DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[Docket No. FWS–R1–ES–2012–0070; 4500030113]

RIN 1018–AY09

Endangered and Threatened Wildlife and Plants; Determination of Endangered Species Status for 15 Species on Hawaii Island

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Final rule.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), determine endangered species status under the Endangered Species Act of 1973 (Act), as amended, for 15 species on the island of Hawaii. In addition, we are recognizing a taxonomic change for one Hawaiian plant currently listed as an endangered species and revising the List of Endangered and Threatened Plants accordingly. The effect of this regulation is to conserve these species under the Act.

DATES: This rule is effective on November 29, 2013.

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

FOR FURTHER INFORMATION CONTACT: Loyal Mehrhoff, Field Supervisor, U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, 300 Ala Moana Boulevard, Room 3–122, Honolulu, HI 96850; by telephone at 808–792–9400; or by facsimile at 808–792–9581. If you use a telecommunications device for the deaf (TDD), call the Federal Information Relay Service (FIRS) at 800–877–8339.

SUPPLEMENTARY INFORMATION:

Executive Summary

Why we need to publish a rule. This is a final rule to list 15 species (13 plants, 1 insect (picture-wing fly), and 1 crustacean (anchialine pool shrimp)) from the island of Hawaii, in the State of Hawaii, as endangered species. In addition, in this final rule, we also recognize a taxonomic change for one endangered plant species, and revise the List of Endangered and Threatened Plants accordingly.

The basis for our action. Under the Act, we determine that a species is an endangered or threatened species based on any of five factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence. We have determined that the 15 Hawaii Island species are currently in danger of extinction throughout all their ranges as the result of ongoing threats that include the destruction and modification of habitat from nonnative feral ungulates (e.g., pigs, goats); competition with nonnative plant and animal species; agricultural and urban development; wildfire, erosion, drought, and hurricanes; climate change; predation and herbivory; the inadequacy of existing regulatory mechanisms; human dumping of nonnative fish and trash; small numbers of individuals and populations; hybridization; the lack of reproduction in the wild; loss of host plants; and competition with nonnative tipulid flies (large crane flies). We fully considered comments from the public, including comments we received during a public hearing, and comments we received from peer reviewers, on the proposed rule.

Peer reviewers support our methods. We obtained opinions from 11 knowledgeable individuals with scientific expertise to review our technical assumptions, to review our analysis, and to determine whether or not we used the best available information. Nine (2 plant reviewers, 2 picture-wing fly reviewers, and 5 of the 7 anchialine pool shrimp reviewers) of these 11 peer reviewers generally concurred with our methods and provided additional information, clarifications, and suggestions to improve this final rule. One shrimp peer reviewer recommended further surveys for the anchialine pool shrimp, and a second shrimp reviewer commented that we should proceed with caution regarding listing the shrimp due to the lack of biological information. A response to all peer review comments is provided elsewhere in this final rule.

The final critical habitat designation for *Bidens micrantha* ssp. *ctenophylla, Isodendrion pyrifolium,* and *Mezoneuron kavaiense,* as proposed in the **Federal Register** (77 FR 63928; October 17, 2012), is still under development and undergoing agency review. It will publish in the near future in the **Federal Register** under Docket No. FWS–R1–ES–2013–0028.

Previous Federal Actions

Federal actions for these species prior to October 17, 2012, are outlined in our proposed rule (77 FR 63928), which was published on that date. Publication of the proposed rule opened a 60-day comment period, which closed on December 17, 2012. In addition, we published a public notice of the proposed rule on October 20, 2012, in the local Honolulu Star Advertiser, West Hawaii Today, and the Hawaii Tribune Herald newspapers. On April 30, 2013, we published in the **Federal Register** a document (78 FR 25243) that made available and requested public comments on the draft economic analysis for the October 17, 2012, proposed critical habitat designation (77 FR 63928); announced a public information meeting and hearing to be held in Kailua-Kona, Hawaii Island, on May 15, 2013; and reopened the comment period on the October 17, 2012, proposed rule for an additional 30 days. This second comment period closed on May 30, 2013. In total, we accepted public comments on the October 17, 2012, proposed rule for 90 days.

Background

Hawaii Island Species Addressed in This Final Rule

The table below (Table 1) provides the scientific name, common name, and listing status for the species that are the subjects of this final rule.

TABLE 1—THE HAWAII ISLAND SPECIES ADDRESSED IN THIS FINAL RULE

[Note that many of the species share the same common name]

Scientific name	Common name(s)	Listing status
Plants:		
Bidens hillebrandiana ssp. *hillebrandiana*	kookoolau	Endangered.
Bidens micrantha ssp. *ctenophylla*	kookoolau	Endangered.
Cyanea marksii	haha	Endangered.
Cyanea tritomantha	aku	Endangered.
Cyrtandra nanawaleensis	haiwale	Endangered.
Cyrtandra wagneri	haiwale	Endangered.
Mezoneuron kavaiense (taxonomic change accepted) (Formerly listed as *Caesalpinia kavaiense*).	uhiuhi	Endangered—Listed in 1986.
Phyllostegia floribunda	NCN [1]	Endangered.
Pittosporum hawaiiense	hoawa, haawa	Endangered.
Platydesma remyi	NCN	Endangered.
Pritchardia lanigera	loulu	Endangered.
Schiedea diffusa ssp. *macraei*	NCN	Endangered.
Schiedea hawaiiensis	NCN	Endangered.
Stenogyne cranwelliae	NCN	Endangered.
Animals:		
Drosophila digressa	picture-wing fly	Endangered.
Vetericaris chaceorum	anchialine pool shrimp	Endangered

[1] NCN = no common name.

Taxonomic Change Since Listing for One Plant Species

We listed *Mezoneuron kavaiense* as an endangered species in 1986 (51 FR 24672; July 8, 1986), based on the taxonomic treatment of Hillebrand (1888, pp. 110–111). Following the reduction of *Mezoneuron* to *Caesalpinia* by Hattink (1974, p. 5), Geesink *et al.* (1990, pp. 646–647) changed the name to *Caesalpinia kavaiensis.* In 1989, the List of Endangered and Threatened Plants (List) was revised to identify the listed entity as *Caesalpinia kavaiense,* although the specific epithet was misspelled in the List (at that time the correct spelling for this entity was *Caesalpinia kavaiensis*). Recent phylogenetic studies support separation of *Mezoneuron* from *Caesalpinia* (Bruneau *et al.* 2008, p. 710). The recognized scientific name for this species is *Mezoneuron kavaiense* (Wagner *et al.* 2012, p. 37). The range of the species between the time of listing and now has not changed. Therefore, we recognize the listed species as *Mezoneuron kavaiense.* We are amending the List to reflect this taxonomic change, but this amendment does not in any way change the listed entity or its protections under the Act (16 U.S.C. 1531 *et seq.*).

