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


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 hawaiiana), and seven yellow-faced bees (Hylaeus anthracinus, H. assimilans, H. facilis, H. hilaris, 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 date. We must receive requests for public hearings, in writing, at the

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!”


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).

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 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 (hooved mammals, e.g., pigs, goats, deer, black-tailed deer, moufflon, 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 (Megalagron xanthomelas), the anchialine pool shrimp (Procaris hawaiiensis), and seven yellow-faced bees, Hyleaenus anthropicus, H. assimilans, H. facilis, H. hilaris, H. kuakea, H. longiceps, and H. mana; and the following 39 plant species: Asplenium dielaciniatum (no common name (NCN)), Calanagrostis expansa (Mau reedgrass), Cyanea kauauensis (NCN), Cyclomorus (previously Christella) boydii (kupukupu makalii), Cyporus neokunthianus (NCN), Cyrtandra hematos (haiwale), Deparia kaalaena (NCN), Dryopteris glabra var. pusilla (hoihi), Exocarpos menziesii (heau), Festuca hawaiiensis (NCN), Gardenia remyi (nanu), Huperzia stemmermannii (NCN), Hypolepis hawaiiensis var. mauriensis (olua), Joinvillea ascendens ssp. ascendens (ohe), Kadua (previously Hedyotis) fluviatilis (kamapuaa, pilo), Kadua haupensis (NCN), Labordia lorenciana (NCN), Lepidium orbiculare (anaunau), Microlephia strigosa var. mauriensis (NCN), Myrsine fosbergii (kolea), Nothocentrum latifolium (aiea), Ochromia haleakalae (holi), Phyllostegia brevifolia (NCN), Phyllostegia helleri (NCN), Phyllostegia stachyoides (NCN), Portulaca villosa (ihi), Pritchardia bakeri (Baker’s ioulou), Pseudognaphalium sandwicensium var. molokaensei (enena), Ranunculus hawaiiensis (makou), Ranunculus mauiensis (makou), Sanicula sandwicensis (NCN), Santalum involutum (iliahi), Schiedea diffusa ssp. diffusa (NCN), Schiedea pubescens (maolioli), Sicyos lanceolaeodes (anunu), Sicyos macrophyllus (anunu), Solanum nelsonii (popolo), Stenogyne kaalae ssp. sherffii (NCN), and Wikstroemia skottsbergiana (ekia). The candidate status of those 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.

...
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

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Common name</th>
<th>Hawaiian Island</th>
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<tbody>
<tr>
<td>Asplenium dielaciniatum</td>
<td>No common name (NCN)</td>
<td>Kauai.</td>
</tr>
<tr>
<td>Calamagrostis expansa</td>
<td>Maui reedgrass</td>
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</tr>
<tr>
<td>Cyanea kauaena</td>
<td>NCN</td>
<td>Maui.</td>
</tr>
<tr>
<td>Cyclosorus boydiae</td>
<td>kupukupu makali</td>
<td>Hawaii (H), Maui, Oahu.</td>
</tr>
<tr>
<td>Cyperus neokunthianus</td>
<td>NCN</td>
<td>Hawaii (H), Molokai.</td>
</tr>
<tr>
<td>Cyrtandra hematos</td>
<td>hawaiolii</td>
<td>Hawaii (H), Molokai.</td>
</tr>
<tr>
<td>Deparia kaalana</td>
<td>NCN</td>
<td>Hawaii (H), Kauai (H).</td>
</tr>
<tr>
<td>Dryopteris glabra var. pusilla</td>
<td>hohiu</td>
<td>Kauai.</td>
</tr>
<tr>
<td>Exocarpos menziesii</td>
<td>heau</td>
<td>Hawaii, Lanai (H).</td>
</tr>
<tr>
<td>Festuca hawaiiensis</td>
<td>NCN</td>
<td>Hawaii, Maui (H).</td>
</tr>
<tr>
<td>Gardenia remyi</td>
<td>nanu</td>
<td>Hawaii, Maui, Molokai, Kauai.</td>
</tr>
<tr>
<td>Huperzia stemmermanniae</td>
<td>NCN</td>
<td>Hawaii, Maui (H).</td>
</tr>
<tr>
<td>Hypolepis hawaiiensis var. mauliensis</td>
<td>olu</td>
<td>Hawaii (H), Oahu.</td>
</tr>
<tr>
<td>Joinvillea ascendens ssp. ascendens</td>
<td>ohe</td>
<td>Oahu, Kauai.</td>
</tr>
<tr>
<td>Kadua fluviatilis</td>
<td>kamapua, pilo</td>
<td>Kauai (H).</td>
</tr>
<tr>
<td>Kadua haupuensis</td>
<td>NCN</td>
<td>Kauai.</td>
</tr>
<tr>
<td>Labordia lorenciana</td>
<td>NCN</td>
<td>Kauai.</td>
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<tr>
<td>Lepidium orbiculare</td>
<td>anaunau</td>
<td>Kauai.</td>
</tr>
<tr>
<td>Microlepia strigosa</td>
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</tr>
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<td>Myrsine fosbergii</td>
<td>NCN</td>
<td>Oahu, Kauai.</td>
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<tr>
<td>Nothocestrum latifolium</td>
<td>aiea</td>
<td>Maui, Lanai (H), Molokai, Oahu, Kauai (H).</td>
</tr>
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<td>Octrosia haleakalae</td>
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<td>Phyllostegia brevidens</td>
<td>NCN</td>
<td>Hawaii (H), Maui.</td>
</tr>
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<td>Phyllostegia helleri</td>
<td>NCN</td>
<td>Kauai.</td>
</tr>
<tr>
<td>Phyllostegia stachyoides</td>
<td>NCN</td>
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</tr>
<tr>
<td>Portulaca villosa</td>
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<td>Hawaii, Maui, Kahoolawe, Lanai, Molokai, Oahu (H), Kaua (H), Lehua (H), Nihoa (H).</td>
</tr>
<tr>
<td>Pritchardia bakeri</td>
<td>NCN</td>
<td>Kauai.</td>
</tr>
<tr>
<td>Pseudognaphalium sandwicensium var. molokaiense</td>
<td>NCN</td>
<td>Hawaii, Maui (H).</td>
</tr>
<tr>
<td>Ranunculus mauliensis</td>
<td>NCN</td>
<td>Hawaii, Maui (H).</td>
</tr>
<tr>
<td>Sanicula sandwicensis</td>
<td>NCN</td>
<td>Hawaii, Maui, Molokai.</td>
</tr>
<tr>
<td>Santalum involutum</td>
<td>iliahi</td>
<td>Kauai.</td>
</tr>
<tr>
<td>Schiedea diffusa ssp. diffusa</td>
<td>NCN</td>
<td>Maui, Molokai.</td>
</tr>
<tr>
<td>Schiedea pubescens</td>
<td>NCN</td>
<td>Maui, Lanai (H), Molokai, Oahu, Kauai.</td>
</tr>
<tr>
<td>Sicyos lanceoloides</td>
<td>anunu</td>
<td>Oahu, Kauai.</td>
</tr>
<tr>
<td>Sicyos macrophyllus</td>
<td>NCN</td>
<td>Hawaii, Maui (H).</td>
</tr>
<tr>
<td>Solanum nelsoni</td>
<td>NCN</td>
<td>Hawaii, Maui, Molokai, Nihau (H), Pearl &amp; Hermes, Kure, Midway, Laysan, Nihoa.</td>
</tr>
<tr>
<td>Stenogyne kaalae ssp. shortii</td>
<td>NCN</td>
<td>Oahu (H).</td>
</tr>
<tr>
<td>Wikstroemia skottbergiana</td>
<td>NCN</td>
<td>Kauai.</td>
</tr>
</tbody>
</table>

(H) = Historically known from the island, but not observed in the past 20 years.
of Hawaii, has been erupting continuously since 1983. Loihi Seamount, at 3,200 feet (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).

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 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 Papahanaumokuakea 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.

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the State, nearly one million people (World Population Review 2015, in litt.). The flora and fauna of Oahu have undergone extreme altercations 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 Kalua Pua 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 higher 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 Kaua‘i (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 Kaua‘i is 1,476 ft (450 m) at the summit of Puu O Moaula Nui (Juvik and Juvik 1998, pp. 15–16). Kaua‘i 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 1999, the island was placed under the administration of the Kaua‘i 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 wetlands (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 3,970 ft (1,210 m), a dormant volcano; and Mauna Loa (13,677 ft (4,169 m)) and Kilauea (10,064 ft (3,014 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 1999, p. 7). Hawaii’s vegetation 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 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).

