3–5).

In addition to indirect impacts resulting from changes in habitat and disturbance regimes, these species may experience direct impacts of climate change, for example, physiological stress in the orangeblack Hawaiian damselfly caused by increased stream 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). These aspects of climate change and their impacts on native species and ecosystems may be exacerbated by human demand 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). Although we do not consider climate change to be a current threat, we anticipate that climate change impacts are likely to contribute to the multiple stressors affecting the status of all of these species, and are likely to become a threat to most or all of them in the future.

#### Summary of Factor E

We consider the threat from artificial lighting and structures to be an ongoing threat to the band-rumped storm-petrel in Hawaii, proposed for listing in this rule, because these threats can cause injury and mortality, resulting in a loss of breeding individuals and juveniles, and this threat is expected to continue into the future. The potential threats of injury or mortality, or loss of food sources, caused by the activities of commercial fisheries, and injury or mortality from ingestion of plastics and marine debris, can 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 hawaiiensis* proposed for listing in this rule to be 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 can lead to accelerated sedimentation in the pool, exacerbating conditions leading to its senescence. Nonnative fish prey on, or outcompete, native herbivorous anchialine pool shrimp that serve as the prey base for predatory species of anchialine pool shrimp, and may also prey on *Procaris hawaiiensis*. Changing the anchialine pool system by dumping of trash, introduction of nonnative fish, and sedimentation may also affect habitat for the orangeblack Hawaiian damselfly.

We consider the impacts from limited numbers of individuals and populations to be an ongoing threat to all 39 plant species proposed for listing in this rule, and especially 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*, *Nothoctrum latifolium*, *Phyllostegia brevidens*, *P. helleri*, *Pritchardia bakeri*, *Santalum involutum*, *Stenogyne kaalae* ssp. *sherffii*, and *Wikstroemia skottsbergiana*. 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 probability of long-term persistence is diminished, potentially resulting in extirpation and extinction. 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 an ongoing threat to all 10 animal species proposed for listing in this rule.

The threat to the band-rumped storm-petrel from limited numbers and populations is ongoing and is expected to continue into the future.

We also consider the impacts from limited numbers of individuals and populations to be an ongoing threat to the orangeblack Hawaiian damselfly, the anchialine pool shrimp *Procaris hawaiiensis*, and to the yellow-faced bees *Hylaeus anthracinus*, *H. assimulans*, *H. facialis*, *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 may experience reduced reproductive vigor due to inbreeding depression; and (4) they may 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 *Microlepis strigosa* var. *mauiensis*, as has been observed at occurrences on Oahu.

We consider the threat to *Cyanea kauaulaensis*, *Cyrtandra hematos*, *Gardenia remyi*, *Joinvillea ascendens* ssp. *ascendens*, *Labordia lorenciana*, *Lepidium orbiculare*, and *Nothoctrum latifolium* from lack of regeneration to be ongoing 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 invertebrates an ongoing threat to the yellow-faced bees, *Hylaeus anthracinus*, *H. assimulans*, *H. facialis*, *H. hilaris*, *H. kuakea*, *H. longiceps*, and *H. mana*, proposed for listing in this rule. 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.

The projected effects of increasing temperature and other aspects of climate change on the 49 species may be direct, such as physiological stress caused by increased temperature or lack of moisture, or indirect, such as the modification or destruction of habitat, increased competition by nonnative species, and changes in disturbance regimes that lead to changes in habitat (e.g., fire, drought, flooding, and hurricanes). The specific and cumulative effects of climate change on each of these 49 species are presently unknown, but we anticipate that these effects, if realized, will exacerbate the current threats to these species and become a threat to most or all of them in the future.