An Ecosystem-Based Approach to Listing 15 Species on Hawaii Island

On the island of Hawaii, as on most of the Hawaiian Islands, native species that occur in the same habitat types (ecosystems) depend on many of the same biological features and the successful functioning of that ecosystem to survive. We have therefore organized the species addressed in this final rule by common ecosystem. Although the listing determination for each species is analyzed separately, we have organized the individual analysis for each species within the context of the broader ecosystem in which it occurs to avoid redundancy. In addition, native species that share ecosystems often face a suite of common factors that may be a threat to them, and ameliorating or eliminating these threats for each individual species often requires the exact same management actions in the exact same areas. Effective management of these threats often requires implementation of conservation actions at the ecosystem scale to enhance or restore critical ecological processes and provide for long-term viability of those species in their native environment. Thus, by taking this approach, we hope not only to organize this final rule efficiently, but also to more effectively focus conservation management efforts on the common threats that occur across these ecosystems. Those efforts would facilitate restoration of ecosystem functionality for the recovery of each species, and provide conservation benefits for associated native species, thereby potentially precluding the need to list other species under the Act that occur in these shared ecosystems. In addition, this approach is in accord with the primary stated purpose of the Act (see section 2(b)): ''to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved.''

We are listing the plants *Bidens hillebrandiana* ssp. *hillebrandiana, Bidens micrantha* ssp. *ctenophylla, Cyanea marksii, Cyanea tritomantha, Cyrtandra nanawaleensis, Cyrtandra wagneri, Phyllostegia floribunda, Pittosporum hawaiiense, Platydesma remyi, Pritchardia lanigera, Schiedea diffusa* ssp. *macraei, Schidea hawaiiensis,* and *Stenogyne cranwelliae;* and the animals *Drosophila digressa* and *Vetericaris chaceorum,* from Hawaii Island as endangered species. These 15 species (13 plants, 1 anchialine pool shrimp, and 1 picture-wing fly) are found in 10 ecosystem types: anchialine pool, coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, dry cliff, and wet cliff (Table 2).

TABLE 2—THE 15 HAWAII ISLAND SPECIES AND THE ECOSYSTEMS UPON WHICH THEY DEPEND

Ecosystem	Species	
	Plants	Animals
Anchialine Pool		*Vetericaris chaceorum.*

TABLE 2—THE 15 HAWAII ISLAND SPECIES AND THE ECOSYSTEMS UPON WHICH THEY DEPEND—Continued

Ecosystem	Species	
	Plants	Animals
Coastal	*Bidens hillebrandiana* ssp. *hillebrandiana*.	
Lowland Dry	*Bidens micrantha* ssp. *ctenophylla*.	
Lowland Mesic	*Pittosporum hawaiiense*	*Drosophila digressa*.
	Pritchardia lanigera.	
Lowland Wet	*Cyanea marksii*.	
	Cyanea tritomantha.	
	Cyrtandra nanawaleensis.	
	Cyrtandra wagneri.	
	Phyllostegia floribunda.	
	Platydesma remyi.	
	Pritchardia lanigera.	
Montane Dry	*Schiedea hawaiiensis*.	
Montane Mesic	*Phyllostegia floribunda*	*Drosophila digressa*.
	Pittosporum hawaiiense.	
Montane Wet	*Cyanea marksii*	*Drosophila digressa*.
	Cyanea tritomantha.	
	Phyllostegia floribunda.	
	Pittosporum hawaiiense.	
	Platydesma remyi.	
	Pritchardia lanigera.	
	Schiedea diffusa ssp. *macraei*.	
	Stenogyne cranwelliae.	
Dry Cliff	*Bidens hillebrandiana* ssp. *hillebrandiana*.	
Wet Cliff	*Cyanea tritomantha*.	
	Pritchardia lanigera.	
	Stenogyne cranwelliae.	

For each species, we identified and evaluated those factors that adversely impact the species and that may be common to all of the species at the ecosystem level. For example, the degradation of habitat by nonnative ungulates is considered a threat to all 15 species, and is likely a threat to many, if not most or all, of the native species within a given ecosystem. We consider such a threat factor to be an ''ecosystem-level threat,'' as each individual species within that ecosystem faces a threat that is essentially identical in terms of the nature of the impact, its severity, its timing, and its scope. Beyond ecosystem-level threats, we further identified and evaluated threat factors that may be unique to certain species and that do not apply to all species under consideration within the same ecosystem. For example, the threat of predation by nonnative wasps is unique to the picture-wing fly *Drosophila digressa,* and is not applicable to any of the other 14 species. We have identified such threat factors, which apply only to certain species within the ecosystems addressed here, as ''species-specific threats.''

Please refer to the proposed rule (77 FR 63928; October 17, 2012) for a description of the island of Hawaii and associated map, and for a description of the 10 ecosystems on Hawaii Island that support the 15 species. We have made minor revisions to our description of the anchialine pool ecosystem described in the proposed rule (77 FR 63928; October 17, 2012); therefore, we have included the revised version in its entirety in this final rule (see *Hawaii Island Ecosystems,* below).

Hawaii Island Ecosystems

There are 12 different ecosystems (anchialine pool, coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, subalpine, alpine, dry cliff, and wet cliff) recognized on the island of Hawaii. The 15 species addressed in this final rule occur in 10 of these 12 ecosystems (none of the 15 species are reported in subalpine and alpine ecosystems). The 10 Hawaii Island ecosystems that support the 15 species are described in the proposed rule (77 FR 63928; October 17, 2012), with the exception of a revised description of the anchialine pool ecosystem below; see Table 2 (above) for a list of the species that occur in each ecosystem type.

Anchialine Pools

Anchialine pools are land-locked bodies of water that have indirect underground connections to the sea, contain varying levels of salinity, and show tidal fluctuations in water level. Anchialine pool habitats can be distinguished from similar systems (i.e., tidal pools) in that they are land-locked with no surface connections to water sources either saline or fresh, but have subterranean hydrologic connections to both fresh and ocean water where water flows through cracks and crevices, and remain tidally influenced (Holthuis 1973, p. 3; Stock 1986, p. 91). Anchialine habitats are ecologically distinct and unique, and while widely distributed throughout the world, they only occur in the United States in the Hawaiian Islands (Brock 2004, pp. i, 2, and 12). In Hawaii, the anchialine pool ecosystem has been reported from Oahu, Molokai, Maui, Kahoolawe, and Hawaii Island. In the Hawaiian Islands, there are estimated to be 600 to 700 anchialine pools, with the majority occurring on the island of Hawaii (Brock 2004, p. i). Over 80 percent of the State's anchialine pools are found on the island of Hawaii, with a total of approximately 520 to 560 pools distributed over 130 sites along all but the island's northernmost and steeper northeastern shorelines. Characteristic animal species include crustaceans (e.g., shrimps, prawns, amphipods, isopods, etc.), several fish species, mollusks, and other invertebrates adapted to the pools' surface and subterranean habitats (Brock 2004, p. i; The Nature Conservancy (TNC) 2009, pp. 1–3). Generally, vegetation within the anchialine 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 groundcover, shrub, and tree species (Chai *et al.* 1989, pp. 2–24; Brock 2004, p. 35). The anchialine pool shrimp in this final rule, *Vetericaris chaceorum,* occurs in this ecosystem (Kensley and Williams 1986, pp. 417–437).