<p>| TABLE 2—THE 49 HAWAIIAN ISLANDS SPECIES AND THE ECOSYSTEMS UPON WHICH THEY DEPEND |
|----------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Species</th>
<th>Island</th>
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<td>Orangeback Hawaiian damselfly (Malgastrum xanthomelas)</td>
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<td>Anchialine pool shrimp (Procarris hawaiana)</td>
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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 Ahilii-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. 1–4). 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, Megalonarix xanthomelas, which are proposed 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 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 prevailingly 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 Santanal ellipticum (iliihaleo, 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: Nootoeconomum latifolium (Maui, Lanai, and Oahu) and Portulaca villosa (Hawaii Island, Maui, Kahoolawe, Oahu, Lehua, and Kaula). 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 Hylaena anthracinus (Hawaii Island, Maui, Kahoolawe, and Lanai), H. assimilans (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 ecosystem (TNCH 2006). The following plants proposed for listing as endangered in this rule reported currently or historically from this ecosystem are: Deparia kauaensis (Hawaii Island, Maui, and Kauai), Exocarpus menziesii (Hawaii Island and Lanai), Gardenia remyi (Hawaii Island, Molokai, and Kauai), Joinvillea ascends ssp. ascendens (Kauai), Kadua flavitilis (Kauai), K. haupuensis (Oahu), Lepidium orbiculare (Kauai), Microlepia stigosa var. mauiensis (Oahu), Myrsine fosbergii (Oahu and Kauai), Nothoeconomum latifolium (Maui, Lanai, Molokai, and Oahu), Ochrosia haleakalae (Hawaii Island and Maui), Prickardia bakerii (Oahu), Santanal involutum (Kauai), and Sicyos lanceoloides (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 Hylaena facilis (Maui, Lanai, and Oahu), H. kaukea (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, 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), *Cyclcosorus boydiae* (Hawaii Island and Maui), *Cyperus neokunthianus* (Maui), *Deparia kaalaena* (Hawaii Island, Maui, and Kauai), *Gardenia remyi* (Hawaii Island, Maui, Molokai, and Oahu), *Kadua fluitalis* (Oahu), *Myrsine fosbergii* (Oahu and Kauai), *Oehrosia haleakalae* (Hawaii Island), *Phyllostegia brevidens* (Maui), *P. helleri* (Kauai), *Santalum involutum* (Kauai), *Labordia lorenciana* (Kauai), *Microlepia strigosa var. maulensis* (Hawaii Island, Oahu), *Ochrosia haleakalae* (Hawaii Island), *Ranunculus hawaiensis* (Hawaii Island), *Sanicula sandwicensis* (Hawaii Island and Maui), *Schiedea pubescens* (Maui), *Sicyos lanceoloideus* (Kauai), and *S. macrophyllus* (Hawaii Island) (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), *Cyclcosorus boydiae* (Maui and Oahu), *Cystandra hematos* (Molokai), *Dryopteris glabra var. pusillo* (Kauai), *Huperzia stemmernani* (Hawaii Island and Maui), *Hypolepis hawaiensis var. maulensis* (Maui), *Joinvillea ascends* ssp. *ascends* (Hawaii Island, Maui, Molokai, Oahu, and Kauai), *Microlepia strigosa var. maulensis* (Hawaii Island and Maui), *Myrsine fosbergii* (Kauai), *Phyllostegia brevidens* (Hawaii Island), *P. helleri* (Kauai), *P. stachyoides* (Hawaii Island and Maui), *Portulaca villosa* (Hawaii Island), *Ranunculus hawaiensis* (Hawaii Island), *Sanicula sandwicensis* (Hawaii Island), and *Sicyos 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), *Phyllostegia brevidens* (Hawaii Island), and *Sicyos lanceoloideus* (Oahu) (TNCH 2007; HBMP 2010). 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 maulensis* (Maui and Molokai), and *Schiedea pubescens* (Molokai, Lanai, and Oahu) (TNCH 2007; HBMP 2010). The band-rumped storm-petrel is reported currently or historically from the wet 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: *Hypolepis hawaiensis* (Maui, Lanai, Oahu, and Kauai), *Oehrosia haleakalae* (Maui), and *Sicyos lanceoloideus* (Oahu) (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 determined 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 (persisting 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 uncertain, 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 Aguraita, 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 lacinuata (Botanischer Garten und Botanisches Museum (BGBM) 2014, in litt.). Brackenridge also interpreted Diella as lineary ovate having morphological characteristics of those in the genus Lindsea (1854, pp. 218–220), followed by other Hawaiian authors, and this fern was described as Dielai lacinuata in Rock (1913, p. 59) and in Wagner (1952, pp. 11, 57–63). Palmer did not recognize D. lacinuata 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 907; 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. diellaciatiun occurs (HBMP 2010; Wood 2013, in litt.). Feral pigs, goats, and black-tailed deer are major pests and a significant threat to this fern in its natural habitat in Kauai. Other nonnative herbivores, such as predation, disease, pollination, and competition by nonnative plants, destruction by ungulates and by direct destruction, or to 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 a species such as this that 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.; Pelman 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 Cyanea kauaulaensis (Oppenheimer and Lorence 2012, p. 20). Additionally, Rats and slugs are noted as a threat to Cyanea. Rats and slugs are noted as a threat to Cyanea species, negatively affecting native habitat and outcompete native nonnative plants modify and destroy native habitat and outcompete native 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 Metroseros (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 ungulate herbivory 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 boydai (previously Christella boydai) (kupukupu makalii) is a small to medium-sized member of the thelypterid 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 (Cystodium) boydai, 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. exalatum 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 boydai on Oahu and Cyclosorus variety kipahualuenis 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 boydai is the most recently accepted scientific name for this fern. Typical habitat for Cyclosorus boydai is exposed, rocky, or moss-covered banks of stream courses in dense-wet Metroseros-Accacia (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 boydai 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.; PP 2008). In 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 Wagner (1999, 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 or reduce herbivory. This occurrence has not been monitored since 1999 (USFWS Rare Taxon Database, 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 may 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 (Cesneriaceae), 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 Oloku Plateau, Kawela, and Kaahouahou Valley on Molokai (Wagner et al. 1999, pp. 760, 762). Currently, approximately 30 individuals are known from Kapulei. 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 or reduce herbivory. This occurrence has not been monitored since 1999 (USFWS Rare Taxon Database, 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 may make this species more vulnerable to extinction because of the higher risks from genetic bottlenecks, random demographic fluctuations, and localized catastrophes.
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 (kahiilih 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.

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Nonnative slugs such as Derocerus 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 Kawaikoi stream area (HBMP 2010). Currently, this species is known from fewer than 250 individuals in the Alakai Wilderness Preserve (including the Kawaikoi 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 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-tipped 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; VMP 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 (Kaipolena Gulch) and was formerly more wide-spread on the island of Hawaii (from Kahuku Ranch in the south to Hualalai and Puu Kapele on the leeward slopes) (Wagner et al. 1999, p. 1218; TNCH 2007; HBMP 2010). Currently, there is a 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. This has 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 exclosures 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. 2015, 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 hawaiensis* (NKN) is a cespitose (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 hawaiensis* was treated by Hillebrand (1882, pp. 534–535) as an introduced species, *F. drymeia*; however, *F. hawaiensis* 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. hawaiensis* 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. hawaiensis* 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 hawaiensis*. These ungulates browse on native plants such as grasses, and likely browse on *F. hawaiensis*. Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction, or 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. hawaiensis* outside of fenced exclosures or outside of the managed area are at risk. Non-native plants, such as *Cenchrus setaceus* (*Penisetum setaceum*, fountain grass), are naturalized in the area, and outcompete *F. hawaiensis* and other native plants. Occurrences and numbers of individuals are declining on the island of Hawaii, and *F. hawaiensis* 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, 6 millimeter 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 Wailauika and Waikamoi in the Koolau FR, and from Papaea and Kipahulu. On Molokai, this species was known from Keopukaloa, Pukoo, Honomuni, Halawa, and Kaluahua (HBMP 2010). On Kauai, this species ranged across the island, and was known from Halelea, Kealia, Moloaa, and Lihue-K-loa FRs, including Hanakapiai Valley, Mahaulepu, and east Waiawa 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.). 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 Puuauauka, 2 at Puu Kolo, 1 at Waioli Valley, 1 at Kahili, and 6 at Waipaa (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-K-loa 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 Kekaha 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 Honopuu 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 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 strolli (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. This in turn increases 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 (ola) 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 (Hawaii Initiative 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. 180–230; Vitousek et al. 1987 in Cudlith and Stones 1999; MNTF 2010). This form 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 (oho) 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 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 Pelekuʻu 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 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.; Wolton 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 Joinvillea 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 Hedychium fluviatilis) (kamapua, 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-oblancoeleata 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 Hedychium by Forsberg (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 Hedychium 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 from 150 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 oblanceolate, occasionally lanceolate or oblanceolate, 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 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 Kawaiikī 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 (banana poka), Lepidium orbiculare (Lorence et al. 2010, p. 139), Rubus argutus, Psidium cattleianum (banana poka), and Lantana camara, Passiflora tarminiana (banana poka). 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 Pinson 1997, p. 361; PEPP 2014, p. 34).