#### Proposed 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 proposed for listing. 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 is a threat to four plants (*Nothoctrum latifolium*, *Portulaca villosa*, *Pseudognaphalium*

*sandwicensium* var. *molokaiense*, and *Solanum nelsonii*) and six animals (the orangeblack Hawaiian damselfly, the anchialine pool shrimp (*Procaris hawaiiiana*), *Hylaesus anthracinus*, *H. assimulans*, *H. hilaris*, and *H. longiceps*) (Factor A). Habitat destruction and modification by nonnative feral ungulates or nonnative plants poses a threat to 46 of the 49 species (all except for *Cyanea kauaulaensis*, *Hypolepis hawaiiensis* var. *mauiensis*, and the anchialine pool shrimp) (Factor A). Fifteen of the plant species (*Exocarpos menziesii*, *Festuca hawaiiensis*, *Joinvillea ascendens* ssp. *ascendens*, *Labordia lorenciana*, *Nothoecstrum latifolium*, *Ochrosia haleakalae*, *Phyllostegia stachyoides*, *Portulaca villosa*, *Ranunculus mauiensis*, *Sanicula sandwicensis*, *Santalum involutum*, *Schiedea pubescens*, *Sicyos lanceoloideus*, *S. macrophyllus*, and *Solanum nelsonii*), the orangeblack Hawaiian damselfly, and all seven yellow-faced bees, are threatened by habitat destruction and modification from fire. Nineteen of the plant species (*Cyanea kauaulaensis*, *Cyclosorus boydiae*, *Deparia kaalaana*, *Gardenia remyi*, *Joinvillea ascendens* ssp. *ascendens*, *Kadua fluviatilis*, *K. huapuensis*, *Labordia lorenciana*, *Lepidium orbiculare*, *Ochrosia haleakalae*, *Phyllostegia brevidens*, *P. helleri*, *P. stachyoides*, *Portulaca villosa*, *Pseudognaphalium sandwicensium* var. *molokaiense*, *Ranunculus hawaiiensis*, *R. mauiensis*, *Sanicula sandwicensis*, and *Schiedea pubescens*, and *Solanum nelsonii*) and the band-rumped storm-petrel are threatened by the destruction and modification of their habitats from either singly or in combination: landslides, rockfalls, treefalls, or flooding (Factor A). Habitat loss or degradation, or loss of host plants, or mortality, and water extraction, due to drought is a threat to *Deparia kaalaana*, *Huperzia stemmermanniae*, *Phyllostegia stachyoides*, *Ranunculus hawaiiensis*, *R. mauiensis*, *Sanicula sandwicensis*, *Schiedea pubescens*, *Sicyos lanceoloideus*, and *Solanum nelsonii*; and to the orangeblack Hawaiian damselfly; and all seven yellow-faced bees (Factor A and Factor E). 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). Overcollection for commercial purposes poses a threat to the anchialine pool shrimp, *Procaris hawaiiiana* (Factor B). Predation and herbivory is an ongoing threat to 33 of the 39 plant species (by feral pigs, goats,

axis deer, black-tailed deer, cattle, sheep and mouflon, rats, and slugs; see Table 3); to the band-rumped storm petrel (by owls, cats, rats, and mongoose); to the orangeblack Hawaiian damselfly (by backswimmers); and to the seven yellow-faced bees (by ants and wasps) (Factor C). Predation by nonnative fish is a potential threat to the orangeblack Hawaiian damselfly and the anchialine pool shrimp (Factor C). The inadequacy of existing regulatory mechanisms (*i.e.*, inadequate protection of habitat and inadequate protection from the introduction of nonnative species) poses an ongoing threat to all 49 species (Factor D). Injury and mortality caused by artificial lighting and structures are ongoing threats to the band-rumped storm-petrel (Factor E). There are 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*, *Lepidium orbiculare*, and *Nothoecstrum latifolium*) is exacerbated by lack of regeneration in the wild (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 may use 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 (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. In addition, we are concerned about the projected effects of rising temperature and other aspects of climate change on all 49 species (Factor E). We recognize that limited information exists on the exact nature of impacts that these species may experience, but we anticipate that climate change effects are likely to exacerbate the current threats to these species and may become a threat to most of all of them in the future.