Description of the 15 Species

Below is a brief description of each of the 15 species, presented in alphabetical order by genus. Plants are presented first, followed by animals.

Plants

In order to avoid confusion regarding the number of locations of each species (a location does not necessarily represent a viable population, as in some cases there may only be one or a very few representatives of the species present), we use the word ''occurrence'' instead of ''population.'' Each occurrence is composed only of wild (i.e., not propagated and outplanted) individuals.

Bidens hillebrandiana ssp. *hillebrandiana* (kookoolau), a perennial herb in the sunflower family (Asteraceae), occurs only on the island of Hawaii (Ganders and Nagata 1999, pp. 275–276). Historically, *B. hillebrandiana* ssp. *hillebrandiana* was known from two locations along the windward Kohala coastline, in the coastal and dry cliff ecosystems, often along rocks just above the ocean (Degener and Wiebke 1926, in litt.; Flynn 1988, in litt.). Currently, there are two known occurrences of *B. hillebrandiana* ssp. *hillebrandiana* totaling 40 or fewer individuals along the windward Kohala coast, in the coastal and dry cliff ecosystems. There are 30 individuals on the Pololu seacliffs, and 5 to 10 individuals on the seacliffs between Pololu and Honokane Nui (Perlman 1998, in litt.; Perlman 2006, in litt.). Biologists speculate that this species may total as many as 100 individuals with further surveys of potential habitat along the Kohala coast (Mitchell *et al.* 2005b; PEPP 2006, p. 3).

Bidens micrantha ssp. *ctenophylla* (kookoolau), a perennial herb in the sunflower family (Asteraceae), occurs only on the island of Hawaii (Ganders and Nagata 1999, pp. 271, 273). Historically, *B. micrantha* ssp. *ctenophylla* was known from the north Kona district, in the lowland dry ecosystem (HBMP 2010b). Currently, this subspecies is restricted to an area of less than 10 square miles (sq mi) (26 square kilometers (sq km)) on the leeward slopes of Hualalai volcano, in the lowland dry ecosystem in 6 occurrences totaling fewer than 1,000 individuals. The largest occurrence is found off Hina Lani Road with over 475 individuals widely dispersed throughout the area (Zimpfer 2011, in litt.). Another occurrence at Kealakehe was reported to have been abundant and common in 1992, but by 2010 had declined to low numbers (Whister 2007, pp. 1–18; Bio 2008, in litt.; HBMP 2010b; Whister 2008, pp. 1–11). In addition, there are three naturally occurring individuals in Kaloko–Honokohau National Historical Park (NHP) (Beavers 2010, in litt.), and three occurrences within close proximity to each other to the northeast of the park: Five individuals in an exclosure at Puuwaawaa Wildlife Sanctuary (HBMP 2010b); a few scattered individuals at Kaupulehu; and a few individuals on private land at Palani Ranch (Whistler 2007, pp. 1–18; Whistler 2008, pp. 1–11). *Bidens micrantha* ssp. *ctenophylla* has also been outplanted within Kaloko–Honokohau NHP (49 individuals), Koaia Tree Sanctuary (1 individual), and Puuwaawaa (5 individuals) (Boston 2008, in litt.; HBMP 2010b; Billings 2012, in litt.).

Cyanea marksii (haha), a shrub in the bellflower family (Campanulaceae), is found only on the island of Hawaii. Historically, *C. marksii* was known from the Kona district, in the lowland wet and montane wet ecosystems (Lammers 1999, p. 457; HBMP 2010e). Currently, there are 27 individuals distributed among 3 occurrences in south Kona, in the lowland wet and montane wet ecosystems (PEPP 2007, p. 61). There is an adult and 20 to 30 juveniles (each approximately 1 inch (in) (2.54 centimeters (cm) tall)) in a lava tube in the Kona unit of the Hakalau National Wildlife Refuge (NWR) (PEPP 2007, p. 61), 3 adult individuals and 6 seedlings in the Kaohe pit crater in the South Kona FR (Perry 2012, in litt.), and 25 individuals on private land in south Kona (PEPP 2007, p. 61; Bio 2011, pers. comm.). Fruit has been collected from the individuals on private land, and 11 plants have been successfully propagated at the Volcano Rare Plant Facility (VRPF) (PEPP 2007, p. 61; Bio 2011, pers. comm.).

Cyanea tritomantha (aku), a palmlike shrub in the bellflower family (Campanulaceae), is known only from the island of Hawaii (Pratt and Abbott 1997, p. 13; Lammers 2004, p. 89). Historically, this species was known from the windward slopes of Mauna Kea, Mauna Loa, Kilauea, and the Kohala Mountains, in the lowland wet, montane wet, and wet cliff ecosystems (Pratt and Abbott 1997, p. 13). Currently, there are 16 occurrences of *Cyanea tritomantha* totaling fewer than 400 individuals in the lowland wet, montane wet, and wet cliff ecosystems: 10 occurrences (totaling fewer than 240 individuals) in the Kohala Mountains (Perlman 1993, in litt.; Perlman 1995a, in litt.; Perlman and Wood 1996, pp. 1–14; HBMP 2010f; PEPP 2010, p. 60); 2 occurrences (totaling fewer than 75 individuals) in the Laupahoehoe Natural Area Reserve (NAR) (HBMP 2010f; Bio 2011, pers. comm.); 1 occurrence (20 adults and 30 juveniles) at Puu Makaala NAR (Perlman and Bio 2008, in litt.; Agorastos 2010, in litt.; HBMP 2010f; Bio 2011, pers. comm.); 1 occurrence with 10 to 20 individuals off Tom's Trail in the Upper Waiakea Forest Reserve FR (Perlman and Bio 2008, in litt.; Perry 2012, in litt.); and 2 occurrences (totaling fewer than 11 individuals) in Olaa Tract in Hawaii Volcanoes National Park HVNP (Pratt 2007a, in litt.; Pratt 2008a, in litt.; Orlando 2012, in litt.). In 2003, over 75 individuals were outplanted in HVNP's Olaa Tract and Small Tract; however, by 2010, less than one third of these individuals remained (Pratt 2011a, in litt.). In addition, a few individuals have been outplanted at Puu Makaala NAR and Upper Waiakea FR (Hawaii Department of Land and Natural Resources (HDLNR) 2006; Belfield 2007, in litt.; Agorastos 2010, in litt.). *Cyanea tritomantha* produces few seeds, and their viability tends to be low (Moriyasu 2009, in litt.)