The remaining occurrence of Labordia orbiculare and habitat for its reintroduction are at risk; the species continues to be negatively affected by habitat modification and destruction by
Microlepia strigosa
Typical habitat for an endemic variety of the indigenous fern was originally described as Microlepia mauiensis (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 mauliensis 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.). 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 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. Myrsine fosbergii 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 Metroseros-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 Metroseros-Diospyros (ohia-lama) lowland mesic forest and Metroseros-Cheirodendron (ohia-olapa) montane wet forest, often on watercourses in stands, 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 Pua Lanihulu 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 17 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 Koolau Mountains (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.
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 Waielli, Kaumokuni, and Kupehau gulches, and Makua Valley, in the Waianae Mountains of Oahu; the Kawela and Kapaa koa gulches on Molokai; from Koele, Kaohai, and Maunalei Valleys on Lanai; and from the never 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.; Chi ng 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 available 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 (holoie), 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, yellowish drupes are yellow or orange 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 kepau) 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 Kanoa 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-Kanoa on the island of Maui, and from 4 occurrences (Alakahui gulch, Honopue 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 Alakahui Gulch is uncertain after a strong earthquake in 2006; the individual found at Kailikaua Stream was last observed in 2011, and is vulnerable to slides (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 Puaulu and Kipuka Ki in Hawaii Volcanoes National Park; however, survivorship of these individuals is unknown (Pratt 2005, in litt.; Agorastos 2007, pers. comm.; Conry 2012, 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). The taxon 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 introduced plants; the displacement of individuals due to competition with nonnative plants for
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 Kualapūu FR; and from Kipahulu Valley on Maui (Haleakalā 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 re-introduction 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 subshrub in the mint family (Lamiaceae). Stems have inconspicuous glandular dots, and are ridges or spurs at 2,800 to 3,000 ft (860 to 1,200 m) in diverse wet ecosystems that support 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, pp. 816–817; 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, 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...
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; TNCH 2007; 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. Several individuals in the area at Kukui (fewer than 15 individuals) (MNTF 2010). On the island of Lanai, with evidence of rockfalls in areas where P. stachyoides has been observed on the small island of Hawaii, there are five occurrences in the Pohakuloa Training Area, totaling 10 individuals (Evans 2015, in litt.).

Feral pigs, goats, and axis deer modify and destroy native Hawaiian plant species (Smith 1985, pp. 180–250; Vitousek et al. 1999, p. 1074), the most recently accepted taxonomic treatment of this species. Portulaca villosa is recognized as a distinct taxon by Wagner et al. (1999, p. 1074), the included 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 known from all the main Hawaiian Islands except Kauai and Niihau, and from Nihos 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 Nihos dry (NWHI); however, their current status is unknown. This species has not been observed on Oahu since the 1960s, when it was locally abundant at Kahoikaipu 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 Lihi (about 24 individuals), and from Kahoolawe at Puu Koai, Aleale, and above Kamalio (fewer than 15 individuals) (MNTF 2010, in litt.). On the island of Lanai, two individuals were observed at Kaohai in 1996 (HBMP 2010).
family (Arecales). 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 native 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).

Cuddihy et al. (1998) 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 sandwicensium* 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 (Hilalawa Valley and Waiahehawewa 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 sandwicensium* var. *molokaiense* is known only from Molokai on the northwest 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.; 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 sandwicensium* var. *molokaiense*, with evidence of the activities of these animals reported in the areas where this plant occurs (Moses 2006, in litt.; Starr 2006, in litt.; Callstrom 2008, 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 sandwicensium* var. *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 sandwicensium* 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 hawaiensis* (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 hawaiensis 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 hawaiensis 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 2010, p. 177). 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, moufflon, and cattle modify and destroy the habitat of Ranunculus hawaiensis on Hawaii Island, with evidence of the activities of these animals reported in the areas where R. hawaiensis occurs (HBMP 2010). These ungulates, and rats, may also forage on R. hawaiensis. Nonnative plants, such as Holcus lanatus (common velvet grass), Ehrharta stipeides (meadow ricegrass), and various grasses that modify and destroy native habitat and outcompete native plants have been reported in areas where R. hawaiensis occurs (HBMP 2010). Drought and erosion pose a threat to the last known occurrence of R. hawaiensis on Maui (PEPP 2013, p. 177). This species may experience reduced reproductive vigor due to low levels of genetic variability, leading to lowered 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 hawaiensis 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 hawaiensis 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 sparingly 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). Ranunculus mauiensis is found at Kalalau-Honopu (R. mauiensis occurs (HBMP 2010). Herbivory by slugs (Maui) 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–
Sanicula sandwicensis is historically known from the islands of Maui (Haleakala) and Hawaii (Mauna Kea, Mauna Loa, and Haulalai) (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 mapped 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*, *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 Pinson 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 Ke'e, 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 Pohakuau 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 Pinson 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 it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range. *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 Pu`u 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 (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 Pinson 1997, p. 361).

The remaining occurrences of *Schiedea diffusa* ssp. *diffusa* (NCA) 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; 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; TNC 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. hawaiensis* (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,
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 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; PEPP 2014, p. 162). 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 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 Molokai and Maui, 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.
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 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 Niilau at Kealea Bay, Kawaiawae, and Leahi; 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 Niilau 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 at Pu‘u Iki (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 in 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 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).
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 Wellerr 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 Wellerr 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 Wellerr 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 in 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 Opaeula 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.). 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 (Thymelaeaceae). 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 Wahaiwa Mountains, Hanalei Valley, and Kauhau 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 (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 *Oceanodroma castro cryptoleucura*, the Hawaiian storm-petrel (*Harrison et al.* 1990, p. 47). Hawaiian names for this bird include *oooe*, *oweowe*, and *akeake* (*Harrison et al.*, 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 with the 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 2013, in litt.).

When not at nesting sites, adult band-rumped storm-petrels spend their time foraging on the open ocean (Slotterback 2002, p. 2). Food is taken from the ocean surface and consists mostly of small fish and squid (Slotterback 2002, p. 2; Harris 1969, p. 105). Nests are placed in crevices, holes, and protected ledges along cliff faces, where a single egg is laid (Allan 1662, 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 1662, 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 1662, p. 274; Harrison 1983, p. 274). Wintertime 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 islands on the east coast of Japan (Hidejima and Sanganjima in Allan 1662, 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.*, pp. 47–48). As evidenced by bones found in middens on Hawaii Island (*Harrison et al.*, 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.*, 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.*, 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.*, 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, Ni‘ihau, and Hawaii Island (*Harrison et al.*, p. 49; Holmes and Joyce 2009, 4 pp.), and in “rafts” (regular concentrations) of a few birds to as many as 100, possibly awaiting nighttime 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.*, p. 49; Johnston 1992, in litt.; Wood *et al.*, 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.*, 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.


Attraction of fledglings to artificial lights and collisions with structures, such as communication towers and utility lines, is also a threat (Banke et al. 1991, p. 651; Cooper and Day 1998, p. 18; Harrison et al. 1990, p. 49; Holmes and Joyce 2009, p. 2; Podoslky 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 angustirostris* 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, pp. 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, pp. 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 (Soule 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 Hawaiian 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 bee (*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 plumeous (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 that 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 reddish 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 cerasoides* (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 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 pupuana* (NCN), and *S. geminata* (NCN) on *Hylaeus* egg, larva, 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 2003b, p. 177). 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 assimilans*).

*Hylaeus assimilans* 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 punctation on the abdomen (Daly and Magnacca 2003, p. 36). *Hylaeus assimilans* was first described as *Nesoprosopis assimilans* (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 assimilans* by Daly and Magnacca in 2003 (pp. 55–56).

Nests of *H. assimilans* are usually constructed opportunistically within existing burrows, or other similarly small natural cavities under bark or rocks that suit to their own needs (Magnacca 2005b). Adult bees have been observed visiting the flowers of its likely primary nesting native host plant,
Sida falax (ilima), as well as the flowers of native Lipochaeta lobata (neho) (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 Accacia koa (koa), Metrosideros polymorpha (ohia), Leptocophylla tameiameiae (pukiawe), Scaevola sp. (naupaka), and Chamaesyce 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; two locations on Lanai in the lowland dry ecosystem; two locations on Molokai 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 Kualoa (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, Chenopod ciliaris, Chloris barbata (swollen fingergrass), Digitaria insularis (sourgrass), Leucaena leucocephala (kona hoale), Panicum maximum (guinea grass), Pluchea indica (Indian flax), P. carolinensis (sourbush), and Verbascus enceloides (golden crownbeard)) 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 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 1983, 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 wildfie, and the aeries 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 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 sappans, 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), excluding areas where H. assimulans and other yellow-faced bees occur (Cambino 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 sites 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. assimilans* 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 clpeus, 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 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 Puaoa Valley on Oahu (Daly and Magnacca 2003, p. 80). The species was later transferred to the genus *Nesoprosopis* (Perrins 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*, *Leptocophylla tamaicameia*, *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. 73). Existing protected areas, such as the Honokowai Division of Forests and Wildlife (DOFAW) 2007, p. 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 pupana*, and *S. geminata*) on *Hylaeus* egg, larval, 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. assimilans* 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 that pose the most threat.
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) 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 *Prospis hilaris* by Smith in 1879 (in Daly and Magnacca 2003, pp. 103–104), and transferred to the genus * Nesoprosis* 20 years later (Perkins 1899, p. 75). *Nesoprosis* 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. inquiлина*, *H. sphecoides*, 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 factors (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 invasive 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 Hylaenus 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 Hylaenus species; however, we are unable to determine the extent of these negative impacts at this time. Because of these difficulties, we find that Hylaenus 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 (Hylaenus kuakea)

Hylaenus kuakea is a small, black bee with slightly smoky-colored wings. This species does not fit into any of the well-defined Hylaenus 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. Hylaenus 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. Hylaenus kuakea was first described by Daly and Magnacca (2003, pp. 1, 125–127) from specimens collected in 1997 in the Waianae Mountains of Oahu.