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 Hawaiian DPS

of band-rumped storm petrel is presently in danger of extinction throughout its entire range, based on the immediacy, severity, and scope of the threats described above. Therefore, on the basis of the best available scientific and commercial information, we propose to list 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*, *Microlepis strigosa* var. *mauiensis*, *Myrsine fosbergii*, *Nothoecstrum latifolium*, *Ochrosia haleakalae*, *Phyllostegia brevidens*, *Phyllostegia helleri*, *Phyllostegia stachyoides*, *Portulaca villosa*, *Pritchardia bakeri*, *Pseudognaphalium sandwicensium* var. *molokaiense*, *Ranunculus hawaiiensis*, *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 band-rumped storm-petrel (*Oceanodroma castro*), the orangeblack Hawaiian damselfly (*Megalagrion xanthomelas*), the anchialine pool shrimp (*Procaris hawaiiiana*), and the yellow-faced bees *Hylaesus anthracinus*, *Hylaesus assimulans*, *Hylaesus facilis*, *Hylaesus hilaris*, *Hylaesus kuakea*, *Hylaesus longiceps*, and *Hylaesus 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 proposed to list that DPS. Each of the other 48 species endemic to the Hawaiian Islands proposed for 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 proposed 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 on Interpretation of the Phrase "Significant Portion of Its Range" in the Endangered Species Act's Definitions of "Endangered Species" and "Threatened Species" (79 FR 37578, July 1, 2014).

#### Available Conservation Measures

Conservation measures provided to species listed as endangered or threatened under the Act include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain activities. 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 other countries and calls for recovery actions to be carried out for listed species. The protection required by Federal agencies and the prohibitions against certain activities involving listed animals and plants are discussed, in part, below.

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

Recovery planning includes the development of a recovery outline

shortly after a species is listed and preparation of a draft and final recovery plan. The recovery outline guides the immediate implementation of urgent recovery actions and describes the process to be used to develop a recovery plan. Revisions of the plan may be done to address continuing or new threats to the species, as new substantive information becomes available. The recovery plan also identifies recovery criteria for review of when a species may be ready for downlisting or delisting, and methods for monitoring recovery progress. Recovery plans also establish a framework for agencies to coordinate their recovery efforts and provide estimates of the cost of implementing recovery tasks. Recovery teams (comprised of species experts, Federal and State agencies, nongovernmental organizations, and stakeholders) are often established to develop recovery plans. When completed, the recovery outlines, draft recovery plans, and the final recovery plans 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 private and State lands.

If these species are listed, funding for recovery actions will be available from a variety of sources, including Federal budgets, State programs, and cost share grants for non-Federal landowners, the academic community, and nongovernmental organizations. In addition, pursuant to section 6 of the Act, the State of Hawaii would be eligible for Federal funds to implement management actions that promote the protection or recovery of the 49 species. Information on our grant programs that are available to aid species recovery can be found at: <http://www.fws.gov/grants>.

Although these species are only proposed for listing under the Act at this time, please let us know if you are interested in participating in recovery efforts for these 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 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)(4) of the Act requires Federal agencies to confer with the Service on any action that is likely to jeopardize the continued existence of a species proposed for listing or result in destruction or adverse modification of proposed critical habitat. If a species is listed subsequently, section 7(a)(2) of the Act requires Federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of the species or destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into consultation with the Service.

For the 49 plants and animals proposed for listing as endangered species in this rule, Federal agency actions that may require consultation 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 must be issued for the following purposes: For scientific purposes, to enhance the propagation or survival of the species, and 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 in 50 CFR 17.62. The Hawaii ESA prohibits take of plants; however, the Hawaii ESA affords no protection of habitat (HRS 195D-4(a)).

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 proposed listing on proposed and ongoing activities within the range of species proposed for listing. Based on the best available information, the following activities may potentially result in a violation of section 9 of the Act, this list is not comprehensive:

(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 10(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 hawaiiiana*), 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.

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

(4) Introduction of nonnative species that compete with or prey upon the 29 49 species proposed for listing, such as the introduction of competing, nonnative plants or animals to the State of Hawaii.

(5) The unauthorized release of biological control agents that attack any life stage of these 49 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**).

#### Critical Habitat

Section 3(5)(A) of the Act defines critical habitat as (i) the specific areas within the geographical area occupied by the species, at the time it is listed . . . on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed upon a determination by the Secretary that such areas are essential for the conservation of the species. Section 3(3) of the Act defines

conservation as to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to the Act are no longer necessary.