Cyrtandra nanawaleensis (haiwale), a shrub or small tree in the African violet family (Gesneriaceae), is known only from the island of Hawaii (Wagner and Herbst 2003, p. 29; Wagner *et al.* 2005a—*Flora of the Hawaiian Islands database*). Historically, *C. nanawaleensis* was known only from the Nanawale FR and the adjacent Malama Ki FR in the Puna district, in the lowland wet ecosystem (St. John 1987, p. 500; Wagner *et al.* 1988, in litt.; HBMP 2010g; Pratt 2011b, in litt.). Currently, *C. nanawaleensis* is known from 5 occurrences with approximately 160 individuals in the lowland wet ecosystem: 2 occurrences in Malama Ki FR totaling 70 individuals (Lau 2011, pers. comm.); 1 occurrence in Keauohana FR (with 56 individuals) (Magnacca 2011a, in litt.); 2 occurrences in the Halepuaa section of Nanawale FR (one with 28 mature and 65 immature plants at 200 feet (ft) (61 meters (m)) elevation, and a second occurrence with 9 mature and 57 immature plants at 270 ft (82 m)) (Johansen 2012, in litt.; Kobsa 2012, in litt.; Perry 2012, in litt.); and 1 occurrence with an unknown number of individuals on private lands in lower Puna (Perry 2012, in litt.). A total of approximately 56 individuals have been outplanted in Halepuaa and Keauhana (Perry 2012, in litt.).

Cyrtandra wagneri (haiwale), a shrub or small tree in the African violet family (Gesneriaceae), occurs only on the island of Hawaii (Lorence and Perlman 2007, p. 357). Historically, *C. wagneri* was known from a few individuals along the steep banks of the Kaiwilahilahi Stream in the Laupahoehoe NAR, in the lowland wet ecosystem (Perlman *et al.* 1998, in litt.). In 2002, there were 2 known occurrences totaling fewer than 175 individuals in the Laupahoehoe NAR: One occurrence (totaling 150 individuals (50 adults and 100 juveniles)) along the steep banks of the Kilau Stream (Lorence *et al.* 2002, in litt.; Perlman and Perry 2003, in litt.; Lorence and Perlman 2007, p. 359), and a second occurrence (with approximately 10 sterile individuals) along the slopes of the Kaiwilahilahi stream banks (Lorence and Perlman 2007, p. 359). Currently, there are no individuals remaining at Kaiwilahilahi Stream, and the individuals at Kilau Stream appear to be hybridizing with the endangered *Cyrtandra tintinnabula.* Biologists have identified only eight individuals at Kilau Stream that express the true phenotype of *Cyrtandra wagneri,* and only three of these individuals are reproducing successfully (PEPP 2010, p. 102; Bio 2011, pers. comm.).

Phyllostegia floribunda (NCN), a perennial herb in the mint family (Lamiaceae), is found only on the island of Hawaii (Wagner 1999, p. 268; Wagner *et al.* 1999b, p. 815). Historically, *P. floribunda* was reported in the lowland wet, montane mesic, and montane wet ecosystems at scattered sites along the slopes of the Kohala Mountains; southeast through Hamakua, Laupahoehoe NAR, Waiakea FR, and Upper Waiakea FR; and southward into Hilo, HVNP, and Puna. One report exists of the species occurring from north Kona and a few occurrences in south Kona (Cuddihy *et al.* 1982, in litt.; Wagner *et al.* 2005b—*Flora of the Hawaiian Islands database;* Perlman *et al.* 2008, in litt.; HBMP 2010h; Bishop Museum 2011—*Herbarium Database*). Currently, there are 12 known occurrences of *P. floribunda* totaling fewer than 100 individuals, in the lowland wet, montane mesic, and montane wet ecosystems (Bruegmann 1998, in litt.; Giffin 2009, in litt.; HBMP 2010h): 2 occurrences within HVNP, at Kamoamoa (1 individual) (HBMP 2010h) and near Napau Crater (4 individuals) (Pratt 2005, in litt.; Pratt 2007b, in litt.; HBMP 2010h); 1 occurrence behind the Volcano solid waste transfer station (10 to 50 individuals) (Flynn 1984, in litt.; Perlman and Wood 1993—*Hawaii Plant Conservation Maps database;* Pratt 2007b, in litt.; HBMP 2010h); 1 occurrence (with an unknown number individuals) in the Wao Kele O Puna NAR (HBMP 2010h); 1 occurrence with 20 individuals in a fenced exclosure in the Upper Waiakea FR (Perry 2012, in litt.); at least 1 occurrence each (with a few individuals each) in the Puu Makaala NAR, Waiakea FR, and TNC's Kona Hema Preserve (PR) (Perry 2006, in litt.; Perlman 2007, in litt.; Giffin 2009, in litt.; PEPP 2008, pp. 106–107; Perlman *et al.* 2008, in litt.; Pratt 2008a, in litt.; Pratt 2008b, in litt.; Agorastos 2010, in litt.); 2 occurrences (each with an unknown number of individuals) from the South Kona FR; 1 occurrence (one individual) in the Kipahoehoe NAR; and 1 occurrence (with an unknown number of individuals) in the Lapauhoehoe NAR (Moriyasu 2009, in litt.; HBMP 2010h; Agorastos 2010, in litt.). Since 2003, over 400 individuals have been outplanted at HVNP, Waiakea FR, Puu Makaala NAR, Honomalino in TNC's Kona Hema PR, and Kipahoehoe NAR (Bruegmann 2006, in litt.; HDLNR 2006, p. 38; Tangalin 2006, in litt.; Belfield 2007, in litt.; Pratt 2007b, in litt.; VRPF 2008, in litt.; VRPF 2010, in litt.; Bio 2008, in litt.; Agorastos 2010, in litt.). However, for reasons unknown, approximately 90 percent of the outplantings experience high seedling mortality (Pratt 2007b, in litt.; Van DeMark *et al.* 2010, pp. 24–43).

Pittosporum hawaiiense (hoawa, haawa), a small tree in the pittosporum family (Pittosporaceae), is known only from the island of Hawaii (Wagner *et al.* 1999c, p. 1,044). Historically, *P. hawaiiense* was known from the leeward side of the island, from the Kohala Mountains south to Kau, in the lowland mesic, montane mesic, and montane wet ecosystems (Wagner *et al.* 1999c, p. 1,044). Currently, there are 14 known occurrences totaling fewer than 175 individuals, from HVNP to Puu O Umi NAR, and south Kona, in the lowland mesic, montane mesic, and montane wet ecosystems: 1 occurrence in Puu O Umi NAR (several scattered individuals) (Perlman 1995b, in litt.); 1 occurrence (with a least one individual) in TNC's Kona Hema PR (Oppenheimer *et al.* 1998, in litt.); 1 occurrence with 50 to 100 individuals at Kukuiopae in the South Kona FR (Perlman and Perry 2002, in litt.; Perry 2012, in litt.); 1 occurrence (with a few individuals) in the Manuka NAR (Perry 2011, in litt.); 8 occurrences (totaling fewer than 58 individuals) scattered within the Kahuku unit of HVNP; 1 occurrence in the Olaa FR (at least one individual), just adjacent to the Olaa Tract in HVNP; and 1 occurrence (with fewer than 6 individuals) at the Volcano solid waste transfer station (Wood and Perlman 1991, in litt.; McDaniel 2011a, in litt.; McDaniel 2011b, in litt.; Pratt 2011d, in litt.). Biologists have observed very low regeneration in these occurrences, which is believed to be caused, in part, by rat predation on the seeds (Bio 2011, pers. comm.).