Hylaenus 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 Hylaenus species are known to frequent, including Acacia koa, Metrosideros polymorpha, Leptecophylla taneiameiae, Scaevola spp., and Chamaesyce spp. (Magnacca 2005e, p. 2).

Because the first collection of Hylaenus 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 foral pigs leads to fragmentation, and eventual loss, of foraging and nesting areas of Hylaenus 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 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. assimilans 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 invasion 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 Hylaenus 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; 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).

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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; 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).
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 unpainted (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 subspecies 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), Myopororum sandwicense (naio), Santalum ellipticum (iliahaleo), 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 (pauohiiali) (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, Waiehu 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. assimilans_ 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. 153). 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 _Dumetororum_ 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_
Hylaenus 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 Hylaenus species have been found in this type of forest on Oahu (Daly and Magnacca 2003, p. 136). 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). Hylaenus 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). As they 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 acresages 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 (198). Along with other Hawaiian species (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 Hylaenus species; however, we are unable to determine the extent of these negative impacts at this time. Because of these threats, we find that Hylaenus 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 the Kona Island it was common in stagnant pools up to elevations of about 3,000 ft (900 m).
The orangeblack Hawaiian damselfly was once Hawai’i’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. cxxviii; 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 (Kalawapua 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, Hiloa Stream, Hilo, Honokohau, Kiholo Bay, Ninole Springs, Onomea Bay, Whittington Beach, Keaukaka, 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 Bracharia 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; McPeek 1990a, pp. 92–96). Nonnative backswimmers (aquatic true bugs; Heteroptera) are voracious predators and frequently feed on prey much larger than themselves, such as tadpoles, small fish, and other aquatic invertebrates including damselfly nauplii (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 Procaridiidae) 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 chelae (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 hawaiana. During
nocturnal-diurnal surveys conducted from 2009 to 2010, 19 pools within the
Manuka Natural Area Reserve (NAR) were found to contain P. hawaiana. Five
additional pools located on unencumbered State land adjacent to
Manuka NAR also contained P. hawaiana (from the total 24 recorded pools
within the Manuka watershed). A single pool located at Lua o Palahemo
also contains P. hawaiana, along with the endangered anchialine pool shrimp

Like other anchialine pool shrimp species, P. hawaiana 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. hawaiana, 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 hawaiana 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 hawaiana. 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. 1). 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
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. hawaiana. Nonnative fish
(tilapia, Oreochromis mossambica) also
outcompete native herbivorous species
of shrimp that serve as a prey-base for
P. hawaiana, disrupting the delicate
ecological balance in the anchialine
pool system, and leading to decline of
the pools and the shrimp inhabiting
them (Brock 2004, pp. 13–17). Although
anchialine pools within State 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. hawaiana is hampered by the small
number of extant populations and the
small geographic range of the known
populations. The small populations of
P. hawaiana 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. hawaiana
directly (Conry 2012, in litt.).

The remaining populations of
Procaris hawaiana 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; by water extraction; 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
but the absence of breeding records from western Micronesia (Pyle and Engebret 1983, p. 59) suggests there is a distributional gap between these two archipelaggoes 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 2013, p. 11), we would like 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 highland 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 habitats 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).

**BILLING CODE 4310–55–P**
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

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.
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 mauensis*, *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

<table>
<thead>
<tr>
<th>Species</th>
<th>Ecosystem</th>
<th>Agriculture and urban development</th>
<th>Ungulates</th>
<th>Non-native plants</th>
<th>Fire</th>
<th>Stochastic events</th>
<th>Over-utilization</th>
<th>Predation/herbivory by ungulates</th>
<th>Predation/herbivory by other NN vertebrates</th>
<th>Inadequate existing regulatory mechanisms</th>
<th>Other species-specific threats</th>
<th>Climate change</th>
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<td>AP, CO, LD, LM</td>
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<td>P, G, D</td>
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<td>Ungulates</td>
<td>Non-native plants</td>
<td>Fire</td>
<td>Stochastic events</td>
<td>Over-utilization</td>
<td>Predation/herbivory by ungulates</td>
<td>Predation/herbivory by other non-native vertebrates</td>
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<td>Inadequate existing regulatory mechanisms</td>
<td>Other species-specific threats</td>
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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 = Anchialine Pools; CO = Coastal; LD = Lowland Dry; LM = Lowland Mesic; LW = Lowland Wet; MW = Montane Wet; MM = Montane Mesic; MD = Montane Dry; SA = Subalpine; DC = Dry Cliff; WC = Wet Cliff. A = Ants; B = Bees (competition); BS = Backswimmer; BTD = Black Tailed Deer; C = Cattle; CA = Cats; D = Axis Deer; FS = Fish; G = Goats; M = Mouflon; MO = 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 (fishing, marine debris); HUR = Hurricanes; HY = Hybridization; L = Landslides; LHP = Loss of Host Plants; Li = Lights; LN = Low Numbers; NR = No Regeneration; RF = Rockfalls; RU = Recreational Use (swimming, fishing, dumping trash and non-native 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 (Lasius 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, Carquist (in Carquist 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 (Carquist 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 sandwicensium var. molokaiense, and the yellow-faced bees Hylaeus anthracinus, H. assimulans, H. facilis, and H. longiceps.
- On Molokai, the plants Portulaca villosa, Pseudognaphalium sandwicensium var. molokaiense, and Solanum nelsonii; the orangeblack Hawaiian damselfly; and the yellow-faced bees Hylaeus anthracinus, H. facilis, H. hilaris, and H. longiceps.
- On Lanai, the plants Nothocestrum latifolium, Portulaca villosa, and Pseudognaphalium sandwicensium var. molokaiense; the orangeblack Hawaiian damselfly; and the yellow-faced bees Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris, and H. longiceps.


Although we are unaware of any comprehensive, site-by-site assessment of wetland development in Hawaii (Erikson and Puttuck 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 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 25). 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. 1; 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 hawaiana 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. hawaiana; however, this threat remains a possibility (Brock 2004, pp. 13–17).