Section 4(a)(3) of the Act, as amended, and implementing regulations (50 CFR 424.12), require that, to the maximum extent prudent and determinable, the Secretary will designate critical habitat at the time the species is determined to be an endangered or threatened species. Our regulations (50 CFR 424.12(a)(1)) state that the designation of critical habitat is not prudent when one or both of the following situations exist:

(1) The species is threatened by taking or other human activity, and identification of critical habitat can be expected to increase the degree of threat to the species, or

(2) Such designation of critical habitat would not be beneficial to the species.

Besides the unpermitted collection of the anchialine pool shrimp *Procaris hawaiiiana* for trade for the aquarium hobby market, we do not know of any imminent threat of take attributed to collection or vandalism under Factor B for these plant and animal species. The available information does not indicate that identification and mapping of critical habitat is likely to increase the threat of collection for the pool shrimp or initiate any threat of collection or vandalism for any of the other 48 species proposed for listing in this rule. Therefore, in the absence of finding that the designation of critical habitat would increase threats to a species, if there are any benefits to a critical habitat designation, a finding that designation is prudent is warranted. Here, the potential benefits of designation include: (1) Triggering consultation under section 7 of the Act, in new areas for actions in which there may be a Federal nexus where it would not otherwise occur because, for example, it is unoccupied; (2) focusing conservation activities on the most essential features and areas; (3) providing educational benefits to State or county governments or private entities; and (4) preventing people from causing inadvertent harm to these species.

Because we have determined that the designation of critical habitat will not likely increase the degree of threat to the species and may provide some measure of benefit, we determine that designation of critical habitat is prudent for all 49 species proposed for listing in this rule.

Our regulations (50 CFR 424.12(a)(2)) further state that critical habitat is not

determinable when one or both of the following situations exists: (1) Information sufficient to perform required analysis of the impacts of the designation is lacking; or (2) the biological needs of the species are not sufficiently well known to permit identification of an area as critical habitat.

Delineation of critical habitat requires identification of the physical and biological features, within the geographical area occupied by the species and areas outside the geographical area occupied by the species, that are essential for their conservation. Information regarding these 49 species' life functions is complex, and complete data are lacking for many of them. We require additional time to analyze the best available scientific data in order to identify specific areas appropriate for critical habitat designation and to prepare and develop a proposed rule. Accordingly, we find designation of critical habitat to be "not determinable" at this time.

**Required Determinations**

*Clarity of the Rule*

We are required by Executive Orders 12866 and 12988 and by the Presidential Memorandum of June 1, 1998, to write all rules in plain language. This means that each rule we publish must:

- (1) Be logically organized;
- (2) Use the active voice to address readers directly;
- (3) Use clear language rather than jargon;
- (4) Be divided into short sections and sentences; and
- (5) Use lists and tables wherever possible.

If you feel that we have not met these requirements, send us comments by one of the methods listed in the ADDRESSES section. To better help us revise this proposed rule, your comments should be as specific as possible. For example, you should tell us the numbers of the sections or paragraphs that are unclearly written, which sections or sentences are too long, the sections where you feel lists or tables would be useful, etc.

*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> and upon request from the Pacific Islands Fish and Wildlife Office (see **FOR FURTHER INFORMATION CONTACT**).

**Authors**

The primary authors of this proposed 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.

**Proposed Regulation Promulgation**

Accordingly, we propose to amend part 17, subchapter B of chapter I, title 50 of the Code of Federal Regulations, as set forth below:

**PART 17—[AMENDED]**

- 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 entries an entry for "Storm-petrel, band-rumped" (*Oceanodroma castro*) in alphabetical order under BIRDS; and
  - b. By adding entries for "Bee, yellow-faced" (*Hylaeus anthracinus*), "Bee, yellow-faced" (*Hylaeus assimulans*), "Bee, yellow-faced" (*Hylaeus facilis*), "Bee, yellow-faced" (*Hylaeus hiliaris*), "Bee, yellow-faced" (*Hylaeus kuakea*), "Bee, yellow-faced" (*Hylaeus longiceps*), and "Bee, yellow-faced" (*Hylaeus mana*), and "Damsel fly, orangeblack Hawaiian" (*Megalagrion xanthomelas*) in alphabetical order under INSECTS; and
    - c. By adding an entry for "Shrimp, anchialine pool" (*Procaris hawaiiiana*), in alphabetical order under CRUSTACEANS.