Platydesma remyi (NCN), a shrub or shrubby tree in the rue family (Rutaceae), occurs only on the island of Hawaii (Stone *et al.* 1999, p. 1210; USFWS 2010, pp. 4–66—4–67, A–11, A–74). Historically, *P. remyi* was known from a few scattered individuals on the windward slopes of the Kohala Mountains and several small populations on the windward slopes of Mauna Kea, in the lowland wet and montane wet ecosystems (Stone *et al.* 1999, p. 1210; HBMP 2010i). Currently, *P. remyi* is known from 8 occurrences totaling fewer than 40 individuals, all of which are found in the Laupahoehoe NAR or in closely surrounding areas, in the lowland wet and montane wet ecosystems: Along the banks of Kaiwilahilahi Stream in the Laupahoehoe NAR (unknown number of individuals) (Perlman and Perry 2001, in litt.; Bio 2008, in litt.; HBMP 2010i); near the Spencer Hunter Trail in the Laupahoehoe NAR (fewer than 17 individuals) (PEPP 2010, p. 102); in the central part of the Laupahoehoe NAR (5 to 6 scattered individuals) (HBMP 2010i); near Kilau (1 to 3 individuals) and Pahale (1 to 3 individuals) Streams in Laupahoehoe NAR; in the southeastern region of Laupahoehoe NAR (1 individual); in the Hakalau unit of the Hakalau NWR (1 individual) (USFWS 2010, p. 4–74—4–75); and in the Humuula region of the Hilo FR (2 individuals) (Bruegmann 1998, in litt.; Bio 2008, in litt.; PEPP 2008, p. 107; HBMP 2010i). According to field biologists, this species appears to be declining with no regeneration believed to be caused, in part, by rat predation on the seeds (Bio 2011, pers. comm.). In 2009, 29 individuals of *P. remyi* were outplanted in Laupahoehoe NAR (Bio 2008, in litt.). Their current status is unknown.

Pritchardia lanigera (loulu), a medium-sized tree in the palm family (Arecaceae), is found only on the island of Hawaii (Read and Hodel 1999, p. 1,371; Hodel 2007, pp. 10, 24–25). Historically, *P. lanigera* was known from the Kohala Mountains, Hamakua district, windward slopes of Mauna Kea, and southern slopes of Mauna Loa, in the lowland mesic, lowland wet, montane wet, and wet cliff ecosystems (Read and Hodel 1999, p. 1,371; HBMP 2010c). Currently, *P. lanigera* is known from 8 occurrences totaling fewer than 230 individuals scattered along the windward side of the Kohala Mountains, Kau FR, and TNC Kau Preserve, in the lowland mesic, lowland wet, montane wet, and wet cliff ecosystems. Approximately 100 to 200 individuals are scattered over 1 sq mi (3 sq km) in Waimanu Valley and surrounding areas (Wood 1995, in litt.; Perlman and Wood 1996, p. 6; Wood 1998, in litt.; Perlman *et al.* 2004, in litt.; HBMP 2010c). There are at least five individuals in the back rim of Alakahi Gulch in Waipio Valley (HBMP 2010c), and five individuals in the Kau FR (Perry 2013, in litt.) According to field biologists, pollination rates appear to be low for this species, and the absence of seedlings and juveniles at known locations suggests that regeneration is not occurring, which they believe to be caused, in part, by beetle, rat, and pig predation on the fruits, seeds, and seedlings (Bio 2011, pers. comm.; Crysdale 2013, pers. comm.).

Schiedea diffusa ssp. *macraei* (NCN), a perennial climbing herb in the pink family (Caryophyllaceae), is reported only from the island of Hawaii (Wagner *et al.* 2005c—*Flowering Plants of the Hawaiian Islands database;* Wagner *et al.* 2005d, p. 106). Historically, *S. diffusa* ssp. *macraei* was known from the Kohala Mountains, the windward slopes of Mauna Loa, and the Olaa Tract of HVNP, in the montane wet ecosystem (Perlman *et al.* 2001, in litt.; Wagner *et al.* 2005d, p. 106; HBMP 2010j). Currently, there is one individual of *S. diffusa* ssp. *macraei* on the slopes of Eke in the Kohala Mountains, in the montane wet ecosystem (Wagner *et al.* 2005d, p. 106; Bio 2011, pers. comm.).

Schiedea hawaiiensis (NCN), a perennial herb or subshrub in the pink family (Caryophyllaceae), is known only from the island of Hawaii (Wagner *et al.* 2005d, pp. 92–96). Historically, *S. hawaiiensis* was known from a single collection by Hillebrand (1888, p. 33) from the Waimea region, in the montane dry ecosystem (Wagner *et al.* 2005d, pp. 92–96). Currently, *S. hawaiiensis* is known from 25 to 40 individuals on the U.S. Army's Pohakuloa Training Area (PTA) in the montane dry ecosystem, in the saddle area between Moana Loa and Mauna Kea (Gon III and Tierney 1996 in Wagner *et al.* 2005d, p. 92; Wagner *et al.* 2005d, p. 92; Evans 2011, in litt.). In addition, there are over 150 individuals outplanted at PTA (Kipuka Alala and Kalawamauna), Puu Huluhulu, Puu Waawaa, and Kipuka Oweowe (Evans 2011, in litt.).

Stenogyne cranwelliae (NCN), a vine in the mint family (Lamiaceae), is known only from the island of Hawaii. Historically, *S. cranwelliae* was known from the Kohala Mountains, in the montane wet and wet cliff ecosystems (Weller and Sakai 1999, p. 837). Currently, there are 6 occurrences of *S. cranwelliae* totaling fewer than 160 individuals in the Kohala Mountains, in the montane wet and wet cliff ecosystems: Roughly 1.5 sq mi (2.5 sq km) around the border between the Puu O Umi NAR and Kohala FR, near streams and bogs (ranging from 3 to 100 scattered individuals) (Perlman and Wood 1996, pp. 1–14; HBMP 2010k); Opaeloa, in the Puu O Umi NAR (3 individuals) (Perlman and Wood 1996, pp. 1–14; HBMP 2010k); Puukapu, in the Puu O Umi NAR (6-by-6-ft (2-by-2-m) ''patch'' of individuals) (HBMP 2010k); the rim of Kawainui Gulch (1 individual) (Perlman and Wood 1996, pp. 1–14; HBMP 2010k); along Kohakohau Stream, in the Puu O Umi NAR (a few individuals) (Perlman and Wood 1996, pp. 1–14; HBMP 2010k); and Waimanu Bog Unit in the Puu O Umi NAR (a ''patch'' of individuals) (Agorastos 2010, in litt.)