Destruction and modification of Hylaeus habitat by urbanization and land use conversion, including agriculture, has lead 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 introduction 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), moufflon (Ovis gmelini musimon) (and moufflon-sheep hybrids), and cattle (Bos taurus). Habitat destruction or modification by ungulates is a threat to 37 of the 39 plant species (except Kahoolawe) that are at risk of habitat destruction and modification by feral pigs, 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. 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 and Aplet 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 rooting in the eases 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, pp. 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: Cyclusorus boydii, Gardenia remyi, Joinvillea ascendens ssp. ascendens, Kadua fluviatilis, Kadua haupuensis, Laderonia lorenciana, Lepidium orbiculare, Ochrosia haleakalae, Phyllostegia brevidens, P. helleri, P. stachyoides, Ranunculus hawaiensis, R. mauiensis, and Schiedea pubescens. Thirty-one of the 39 plants (all except for Cyanea kauaaulensis, Exacorbas menziesii, Festuca hawaiensis, Hypolepis hawaiensis var. mauiensis, Portulaca villosa, Pseudognaphalium sandwicensium var. molokaiaense, 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 on Kahoolawe forage as a bomb 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–C–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) destablizing 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, Laborodia lorenciana, Ochoria haleakalae, Phyllostegia helleri, P. stachyoides, Portulaca villosa, Pseudognaphalium sandwicensium var. molaikaense, Ranunculus mauliensis, Santicula sandwicensium, and Schiedea pubescens and the band-rumped storm-petrel. Twenty-two of the 39 plants (all except for Calamagrostis expansa, Cyanea kauauaense, Cyclosorus boydii, Cyperus neokunthianus, Deparia kaalaana, Dryopteris glabra var. pusilla, Hypoepis hawaiiensis var. mauliensis, Kadua haupueni, Lepidium orbiculare, Phyllostegia brevidens, Portulaca villosa, Pritchardia bakteli, Ranunculus hawaiiensis, Schiedea diffusa ssp. diffusa, Sicyos macrophyllus, Solanum nelsonii, Stenocereus sheriffii, and Wikstroemia skottsbergiana), and the band-rumped storm-petrel, the orangeblack Hawaiian damselfly, and the yellow-faced bees Hylaena 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, 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 Insurder 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.). 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–HDOF) 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 stemmermanniae, Joinvillea ascendens ssp. ascendens, Nothocestrum latifolium, Phyllostegia stachyoides, Portulaca villosa, Pseudognaphalium sandwicensium var. molaikaense, Ranunculus mauliensis, Schiedea pubescens, and Solanum nelsonii, and the orangeblack Hawaiian damselfly, and five of the yellow-faced bees (Hylaena anthracinus,
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black-tailed deer are 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, Nothocentrum latifolium, Ranunculus mauensis, and Sanatalum 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 microenvironments, 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, Nothocentrum latifolium, Phyllostegia brevidens, and Portulaca villosa, 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 and Hawaii Island (coastal, lowland dry, lowland mesic, lowland 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 the area. Increased soil compaction, runoff and erosion through the faces of cattle contributes to the ingress of nonnative plant species. a shift from native forest to grassy scrublands (Hess 2008, p. 3). Mouflon only gather in herds when breeding, thus complicating control techniques and hunting efficiency (Hess 2008, p. 3; Ikagawa 2011, in litt.). Currently, many of the current and proposed fence exclosures on Hawaii Island constructed to protect rare species and habitat are 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, Nothocentrum 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 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 the area. Increased soil compaction, runoff and erosion through the faces of cattle contributes to the ingress of nonnative plant species. a shift from native forest to grassy scrublands (Hess 2008, p. 3). Mouflon only gather in herds when breeding, thus complicating control techniques and hunting efficiency (Hess 2008, p. 3; Ikagawa 2011, in litt.). Currently, many of the current and proposed fence exclosures on Hawaii Island constructed to protect rare species and habitat are 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, Nothocentrum 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.
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 stemmernanniae, Joinvillea ascendens ssp. ascendens, the band-rumped storm-petrel, and the anchialine pool shrimp). Fourteen of these nonnative plant species 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 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 sandwicensium var. molokaiense, and Solanum nelsonii) and the coastal ecosystem animals proposed for listing (the orangeblack Hawaiian damselfly, and the yellow-faced bees Hylaenus anthrasicus, H. assimulans, H. facilis, H. hilaris, 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 (kau haole), Neonotonia wightii (glycine), Nicotiana glauca (tree tobacco), Pluchea carolinensis (sourbrush), 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 Accacia farnesiana (kūi) and Prosopis pallidiflora (kūle). In addition, the nonnative grasses Conrachus 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 Hyleaeus anthracinus, H. assimulans, H. facilis, H. hilaris, H. mana) include the nonnative understory and subcanopy species Agaratiina adenophora (Maui pamakani), Asystasia gangetica, Atriplex semibaccata, Conyza baronii, Lantana camara, Leonotis nepetifolia (lion’s ear), Leucaena leucocephala, Neonotonia wightii, Haole), H. longiceps, H. mana, H. assimulans, H. facilis, H. hilaris, Hylaeus anthracinus, yellow-faced bees (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 kaalanea, Gardenia remyi, Joinvillea ascenden ascenden, Kadua fluviatilis, K. haupuensis, Lepidium orbiculare, Microlepis strigosa var. mauicensis, Myrsine fosbergii, Nothocestrum latifolium, Ochrosia haleakalae, Pritchardia baki, Santalum involutum, and Sicyos lanceoloides) and the lowland mesic ecosystem animals proposed for listing (the orangeblack Hawaiian damselfly and the yellow-faced bees Hyleaeus facilis, H. mana) include the nonnative understory and subcanopy species Agaratiina 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 diurum (day cestrum), Clidemia hirta (Koster’s curse), Conyza baronii, Cordyline fruticosa (ti, ki), Cuphea harveyi, Cyclosorus dentatus, Delairea odorata (German ivy), 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 (glossybrush), and Youngia japonica (oriental hawksbeard) and the nonnative canopy species Ardisia elliptica, Cinamomum burmannii (padang cassia), Coffea arabica, Cryptomeria japonica (tsugi pine), Eucalyptus spp., Falcataria moluccana, Helicocarpus popayanensis (moho), 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 plants 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 (gruenwood 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 bovani, Cyrtandra hematos, Dryopteris glabara var. pusilla, Hypolepis hawaiiensis var. mauicensis, Micropleia strigosa var. mauicensis, Myrsine fosbergii, Phyllostegia brevidenis, P. helleri, P. stachyodes, Rhodacanthus mauliensis, Schiedea diffusa var. diffusa, S. pubescens, and Sicyos macrophyllus) include the nonnative understory and subcanopy species Agaratina adenophora, A. riparia, Agratum conyzoides (maile honohono), Anemone hupehensis var. japonica, Blechnum appendiculatum, Buddleja asiatica, Cestrum nocturnum, Clidemia hirta, Cyclosorus dentatus, Drymaria cordata, Erechtites valerianifolia, Erigeron karvinskianus (daisy fleabane), Hedychium gardnerianum (kahili ginger), Juncus effusus, J. riparius, Juncus multiflorus, Juna 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*, canopy species and the nonnative (gorse), and *herbacea*, *Ulex europaeus* *Sphaeropteris cooperi*, *Tibouchina* Himalayan raspberry), *R. rosifolius*, *Schinus terebinthifolius* (HBMP 2010).

Nonnative grasses that negatively impact the montane dry ecosystem include *Anthoxanthum odoratum* (sweet vernalgrass), *Axonopus fissifolius*, *Cortaderia jubata*, *Ehrharta stipoides*, *Holcus lanatus* (common velvet grass), *Melinis minutiflora*, *Paspalum conjugatum*, *Sacciolepis stipoides*, *Holcus lanatus* (sweet vernalgrass), *Axonopus spp.*, *Morella faya*, *Pinus Caudatus, 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 Subalpine Ecosystem: Nonnative plants threatening the subalpine ecosystem plants proposed for listing (*Ranunculus hawaiensis* and *Sanicula sandwicensis*) include the nonnative understory and subcanopy species *Ageratina adenophora*, *Cotoneaster pannosus*, *Epilobium billardierianum* spp., *cineraeum* (willow herb), *E. ciliatum*, *Hypochoeris radicata*, *Lapsana cinereum* Epilobium billardierianum spp., *inermis* (willow herb), *E. ciliatum*, *Hypochoeris radicata*, *Lapsana cinereum* Epilobium billardierianum spp., *inermis* (willow herb), *E. ciliatum*, *Hypochoeris radicata*, *Lapsana cinereum* Epilobium billardierianum spp., *inermis* (willow herb), *E. ciliatum*, *Hypochoeris radicata*, *Lapsana 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 Island 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 et al. 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 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 it establishes in pastures and most livestock. The eupatorium gall fly, *Procecidocharesutilis*, 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 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 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 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 road sides 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. 1, 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 6).

- **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).

- **Anigozanthos australis** (male’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 understorey 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** (shoebuffer 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 et al. 2008, 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 salinity-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 diseases (Molokai Island 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 Ni‘ihau (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 starter (Geesink et al. 1999, p. 647); and is a pest in lowland mesic habitat (Smith 1985, p. 187).

- *Chrysophyllum oliviforme* (ironwood), native to Australia, is a tall tree (66 ft; 20 m) and is naturalized in the Northwestern 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).

- *Conchus ciliaris* (buffelgrass), native to Africa and tropical Asia, is naturalized on Midway Atoll and all the main islands except Ni‘ihau (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).

- *Conchus 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, 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 6 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 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 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, Ni‘ihau, 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* (quince) 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 on 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; Wagen 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, which 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 main islands except Kahoʻolawe and Niʻihau (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/inwweed/weedsHI.html](http://www.ctahr.hawaii.edu/inwweed/weedsHI.html). These characteristics enable the plants to be aggressive and successful competitors in Hawaiian lowland and montane, dry, mesic, and wet ecosystems.

- **Coffee 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 Niʻihau (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 Kahoʻolawe (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 Haleakalā 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 1950, 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 cyathoideas*, forming extensive numbers of the sterile hybrid (Palmer 2003, pp. 86–90).

- **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 Niʻihau (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 roadides 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; Bisachier 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** (kukapehua, 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 (Chippendale 1999, p. 1536). 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, pasture, 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 Niilau (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 Kahoolawe and Niilau) (Motooka et al. 2006), and occurs in lowland to montane, mesic to wet habitats on Kauai, Oahu, Molokai, Maui, and Hawaii Island (Wagner et al. 1999, p. 690; Wagner et al. 2012, p. 252). These species have a high risk of invasiveness or a high risk of becoming a pest species (PIER 2011). 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 Niilau (Goessink et al. 1999, p. 690; Wagner et al. 2012, p. 41).

- **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 Niilau (Wagner et al. 1999, pp. 924–926; Wagner et al. 2012, p. 52). This species has a high risk of invasiveness or a high risk of becoming a pest species (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).

- **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 Niilau) (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 between 1919 and 1959, in an effort to reduce erosion and to provide timber (Motooka 1999, p. 995; Wagner et al. 2012, p. 995; Wagner et al. 2012, p. 11).

- **Hibiscus trionum** (lady’s slipper hibiscus), an annual herb that reproduces and spreads rapidly by wind dispersal and produces thousands of wind-dispersed seeds. This species crowds out and replaces 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).
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 ecosystem, thereby allowing other plants to thrive (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 sinks 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 Ni'ihau (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).

- **Hokus lanatus** (common velvetgrass), native to Europe, is naturalized in Hawaii from montane to subalpine habitat, and occurs on all the main islands except Kauai and Ni’ihau (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). It 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-NGRIP) 2011).