The additions read as follows:

**§ 17.11 Endangered and threatened wildlife.**

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

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
*							
BIRDS							
*							
Storm-petrel, band-rumped.	<i>Oceanodroma castro</i> .	U.S.A. (HI) .....	Entire .....	E	.....	NA	NA
*							
INSECTS							
Bee, yellow-faced ....	<i>Hylaeus anthracinus</i>	U.S.A. (HI) .....	Entire .....	E	.....	NA	NA
Bee, yellow-faced ....	<i>Hylaeus assimulans</i>	U.S.A. (HI) .....	Entire .....	E	.....	NA	NA
Bee, yellow-faced ....	<i>Hylaeus facilis</i> .....	U.S.A. (HI) .....	Entire .....	E	.....	NA	NA
Bee, yellow-faced ....	<i>Hylaeus hiliaris</i> .....	U.S.A. (HI) .....	Entire .....	E	.....	NA	NA
Bee, yellow-faced ....	<i>Hylaeus kuakea</i> .....	U.S.A. (HI) .....	Entire .....	E	.....	NA	NA
Bee, yellow-faced ....	<i>Hylaeus longiceps</i> ..	U.S.A. (HI) .....	Entire .....	E	.....	NA	NA
Bee, yellow-faced ....	<i>Hylaeus mana</i> .....	U.S.A. (HI) .....	Entire .....	E	.....	NA	NA



Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
Damselfly, orangeblack Hawaiian.	<i>Megalagrion xanthomelas</i> .	U.S.A. (HI) .....	Entire .....	E	.....	NA	NA
CRUSTACEANS							
Shrimp, anchialine pool.	<i>Procaris hawaiana</i> ..	U.S.A. (HI) .....	Entire .....	E	.....	NA	NA

■ 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*, *Nothoecstrum latifolium*, *Ochrosia haleakalae*, *Phyllostegia brevidens*, *Phyllostegia*

*helleri*, *Phyllostegia stachyoides*, *Portulaca villosa*, *Pritchardia bakeri*, *Pseudognaphalium sandwicensium* var. *molokaiense*, *Ranunculus hawaiiensis*, *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) \* \* \*

Species		Historic range	Family	Status	When listed	Critical habitat	Special rules
Scientific name	Common name						
FLOWERING PLANTS							
<i>Calamagrostis expansa</i> .	Maui reedgrass .....	U.S.A. (HI) .....	Poaceae .....	E	.....	NA	NA
<i>Cyanea kauaulaensis</i> .	None .....	U.S.A. (HI) .....	Campanulaceae .....	E	.....	NA	NA
<i>Cyperus neokunthianus</i> .	None .....	U.S.A. (HI) .....	Cyperaceae .....	E	.....	NA	NA
<i>Cyrtandra hematos</i> ..	Haiwale .....	U.S.A. (HI) .....	Gesneriaceae .....	E	.....	NA	NA
<i>Exocarpos menziesii</i>	Heau .....	U.S.A. (HI) .....	Santalaceae .....	E	.....	NA	NA
<i>Festuca hawaiiensis</i>	None .....	U.S.A. (HI) .....	Poaceae .....	E	.....	NA	NA
<i>Gardenia remyi</i> .....	Nanu .....	U.S.A. (HI) .....	Rubiaceae .....	E	.....	NA	NA
<i>Joinvillea ascendens</i> ssp. <i>ascendens</i> .	Ohe .....	U.S.A. (HI) .....	Joinvilleaceae .....	E	.....	NA	NA
<i>Kadua fluviatilis</i> .....	Kamapuaa .....	U.S.A. (HI) .....	Rubiaceae .....	E	.....	NA	NA
<i>Kadua haupuensis</i> ...	None .....	U.S.A. (HI) .....	Rubiaceae .....	E	.....	NA	NA
<i>Labordia lorenciana</i>	None .....	U.S.A. (HI) .....	Loganiaceae .....	E	.....	NA	NA