Animals

Drosophila digressa (picture-wing fly), a member of the family Drosophilidae, was described in 1968 by Hardy and Kaneshiro and is found only on the island of Hawaii (Hardy and Kaneshiro 1968, pp. 180–1882; Carson 1986, p. 3–9). This species is small, with adults ranging in size from 0.15 to 0.19 in (4.0 to 5.0 mm) in length. Adults are brownish yellow in color and have yellow-colored legs and hyaline (shiny-clear) wings with prominent brown spots. Breeding generally occurs year round, but egg laying and larval development increase following the rainy season as the availability of decaying matter, which picture-wing flies feed on, increases in response to heavy rains. In contrast to most continental Drosophilidae, many endemic Hawaiian species are highly host-plant-specific (Magnacca *et al.* 2008, p. 1). *Drosophila digressa* relies on the decaying stems of *Charpentiera* spp. and *Pisonia* spp. for oviposition (to deposit or lay eggs) and larval substrate (Magnacca *et al.* 2008, pp. 11, 13; Magnacca 2013, in litt.). The larvae complete development in the decaying tissue before dropping to the soil to pupate (Montgomery 1975, pp. 65–103; Spieth 1986, p. 105). Pupae develop into adults in approximately 1 month, and adults sexually mature 1 month later. Adults live for 1 to 2 months. The adult flies are generalist microbivores (microbe eating) and feed upon a variety of decomposing plant material. *Drosophila digressa* occurs in elevations ranging from approximately 2,000 to 4,500 ft (610 to 1,370 m), in the lowland mesic, montane mesic, and montane wet ecosystems (Magnacca 2011a, pers. comm.). Historically, *D. digressa* was known from six sites: Moanuiahea pit crater on Hualalai, Papa in South Kona, Manuka FR, Kipuka 9 along Saddle Road, Bird Park in HVNP, and Olaa FR (Montgomery 1975, p. 98; Magnacca 2006, pers. comm.; HBMP 2010d; Magnacca 2011b, in litt.; Kaneshiro 2013, in litt.). Currently, *D. digressa* is known from only two locations, one population in the Manuka NAR within the Manuka FR, in the lowland mesic and montane mesic ecosystems, and a second population in the Olaa FR in the montane wet ecosystem (Magnacca 2011b, in litt.). The current number of individuals at each of these locations is unknown (Magnacca 2011b, in. litt.).

Vetericaris chaceorum (anchialine pool shrimp) is a member of the family Procarididae, and is considered one of the most primitive shrimp species in the world (Kensley and Williams 1986, pp. 428–429). Currently known from only two locations on the island of Hawaii, *V. chaceorum* is one of seven described species of hypogeal (underground) shrimp found in the Hawaiian Islands that occur in anchialine pools (Brock 2004, p. 6). Relatively large in size for a hypogeal shrimp species, adult *Vetericaris chaceorum* measure approximately 2.0 in (5.0 cm) in total body length, excluding the primary antennae, which are approximately the same length as the adult's body length (Kensley and Williams 1986, p. 419). The species lacks large chelapeds (claws) (Kensley and Williams 1986, p. 426), which are a key diagnostic characteristic of all other known shrimp species. *V. chaceorum* is largely devoid of pigment and lacks eyes, although eyestalks are present (Kensley and Williams 1986, p. 419). Observations of *Vetericaris chaceorum* indicate the species is a strong swimmer and propels its body forward in an upright manner with its appendages held in a basket formation below the body. Forward movement is produced by a rhythmic movement of the thoracic and abdominal appendages, and during capture of some specimens, *V. chaceorum* escape tactics included only forward movement and a notable lack of tail flicking, which would allow backward movement and which is common to other shrimp species

(Kensley and Williams 1986, p. 426). No response was observed when the species was exposed to light (Kensley and Williams 1986, p. 418).

The feeding habits of *Vetericaris chaceorum* were unknown for decades with the only published data from Kensley and Williams (1986, p. 426), who reported that the gut contents of a captured specimen included large quantities of an orange-colored oil and fragments of other crustaceans, indicating that the species may be carnivorous upon its associated anchialine pool shrimp species. Sakihara (2012, in litt.) recently confirmed that *V. chaceorum* is carnivorous after observing *V. chaceorum* collected from Manuaka Natural Area Reserve actively feeding on *Halocaridina rubra* in the laboratory. In general, hypogeal shrimp occur within both the illuminated part of their anchialine pool habitat as well as within the cracks and crevices in the water table below the surface (Brock 2004, p. 6). The relative abundance of some Hawaii species is directly tied to food abundance (Brock 2004, p. 10). The lighted environment of anchialine pools offers refugia of high benthic productivity, resulting in higher population levels for the shrimp compared to the surrounding interstitial spaces often occupied by these species, albeit in lower numbers (Brock 2004, p. 10; Wada 2013, pers. comm.).

Although over 400 of the estimated 520 to 560 anchialine pool habitats have been surveyed on the island of Hawaii, *Vetericaris chaceorum* has only been documented from two locations: Lua o Palahemo, which is a submerged lava tube located on the southernmost point of Hawaii Island in an area known as Ka Lae (South Point) (Kensley and Williams 1986, pp. 417–418; Brock 2004, p. 2; HBMP 2010), and at Manuka, where only recently *V. chaceorum* was discovered in a series of pristine shallow anchialine pool complexes within and adjacent to the NAR, approximately 15 mi (25 km) northwest of Lua o Palahemo (Sakihara 2012, in litt.). The Service has concluded that the lack of detection of this species in the several hundred anchialine pools surveyed on the island of Hawaii since the 1970s suggests this species has a very limited range (Holthius 1973, pp. 1–128 cited in Sakihara 2012, pp. 83, 91, and 93; Maciolek and Brock 1974, pp. 1–73; Maciolek 1983, pp. 606–618; Kensley and Williams 1986, pp. 417–426; Maciolek 1987, pp. 1–23; Chai *et al.* 1989, pp. 1–37; Chan 1995, pp. 1–31; Brock and Kam 1997, pp. 1–109; Bozanic 2004, p. 1; Brock 2004, pp. 1–60; Sakihara 2009, pp. 1–35; Sakihara 2012, pp. 83–95; Wada 2012, pers. comm.; Wada *et al.* 2012, pp. 1–2; Sakihara 2013 in litt.). In total, only five individuals have been observed during one survey period in 1985 at Lua o Palahmo, and a total of seven individuals were observed in four pools during surveys conducted between 2009 and 2010 at Manuka. These two locations are described below.