- **Juncus ensifolius** (dagger-leaved rush), a perennial herb native to the western United States, is naturalized in Hawaii (Wagner et al. 1999, p. 1453). It forms dense thickets that displace native plants, especially in lowland dry habitat (Wagner et al. 1999, 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 Ni’ihau and Kahoolawe (Wagner et al. 1999, p. 568). It can reproduce by vegetatively at intervals 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 Ni’ihau (Wagner et al. 1999, p. 803; Wagner et al. 2012, p. 6). It forms dense thickets that displace native plants.
forms dense mats from root runners, perennial grass up to 3 ft (1 m) tall that is a spreading, Melinis minutiflora (PIER 2008). This species occurs in disturbed lowland to montane, mesic to wet forest habitat (Wagner et al. 1999, p. 963).

- Leucaena leucocephala (kao 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), a nitrogen-fixer, and alters the dominant vegetation in coastal and lowland dry areas (Geesink 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 (chinarberry) 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 and Niihau (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 et al. 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 Melastomataceae family, are included on the Hawaii State Noxious Weed list (HAR pp. 8–9; Wagner et al. 2012, pp. 96–97).

- 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, which 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 2010).

- Oplismenus hirtellus (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 Shiro 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 1996, p. 83; Motooka 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 Ni‘ihau (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 in 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 torriniana** (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 1820s, 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 alelopathic properties (Gutsher 2007, in litt.). Loh and Tunison (1998, p. 58) 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. elliottii*, *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 invade dry habitats, become a dominant species that shade out native plants and prevent regeneration, and can 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).

- **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).

- **Psychotria glomerata** (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. glomerata* is naturalized on all the main Hawaiian islands except Kaho'olawe 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).

- **Psychotria 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 Kaho'olawe 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 a 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).

- **Ricinocis communis** (casor 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 vegetation, 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 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 reproduce 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 it is quickly spread by frugivorous birds, displacing native vegetation through competition (Tunison 1991, p. 2; Wagner et al. 1999, pp. 1107–1108; 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, p. 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** (glennwood 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 Kaho'olawe 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 montane to subalpine 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 Kaho'olawe 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 removed (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 Kaho'olawe 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 palmyroidea** (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 crowds 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.

- Sphegoperis 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 Cлемesa 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 Nihoa), S. jamaicensis (on Midway Atoll, and all the main islands except Kahoolawe and Nihoa), 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 South America 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 Malaya, is widely cultivated and now naturalized in Hawaii in lowland mesic and dry cliff habitat on all the main islands except Kahoolawe and Nihoa (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 Nihoa (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 Nihoa (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 (Geessink 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 (Tulag 1992, pp. 577–583; Geessink 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 Nihoa (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 roadides 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. matica* 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 Ni‘ihau (Wagner et al. 1999, p. 372; Wagner et al. 2012, p. 16).

- **Youngia japonica** (oriental hawksbeard), 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 Ni‘ihau. *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 pasturlands 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 (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 1990 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 (32,378 ha), including 600 ac (243 ha) of the remote Makakapua 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 *Nothocestrum latifolium*, *Portulaca villosa*, *Ranunculus maulensis*, and *Schiedea pubescens*, *Solandrum nelsonii*; the orangeblack Hawaiian damselfly; and the yellow-faced bees *Hylaeus anthropicus*, *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, Nothocestrum latifolium, and Portulaca villosa, the 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 hawaiensis, Nothocestrum latifolium, Ochrosia haleakalae, Phyllostegia stachyoides, Portulaca villosa, Ranunculus maulensis, Sanicula sandwicensis, Schiedea pubescens, 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 Makua Military Training Area. In 2007, there was a significant fire at Kaukonahua that crossed 12 gulches, eventually encompassing 5,655 ac (2,289 ha) and negatively impacted eight endangered plant species and their habitat (Abutilon sandwicense, Bonamia menziesii, Colobrina oppositifolia, Eugenia koolauensis, Euphorbia haeleeleana, Hibiscus brackenridgei ssp. mokuleanensis, Nototrichium humile, and Schiedea hookerii) (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 weeks to contain.

Species proposed for listing in this rule at risk of wildfire on Oahu include the plants joinvilla ascendens ssp. ascendens, Nothocestrum latifolium, Portulaca villosa, and Sicyos lanceoloides, 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 joinvilla ascendens ssp. ascendens, Labordia lorenciana, Ranunculus maulensis, Santalum involutum, and Sicyos lanceoloides.

In the driest areas on the island of Hawaii, wildfires are exacerbated by the uncontrolled growth of nonnative grasses such as Chencherus 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, this 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 Kilauea Volcano 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 been seen, and were believed to inhibit the recovery of the native Metrosideros polymorpha (ohia) trees (JFSP 2003, pp. 1–2). Nonnative grasses invaded the burn area, increasing the risk of fire encroaching into the surrounding native forest (Ainsworth 2011, in litt.). Extreme drought conditions also contributed to the number and intensity of wildfires on Hawaii Island (Armstrong and Media 2010, in litt.; Loh 2010, in litt.). This “extreme” drought classification for Hawaii was recently lifted to “moderate;” however, drier than average conditions persist, and another extreme drought event may occur (NOAA 2015, in litt.). In addition, El Niño conditions in the Pacific (see “Climate Change” under Factor E, below), a half-century of decline in annual rainfall, and intermittent dry spells have contributed to the conditions favoring wildfires in all the main Hawaiian Islands (Marcus 2010, in litt.). Species proposed for listing in this rule at risk of wildfire on Hawaii Island include the plants Exocarpos menziesii, Festuca hawaiensis, Ochrosia haleakalae, Phyllostegia stachyoides, Portulaca villosa, Ranunculus maulensis, 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 hawaiensis, Joinvillia ascendens ssp. ascendens, Labordia lorenciana, Nothocestrum latifolium, Ochrosia haleakalae, Phyllostegia stachyoides, Portulaca villosa, Ranunculus maulensis, Sanicula sandwicensis, Santalum involutum, Schiedea pubescens, Sicyos lanceoloides, 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 or 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 km/h, 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 km/h, 113 knots), passed directly over the island of Kauai and close to the island of Oahu. 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 damsselfly (Megalagron vogabundum, 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. assimilans, H. facilis, H. hilaris, H. kuakea, H. longiceps, and H. mana.)

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

Habitat destruction and modification by landslides, rockfalls, treecfall, flooding, erosion, and drought affect all 11 ecosystems (singly or in combination). Landslides, rockfalls, treecfall, 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 1981 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 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, treecfall, flooding, and erosion are threats to 20 plant species (Cyanea kauaulaensis, Cyclosorus boydiae, Deparia kaaluana, Gardenia remyi, joinvillea ascendens ssp. ascendens, Kadua fluviatilis, K. haupuensis, Labordia loereniana, Lepidium orbiculare, Ochrosia haleakalae, Phyllostegia brevidens, P. helleri, P. stachyoides, Portalaca villosa, Pseudognaphalium sandwicensium var. molokaenense, Ranunculus haupuensis, R. maulensis, 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 loereniana, 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. Most of the 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 kaaluana, Labordia loereniana, 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 Lorenz 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 kaaluana, Huperzia stemmermanniae, Phyllostegia stachyoides, Ranunculus haupuensis, R. maulensis, 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.
Drought events have the potential to drive 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 et al. 1992, pp. 77–79). Recent episodes of drought have also driven axis deer (Axis axis) on Molokai, Lanai, and Maui; and at least 18 severe or severe drought events on Hawaii Island (Giambelluca et al. 1991, p. 3–4; Hawaii Commission on Water Resource Management (CWRM) 2009a and 2009b; HDLNR 2009, pp. 1–6; Hawaii Civil Defense 2011, pp. 14–14–12). 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, and 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 et al. 1992, in litt.; Nishibayashi 2001, 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, and 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 et al. 1992, in litt.; Nishibayashi 2001, 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, and 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 et al. 1992, in litt.; Nishibayashi 2001, in litt.).
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 Cyanaea kauaiensis and Hypolepis hawaiiensis var. maueriensis), 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; 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 (Cuddighy 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, Nothocentrum latifolium, Ochrosia haleakalae, Phyllostegia stachyoides, Portulaca villosa, Ranunculus maueriensis, Sanicula sandwicensis, Santalum involutum, Schiedea pubescens, Sicyos lanceoloides, 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, invite 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 (Cyanaea kauaiensis, Cyclosorus boydiae, Deparia kaalaana, Gardenia reyi, Joinvillea ascendens ssp. ascendens, Kadua fluitatilis, K. haupuensis, Labordia lorenciana, Lepidium orbiculare, Ochrmosia haleakalae, Phyllostegia brevidens, P. helleri, P. stachyoides, Portulaca villosa, Pseudognaphalium sandwicensum var. molokaiense, Ranunculus hawaiiensis, R. maueriensis, 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. maueriensis, Sanicula sandwicensis, Schiedea pubescens, Sicyos lanceoloides, 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
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 stammermanniae (cattle), Joinvillea ascendens (pigs, goats, deer), Kadua flaviatilis (pigs, goats), Laboria lorenciana (goats), Microlepia strigosa var. mauensis (pigs), Myrsine foshbergii (pigs, goats), Nothocentrum 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 sandwicensianum var. molokaianse (deer), Ranunculus hawaiiensis (pigs, cattle, mouflon), R. mauensis (pigs, goats, deer, black-tailed deer, cattle), Saniculo sandwicensianus (goats), Santalum involutum (black-tailed deer), Schiedea pubescens (deer, cattle), Sicyos lanceoloides (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, Hedysotis [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 spp. 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 flaviatilis on Kauai (HBMP 2010) and Oahu (HBMP 2010); Microlepia strigosa var. mauensis on Maui (Bily 2009, in litt.; Oppenheimer 2007, in litt.); Myrsine foshbergii on Kauai (HBMP 2010); Nothocentrum 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. mauensis 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 Hylaena anthracinus, H. assimilans, 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 Hawai‘i demonstrated that native Acacia koa seedlings are unable to survive due to browsing and grazing by goats (Spatz and Mueller-Dombois 1973, p. 873). 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 Hawai‘i 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 hawaiensis 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), Labordaria lorenciana on Kauai (PEPP 2011, p. 124; PEPP 2013, p. 126), Myrsine fosbergii on Kauai (HBMP 2010), Nothocestrum latifolium on Molokai (HBMP 2010), Phyllostegia stachyoides on Molokai (HBMP 2010), Porcula villosa on Hawaii Island (PEPP 2012, p. 140), Ranunculus mauensis 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 Kauai (PEPP 2011, p. 163), and Sicyos lanceolatus 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. assimilans, H. facilis, H. hilaris, and H. kwaeoa.