Species		Historic range	Family	Status	When listed	Critical habitat	Special rules
Scientific name	Common name						
<i>Lepidium orbiculare</i>	Anaunau	U.S.A. (HI)	Brassicaceae	E		NA	NA
<i>Myrsine fosbergii</i>	Kolea	U.S.A. (HI)	Myrsinaceae	E		NA	NA
<i>Nothoecstrum latifolium</i>	Aiea	U.S.A. (HI)	Solanaceae	E		NA	NA
<i>Ochrosia haleakalae</i>	Holei	U.S.A. (HI)	Apocynaceae	E		NA	NA
<i>Phyllostegia brevidens</i>	None	U.S.A. (HI)	Lamiaceae	E		NA	NA
<i>Phyllostegia helleri</i>	None	U.S.A. (HI)	Lamiaceae	E		NA	NA
<i>Phyllostegia stachyoides</i>	None	U.S.A. (HI)	Lamiaceae	E		NA	NA
<i>Portulaca villosa</i>	Ihi	U.S.A. (HI)	Portulacaceae	E		NA	NA
<i>Pritchardia bakeri</i>	Baker's loulu	U.S.A. (HI)	Arecaceae	E		NA	NA
<i>Pseudognaphalium sandwicensium</i> var. <i>molokaiense</i>	Enaena	U.S.A. (HI)	Asteraceae	E		NA	NA
<i>Ranunculus hawaiiensis</i>	Makou	U.S.A. (HI)	Ranunculaceae	E		NA	NA
<i>Ranunculus mauiensis</i>	Makou	U.S.A. (HI)	Ranunculaceae	E		NA	NA
<i>Sanicula sandwicensis</i>	None	U.S.A. (HI)	Apiaceae	E		NA	NA
<i>Santalum involutum</i>	Iliahi	U.S.A. (HI)	Santalaceae	E		NA	NA
<i>Schideia diffusa</i> ssp. <i>diffusa</i>	None	U.S.A. (HI)	Caryophyllaceae	E		NA	NA
<i>Schiedea pubescens</i>	Maolioli	U.S.A. (HI)	Caryophyllaceae	E		NA	NA
<i>Sicyos lanceoloideus</i>	Anunu	U.S.A. (HI)	Cucurbitaceae	E		NA	NA
<i>Sicyos macrophyllus</i>	Anunu	U.S.A. (HI)	Cucurbitaceae	E		NA	NA
<i>Solanum nelsonii</i>	Popolo	U.S.A. (HI)	Solanaceae	E		NA	NA
<i>Stenogyne kaalae</i> ssp. <i>sherffii</i>	None	U.S.A. (HI)	Lamiaceae	E		NA	NA
<i>Wikstroemia skottbergiana</i>	Akia	U.S.A. (HI)	Thymelaceae	E		NA	NA
FERNS AND ALLIES							

Species		Historic range	Family	Status	When listed	Critical habitat	Special rules
Scientific name	Common name						
<i>Asplenium diellaciniatum</i> .	None	U.S.A. (HI)	Aspleniaceae	E		NA	NA
<i>Cyclosorus boydiae</i>	Kupukupu makalii	U.S.A. (HI)	Thelypteridaceae	E		NA	NA
<i>Deparia kaalaana</i>	None	U.S.A. (HI)	Athyraceae	E		NA	NA
<i>Dryopteris glabra</i> var. <i>pusilla</i> .	Hohiu	U.S.A. (HI)	Dryopteridaceae	E		NA	NA
<i>Huperzia stemmermanniae</i> .	None	U.S.A. (HI)	Lycopodiaceae	E		NA	NA
<i>Hypolepis hawaiiensis</i> var. <i>mauiensis</i> .	Olua	U.S.A. (HI)	Dennstaedtiaceae	E		NA	NA
<i>Microlepia strigosa</i> var. <i>mauiensis</i> .	None	U.S.A. (HI)	Dennstaedtiaceae	E		NA	NA

\* \* \* \* \*

Dated: August 25, 2015.

**James W. Kurth,**

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

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