Lua o Palahemo Site: Age estimates for Lua o Palahemo range from as young as 11,780 years to a maximum of age of 25,000 years, based upon radio carbon data and timing of geophysical climatic events (Kensley and Williams 1986, pp. 417–418). Brock (2004, p. 18) states this lava tube is probably the second most important anchialine pool habitat in the State because of its unique connection to the ocean, the vertical size (i.e., depth), and the presence of a total of five different species including *Halocaridina palahemo, H. rubra, Procaris hawaiiana, Calliasmata pholidota,* and *Vetericaris chaceorum*. Lua o Palahemo is a naturally occurring opening (i.e., a surface collapse) into a large lava tube below. The opening measures approximately 33 ft (10 m) in diameter and is exposed to sunlight. Unlike most anchialine pools in the Hawaiian Islands, which have depths less than 4.9 ft (1.5 m) (Brock 2004, p. 3), Lua o Palahemo's deep pool includes a deep shaft with vertical sides extending downward about 46 ft (14 m) into the lava tube below, which branches in two directions, both ending in blockages (Holthuis 1974, p. 11; Kensley and Williams 1986, p. 418). At the subterranean level at the base of the opening, the lava tube runs generally north and south, extending northward for 282 ft (86 m) and southward for 718 ft (219 m), to a depth of 108 ft (33 m) below sea level (Kensley and Williams 1986, p. 418).

Manuka Site: The anchialine pools at Manuka were first surveyed 1972 (Macioleck and Brock 1972, p. iii); however, this survey primarily covered only the southern extremity of the site. A more thorough survey of the Manuka coastline was conducted between 1989 and 1992 (20 pools along the southern coast of Manuka, which included both diurnal and nocturnal observations (Chan 1995, p. 1). These pools were then diurnally surveyed in 2004 (80 pools along the entire Manuka coastline) (Brock 2004, pp. 1–60), and again between 2008 and 2009 (80 pools along the entire Manuka coastline) (Sakihara 2009, pp. 1–35). The most recent and most comprehensive surveys of Manuka were conducted between 2009 and 2010, when Hawaii State biologists surveyed 81 pools at Manuka both day and night, which resulted in the discovery of *Vetericaris chaceorum* in 4 of the pools surveyed. Three of the pools are within Manuka NAR, and one pool is adjacent to the NAR, on unencumbered State land (collectively referred to as Manuka throughout this final rule) (Sakihara 2013, in litt.). This discovery documents the first observation of this species in almost three decades (Sakihara 2012, in litt.). Visual accounts made by the biologists estimate that *V. chaceorum* is established in four anchialine pools along the southern section of the NAR, approximately 15 mi (25 km) from Lua o Palahemo. A total of seven individuals of this species were observed in four pools around Awili Point and Keawaiki (Sakihara 2012, p. 89; Sakihara 2013, in litt.), although estimates of the total number of individuals are undeterminable due to the cryptic nature of this species (Sakihara 2012, in litt.). Sakihara (2012, in litt.) stated that the anchialine habitat at Manuka is considerably different than that of Lua o Palahemo, and is considered to be one of the most biologically valuable habitats of this type (Sakihara 2012, in litt.; Sakihara 2013, in litt.). The Manuka anchialine pools are characterized by shallow (less than 2 ft (0.5 m)) open pools dispersed throughout barren basaltic terrain. This observation expands the known habitat conditions that support *V. chaceorum* (Sakihara 2012, in litt.). According to Sakihara (2013, in litt.), it appears that three of the Manuka pools (the three pools closest to a jeep road) have a subterranean connection, although this has not been confirmed. Although anchialine pools have been surveyed in the Manuka area in the past (Maciolek and Brock 1974, pp. 1–80; Chan 1995, pp. 1–34; Brock 2004, pp. i–iv; Sakihara 2009, pp. 1–35; Sakihara 2012, pp. 83–95; Sakihara 2013 in litt.), the surveys conducted between 2009 and 2010 were the first to document the presence of *V. chaceorum* in this anchialine pool complex. In 1995, an anchialine pool shrimp matching the description of *V. chaceorum* was observed in at least one pool at Manuka NAR, but its identification was never confirmed (Brock 2004, p. 31; Sakihara 2012, p. 89).

Four surveys have been conducted at Lua o Palahemo (Maciolek and Brock 1974, pp. 1–73; Kensley and Williams 1986, pp. 417–426; Bozanic 2004, p. 1–3; Wada 2012, pers. comm.; Wada *et al.* 2012, pp. 1–2), with five individuals observed during one survey in 1985. Five surveys have been conducted at Manuka (Maciolek and Brock 1974, pp.

1–73; Chan 1995, pp. 1–34; Brock 2004, pp. i–iv, 1–60; Sakihara 2009, pp. 1–35; Sakihara 2012, pp. 83–95; Sakihara 2013 in litt.), with seven individuals observed in four pools between 2009 and 2010. Because of the ability of hypogeal shrimp species to inhabit the interstitial and crevicular spaces in the water table bedrock surrounding anchialine pools, it is very difficult to estimate population size of a given species within a given area (Brock 2004, pp. 10–11). We are unable to estimate the population size of either occurrence of *Vetericaris chaceorum* given this behavior.

Summary of Comments and Recommendations

On October 17, 2012, we published a proposed rule to list 15 Hawaii Island species (13 plants, 1 picture-wing fly, and 1 anchialine pool shrimp) as endangered throughout their ranges, and to designate critical habitat for 3 plant species (77 FR 63928). The comment period for the proposal opened on October 17, 2012, for 60 days, ending on December 17, 2012. We requested that all interested parties submit comments or information concerning the proposed rule. We contacted all appropriate State and Federal agencies, county governments, elected officials, scientific organizations, and other interested parties and invited them to comment. In addition, we published a public notice of the proposed rule on October 20, 2012, in the local Honolulu Star Advertiser, West Hawaii Today, and the Hawaii Tribune Herald newspapers, at the beginning of the comment period. We received four requests for public hearings. On April 30, 2013, we published a document (78 FR 25243) reopening the comment period on the October 17, 2012, proposed rule (77 FR 63928), announcing the availability of our draft economic analysis (DEA) on the proposed critical habitat, and requesting comments on both the proposed rule and the DEA. In addition, in that same document (78 FR 25243; April 30, 2013), we announced a public information meeting and hearing, which was held in Kailua-Kona, Hawaii, on May 15, 2013.

During the comment periods, we received 33 comment letters, including the 11 peer review comment letters, on the proposed listing of 15 species, proposed taxonomic change for 1 endangered plant species, and proposed designation of critical habitat. In this final rule, we address only the comments regarding the proposed listing of 15 species and proposed taxonomic change for 1 plant species. Comments addressing the proposed critical habitat designation will be fully addressed in a separate rulemaking action, and published in the **Federal Register** at a later date.

Two commenters were State of Hawaii agencies ((1) Hawaii Department of Business, Economic Development, and Tourism's Hawaii Housing Finance and Development Corporation, and (2) Hawaii Department of Hawaiian Home Lands); one was a county agency (County of Hawaii Planning Department); two were Federal agencies; and 28 were nongovernmental organizations or individuals. During the May 15, 2013, public hearing, no individuals or organizations made comments on the proposed listing.