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 (williwili), 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 (ulei) and Leptoccephylla tamaianeae (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 cause 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), Nothocestrum latifolium on Lanai (PEPP 2012, p. 129), Phyllostegia stachyoides on Molokai (HBMP 2010), Portulaca villosa on Lanai (HBMP 2010), Pseudognaphalium sandwicensium var. molokaiense on Molokai (Wood 2005, in litt.; Kallstrom 2008, in litt.; MNTF 2010), Ranunculus mauensis 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. assimilans, 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 1980s, it was estimated there were about 350 animals remaining near Wai‘oli in 1997; 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 (aali’i), 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, Nothocestrum latifolium, Ranunculus mawiensis, 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 browsing 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), Silene sandwicensis, and Gardenia 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 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.); *Nothocestrum 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. hiliaris*, 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, 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: *Hypeiria stemmermannii* on Maui (de Sa et al. 2010, p. 96); *Orotchis haleakalae* on Maui (HBMP 2010); *Phyllostegia brevidens* on Hawaii Island (PEPP 2011, p. 144); *Ranunculus hawaiiensis* on Hawaii Island (HBMP 2010); *R. mawiensis* 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*, *Nothocestrum latifolium*, *Portulaca villosa*, *Pseudognaphalium sandwicensis* var. *molokaicensis*, *Ranunculus mawiensis*, and *Solanum nelsonii*. The blackbuck antelope may potentially threaten the yellow-faced bees *Hylaeus anthracinus*, *H. facilis*, *H. hiliaris*, 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 antelope are primarily found in rural and remote areas of Hawaii, in dry to wet habitats, while the Norway rat is found across all habitats.
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 kauaaulaenas (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 hawaiensis (Maui, Hawaii Island; HBMP 2010), R. mauensis (Kauai, Oahu, Molokai, Maui, and Hawaii Island; HBMP 2010), Sanicula sandwicensis (Molokai and Maui; HBMP 2012, p. 148), Santalam involutum (Kauai; Harbaugh et al. 2010, pp. 835–836), Schiedea diffusa ssp. diffusa (Molokai, Maui; HBMP 2010), S. pubescens (Molokai, Lanai, Maui; Wood 2005, in litt.; HBMP 2010), Sicyos macrophyllus (Molokai 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.).

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 seabirds to rat predation and have experienced population level impacts and extinction 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 puaoihi (small Kauai thrush, Myaestes 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 (Tнопич 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 litt.). 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, p. 90–96). 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 (ala, Corvus hawaiiensis), the Hawaiian duck (koloa, Anas wyvilliana), the Hawaiian coot (ala keokeo, Fulica alai), the Hawaiian stil (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, 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 Damselfly

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; McPeek 1990a, pp. 92–93). The naiads of these species tend to occupy more exposed positions and engage in conspicuous foraging behavior that makes them susceptible to predation by fishes (Macan 1977, p. 47; McPeek 1990b, p. 1722). The introduction of nonnative fishes has been implicated in the extirpation of a species related to the orangeblack Hawaiian damselfly, the Pacific Hawaiian damselfly (Megalagron 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 mosquitos (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 endemic Hawaiian damselfly (M. oceanicum), the endangered crimson Hawaiian
damselfly (M. leptocephalus), and the endangered blackline Hawaiian damselfly (M. nigrohamatum nigrolineatum). Currently, these damselflies are found only in drainages or higher parts of stream systems where nonnative fish are not yet established (Englund and Polhemus 1994, pp. 8–9; Englund 2004, in litt., p. 27). In summary, Hawaiian damselflies evolved with few, if any, predatory fishes and exposed behavior of most of the fully aquatic species, including the orangeblack Hawaiian damselfly, 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); Daporia kaalana (Kauai, Maui, Hawaii Island), Labordia lorenciana (Kauai), Phyllostegia brevidens (Maui), P. stachyoides (Molokai, Maui), Ranunculus mauiensis (Kauai, 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 Cyrtsandra species in the wild (Wood 2001, in litt.; Sailor 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), Alsihidendron sp., Hibiscus sp., Schiedea kaalae (maolili), Solanum sandwicense (popolo aiakau), and Urena 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 superb 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 damselfly. Backswimmers are aquatic true bugs (Heteroptera) in the family Notonectidae, so called because they swim upside down. Backswimmers are voracious predators and frequently feed on prey much larger than themselves, such as tadpoles, small fish, and other aquatic invertebrates including damselfly naiads (Borror et al. 1978, p. 296; Zalom 1978, p. 617). Backswimmers (several species) were introduced in recent times. Buenoa pallipes (NCN) has been recorded from Hawaii Island, Oahu, Maui, and Kauai (Zimmerman 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 suitable sized insect, including damselfly naiads (Zalom 1978, p. 617). Two additional species of backswimmers have become established in Hawaii, Anisops kuroiwae (NCN) on Maui and Laccorna 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 damselfly.

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 ant species occur in Hawaii, and the native yellow-faced bee species in Hawaii evolved in the absence of predation pressure from ants. Ants are known to prey upon Hawaiian yellow-faced bee (Hylaeus) species, with observations of drastic reductions in yellow-faced bee populations in ant-infested areas (Medeiros et al. 1986, pp. 45–46; Reimer 1994, p. 17; Stone and Loope 1987, p. 251; Cole et al. 1992, pp. 1313, 1317, 1320). The presence of ants in nearly all of the low-elevation habitat sites currently and historically occupied by yellow-faced bee species may preclude these species’ recovery in some of these areas (Reimer 1994, pp. 17–18; Daly and Magnacca 2003, pp. 9–10). Although the primary impact of ants on Hawaii’s native invertebrate fauna is via predation, they also compete for nectar (Reimer 1994, p. 17; Howarth 1985, p. 155; Hopper et al. 1996, p. 9; Holway et al. 2002, pp. 188, 209; Daly and Magnacca 2003, pp. 9; Lach 2008, p. 155) and nest sites (Krushelnycky 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 (Krushelnycky 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 1870 (Krushelnycky et al. 2005, p. 274). 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 habitats 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 amphialine pool shrimp, Procoris hawaiana, 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 naiaids, including those of the orangeblack Hawaiian damselfly, to stop foraging, reducing their growth, development, and survivability. In addition, backswimmers can directly feed on damselfly naiaids, 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 Presence of Threatening Disease and 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, moufflon, and moufflon-sheep hybrids) hunting opportunities on 91 State-designated public hunting areas (within 45 units) on all the main Hawaiian Islands except Kahoolawe and Nihau (HAR 2003, 13–123, rev 2010; HDLNR 2009, pp. 25–30); however, there are private hunting opportunities on Nihau (Nihau 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 assimilans, H. facialis, 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 HARS 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 HDLNRLNR 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 HARS 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 specific 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 hawaiiensis, 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 Animal Welfare Act, and conducts 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). Intestate 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 2011(11)). From a Federal perspective, there is 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 calvemens (miconia) and Cordataiera 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://dlnr.hawaii.gov/meetings-reports/proposededar, 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 and habitat (DLNR 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–5.5). 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. 2–12–14). 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 bulbul, 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 bulbul are already established in Hawaii, and are difficult and costly to control, or are not controlled at all. Additionally, a species may be 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 2015 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 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 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 (Hylabela 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 (Montevetschii 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. 33–35).
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 depresidential features of anchialine pools make them susceptible to dumping. Refuse found in degraded pools and pools that have been filled with rubble have been dated to about 100 years old, and the practice of dumping trash into pools continues today (Brock 2004, p. 15). For example, Lua O Palahemo (Hawaii Island) is located approximately 560 ft (170 m) from a sandy beach frequented by visitors who fish and swim. There are multiple dirt roads that surround the pool making it highly accessible. Plastic bags, paper, fishing line, water bottles, soda cans, radios, barbed wire, and a bicycle 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 hawaiiana, 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 hypogeal (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 hypogeal shrimp that are usually a dominant and essential faunal component of anchialine pool ecosystems (Brock 1993, p. 338–355). This 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 hawaiiana 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
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*, *Cytandra 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 haupuenisi*, and *Stenogyne kaalae* ssp. *sherfii* are extirpated; there is one remaining individual of *Deparia kaalana*, and only two individuals of *Phyllostegia brevidens*. *Kadua haupuenisi*, *Phyllostegia brevidens*, and *Stenogyne kaalae* ssp. *Sherfii* only exist in propagation.
- The following single-island endemic species are known from fewer than 250 individuals: *Asplenium diellaciniatum*, *Cyanea kauaulaensis*, *Cyperus neokunthianus*, *Cytandra hematos*, *Dryopteris glabra* var. *pusilla*, *Hypolepis hawaiensis* var. *mauiensis*, *Kadua haupuenisi*, *Labordia lorenciana*, *Lepidium orbiculare*, *Phyllostegia helleri*, *Pritchardia bakeri*, *Santalum involutum*, *Stenogyne kaalae* ssp. *sherfii*, and *Wikstroemia skottsbergiana*.

Animals  

Like most native island biota, the Hawaiian population of band-rumped storm-petrel, the orangeblack Hawaiian damselfly, the anchialine pool shrimp (*Procaris hawaiana*), and the seven yellow-faced bees are particularly sensitive to disturbances due to their diminished numbers of individuals and populations, and small geographic ranges. The band-rumped storm-petrel is represented in Hawaii by very small numbers of populations, and perhaps not more than a few hundred individuals (Harrison *et al.* 1990, p. 49). A single human-caused action such as establishment of mongoose on Kauai, or a hurricane during 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 populations because this species is known from only 25 of over 500 assessed anchialine pools on Hawaii Island, and from only 2 anchialine pools on Maui. Threats to *P. hawaiana* include: Habitat destruction and modification 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. hawaiana*.

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. assimilans* 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 of host plants; and predation or competition by nonnative ants, wasps, and bees.
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. 149), 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 Microlepis strigosa var. maulensis 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 Nothocestrum 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) 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. strenus (NCN), and Lasiosoglossum 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 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 Curtailment 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 effects 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, pp. 2, Figure 2). 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 remaining 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 substantially 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, as well as 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 orange-black 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 hawaiana 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 hawaiana.

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 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 hawaiana, and to the yellow-faced bees Hylaeeus anthracinus, H. assimulans, H. facilis, H. hilaris, H. kuakea, H. longiceps, and H. mana. The threat from limited numbers of individuals and populations is ongoing and is expected to continue into the future because: (1) A single catastrophic event may result in extirpation of remaining populations and extinction of these species; (2) species with few known occurrences are less resilient to threats that might otherwise have a relatively minor impact on widely-distributed species; (3) these species 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. mauerensis, 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, Nothocestrum latifolium, Phyllostegia brevidens, P. helleri, Pritchardia bakeri, Santalum involutum, Stenogyne kaaloa ssp. sherffii, and Wikstroemia skottsb ergiana. 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 threats from 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 (Nothocestrum latifolium, Portulaca villosa, Pseudognaphalium hawaiiensis var. mauerensis, Joinvillea ascendens ssp. ascendens, Kadua haupuensis, Labordia lorenciana, Lepidium orbiculare, Nothocestrum latifolium, Phyllostegia brevidens, P. helleri, Pritchardia bakeri, Santalum involutum, Stenogyne kaaloa ssp. sherffii, and Wikstroemia skottbergiana). 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 hawaiana, and to the yellow-faced bees Hylaeeus anthracinus, H. assimulans, H. facilis, H. hilaris, H. kuakea, H. longiceps, and H. mana. The threat from limited numbers of individuals and populations is ongoing and is expected to continue into the future because: (1) A single catastrophic event may result in extirpation of remaining populations and extinction of these species; (2) species with few known occurrences are less resilient to threats that might otherwise have a relatively minor impact on widely-distributed species; (3) these species 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. mauerensis, 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 Nothocestrum latifolium 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, Hylaeeus anthracinus, H. assimulans, H. facilis, 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 nestig 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.
sandwicensium var. molokaiense, and Solanum nelsonii) and six animals (the orangeblack Hawaiian damselfly, the anchialine pool shrimp (Procaris hawaiiana), Hylaea 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 hawaiensis var. mauliensis, and the anchialine pool shrimp) (Factor A). Fifteen of the plant species (Exocarpos menziesii, Festuca hawaiensis, Joinvillea ascendens ssp. ascendens, Labordia lorenciana, Nothocestrum latifolium, Ochrosia haleakalae, Phyllostegia stachyoides, Portulaca villosa, Ranunculus mauliensis, 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 kaalaena, Gardenia renyi, Joinvillea ascendens ssp. ascendens, Kadua fluvitilis, K. haupuensis, Labordia lorenciana, Lepidium orbiculare, Ochrosia haleakalae, Phyllostegia brevidens, P. helleri, P. stachyoides, Portulaca villosa, Pseudognaphalium sandwicensium var. molokaiense, Ranunculus hawaiensis, R. mauliensis, 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, treesfalls, 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 kaalaena, Hupezia stemmermanniae, Phyllostegia stachyoides, Ranunculus hawaiensis, R. mauliensis, Sanicula sandwicensis, Schiedea pubescens, Sicyos lanceoloideus, and Solanum nelsonii; and to the anchialine 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 hawaiiana. 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 renyi, Joinvillea ascendens ssp. ascendens, Labordia lorenciana, Lepidium orbiculare, and Nothocestrum 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 kaalaena, Dryopteris glabra var. pusilla, Exocarpos menziesii, Festuca hawaiensis, Gardenia renyi, Huperzia stemmermanniae, Hypolepis hawaiensis var. mauliensis, Joinvillea ascendens ssp. ascendens, Kadua fluvitilis, Kadua haupuensis, Labordia lorenciana, Lepidium orbiculare, Microlepia strigosa var. mauliensis, Myrsine fosbergii, Nothocestrum latifolium, Ochrosia haleakalae, Phyllostegia brevidens, Phyllostegia helleri, Phyllostegia stachyoides, Portulaca villosa, Pritchardia bakeri, Pseudognaphalium sandwicensium var. molokaiense, Ranunculus hawaiensis, Ranunculus mauliensis, Sanicula sandwicensis, Santalum involutum, Schiedea diffusa ssp. diffusa, Schiedea pubescens, Sicyos lanceoloideus, Sicyos macrophyllus, Solanum nelsonii, Stenogyne kaala ssp. sherfii, 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 hawaiiana), and the yellow-faced bees Hylaea anthracinus, Hylaea assimulans, Hylaea facils, Hylaea hilaris, Hylaea kuakea, Hylaea longiceps, and Hylaea 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 proposes for listing in this rule is highly restricted in its range, and 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)(D) 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 regard 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 from 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 hawaiana), and the seven yellow-faced bees by causing significant habitat modification or degradation such that it causes actual injury by significantly impairing essential behavior patterns. This may include introduction of nonnative species that compete with or prey upon the 10 animal species or the unauthorized release of biological control agents that attack the life stage of any of these 10 species.

(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 hawaiana 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
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 assimilans), “Bee, yellow-faced” (Hylaeus facilis), “Bee, yellow-faced” (Hylaeus hilaris), “Bee, yellow-faced” (Hylaeus kuakea), “Bee, yellow-faced” (Hylaeus longiceps), and “Bee, yellow-faced” (Hylaeus mana), and “Damselflly, orangeblack Hawaiian” (Megaglorion xanthomelas) in alphabetical order under INSECTS; and

c. By adding an entry for “Shrimp, anchialine pool” (Procaris hawaiiana), in alphabetical order under CRUSTACEANS.

The additions read as follows:

§17.11 Endangered and threatened wildlife.

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

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<th>Common name</th>
<th>Scientific name</th>
<th>Historic range</th>
<th>Vertebrate population where endangered or threatened</th>
<th>Status</th>
<th>When listed</th>
<th>Critical habitat</th>
<th>Special rules</th>
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### FLOWERING PLANTS

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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*, *Cyttandra hematos*, *Exocarpus menziesii*, *Festuca hawaiensis*, *Gardenia remyi*, *Joinvillea ascendens ssp. ascendens*, *Kadua fluviatilis*, *Kadua haupuensis*, *Labordia lorenciana*, *Lepidium orbiculare*, *Myrsine fosbergii*, *Nothocestrum latifolium*, *Ochrosia haleakalae*, *Phyllostegia brevidens*, *Phyllostegia helleri*, *Phyllostegia stachyoides*, *Portulaca villosa*, *Prichardia bakeri*, *Pseudognaphalium sandwicensium var. molekaian**, *Ranunculus hawaiensis*, *Ranunculus mauliensis*, *Sanicula sandwicensis*, *Santalum involutum*, *Schiedea diffusa ssp. diffusa*, *Schiedea pubescens*, *Sicyos lanceoloides*, *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 hawaiensis var. mauliensis*, *Microlepia strigosa var. mauliensis* in alphabetical order under FERNS AND ALLIES.

The additions read as follows:

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**Ferns and Allies**

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James W. Kurth,
Acting Director, U.S. Fish and Wildlife Service.