All substantive information related to the listing of the 15 species or the taxonomic change for 1 species provided during the comment periods has either been incorporated directly into this final determination or is addressed below. Comments received were grouped into general issues specifically relating to the proposed listing status of the 13 plants, or the picture-wing fly or anchialine pool shrimp, or the proposed taxonomic change for 1 plant species, and are addressed in the following summary and incorporated into the final rule as appropriate.

Peer Review

In accordance with our peer review policy published in the **Federal Register** on July 1, 1994 (59 FR 34270), we solicited expert opinions from 14 knowledgeable individuals with scientific expertise on the Hawaii Island plants, picture-wing fly, and anchialine pool shrimp, and their habitats, including familiarity with the species, the geographic region in which these species occur, and conservation biology principles. We received responses from 11 of these peer reviewers. Nine of these 11 peer reviewers generally supported our methodology and conclusions. One peer reviewer expressed concern regarding the lack of more recent survey data for the anchialine pool shrimp at Manuka, and was unaware of the recent surveys (between 2009 and 2010) conducted by Hawaii State biologists. Another commented that we should proceed with caution due to the lack of biological information regarding the shrimp. Three peer reviewers supported the Service's ecosystem-based approach for organizing the rule and for focusing on the actions needed for species conservation and management, and all 11 reviewers provided information on one or more of the Hawaii Island species, which was incorporated into this final rule (see also Summary of Changes from Proposed Rule). We reviewed all comments received from the peer reviewers for substantive issues and new information regarding the listing of 15 species and taxonomic change for 1 plant species. Peer reviewer comments are addressed in the following summary and incorporated into the final rule as appropriate.

Peer Review Comments on Plants

(1) *Comment:* One peer reviewer recommended that we include inundation by high surf and subsequent erosion, and the nonnative plant *Wedelia* [*Sphagneticola*] *trilobata* (wedelia), as threats to the plant *Bidens hillebrandiana* ssp. *hillebrandiana.*

Our Response: We have incorporated this information, as appropriate, into Summary of Changes from Proposed Rule, Table 3, and in the sections ''Nonnative Plants in the Coastal Ecosystem'' and ''Habitat Destruction and Modification Due to Rockfalls, Treefalls, Landslides, Heavy Rain, Inundation by High Surf, Erosion, and Drought'' under *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range* in this final rule (see below).

(2) *Comment:* One peer reviewer recommended that we include vandalism and trash dumping as threats to the plant *Bidens micrantha* ssp. *ctenophylla,* in the Kaloko Makai area.

Our Response: We are aware that vandalism and trash dumping has occurred in the Kaloko Makai area near the individuals of *Bidens micrantha* ssp. *ctenophylla* in the past, although it has not been recently observed (Ball 2013, pers. comm.). We will continue to monitor this potential threat in that area.

(3) *Comment:* One peer reviewer informed us of an act of vandalism where approximately 150 ft (46 m) of fencing was removed from a fenced exclosure in the Upper Waiakea FR where individuals of the plant *Phyllostegia floribunda* are found. The fencing was repaired later in the same month (November 2012), and the plants appeared to suffer no adverse impacts.

Our Response: We agree that vandalism is a potential threat to all fenced species. However, vandalism is not considered an imminent threat at this time because the frequency at which vandalism occurs and the degree of impact cannot be determined in advance of the incident occurring. We will continue to monitor the area and gather information on this potential threat.

(4) *Comment:* One peer reviewer suggested that we identify the nonnative plant *Paederia foetida* (skunk weed) as a threat to the plant *Cyrtandra*

nanawaleensis because it completely covers and smothers understory vegetation and outcompetes low-growing plants and small shrubs for light and space and that we identify *Psidium cattleianum* (strawberry guava) as a threat to *Cyanea tritomantha* because it forms dense stands in which few other plants can grow, displacing native vegetation through competition.

Our Response: We have included this information in this final rule (see Summary of Changes from Proposed Rule, below).

(5) *Comment:* One peer reviewer supported the listing of the plants *Schiedea diffusa* ssp. *macraei, S. hawaiiensis,* and *Stenogyne cranwelliae* as endangered, and stated that we did a very thorough job of outlining the threats for these three species. In addition, this peer reviewer expressed appreciation for our emphasis on the anticipated effects of climate change in the proposed rule.

Our Response: We appreciate the support from this peer reviewer regarding our threats analysis, and our discussion on the anticipated threats from climate change. All 15 species we are listing in this final rule may be especially vulnerable to the effects of climate change due to their small number of populations and individuals, as well as highly restricted ranges. Environmental changes that may affect these species are expected to include habitat loss or alteration and changes in disturbance regimes (e.g., storms, hurricanes, and drought).

(6) *Comment:* One peer reviewer stated that climate change appears to be having especially serious effects on *Schiedea* species occurring in dry habitats due to death of adult plants, presumably through drought, failure to regenerate due to drought, and increased fire frequency. Drought may have a pronounced effect on *Schiedea hawaiiensis.*

Our Response: We agree that drought is a threat to *Schiedea hawaiiensis,* for the reasons mentioned above (see also ‘‘Habitat Destruction and Modification by Fire’’ and ‘‘Habitat Destruction and Modification Due to Rockfalls, Treefalls, Landslides, Heavy Rain, Inundation by High Surf, Erosion, and Drought’’ under *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range,* below).

(7) *Comment:* One peer reviewer stated that *Schiedea diffusa* ssp. *macraei* and *S. hawaiiensis* are obligate autogamous species (i.e., reproduces by self-pollination) and facultative autogamous (i.e., reproduces by self- and cross-pollination), respectively. Because both of these species are hermaphroditic and autogamous, they are capable of regenerating from single individuals, and may not be severely hampered by inbreeding depression. Unfortunately, autogamous species of *Schiedea* also appear to be short-lived, emphasizing the importance of appropriate conditions for regeneration.

Our Response: We agree that the obligate and facultative autogamous nature of *Schiedea diffusa* ssp. *macraei* and *S. hawaiiensis,* respectively, in addition to being hermaphroditic, afford these species the ability to regenerate from single individuals and may not be severely hampered by inbreeding depression. However, there are other negative impacts that can result from low number of individuals (e.g., random demographic fluctuations; climate change effects; and localized catastrophes, such as hurricanes, drought, rockfalls, landslides, and disease outbreaks (Pimm *et al.* 1988, p. 757; Mangel and Tier 1994, p. 607). Any of these stressors represent threats that can lessen the chances of survival for these species in the wild. We agree that the short-lived nature of these species increases the importance for appropriate conditions for regeneration, and have added this information to our files.

(8) *Comment:* One peer reviewer pointed out that it was incorrect to state, in our proposed rule (77 FR 63928; October 17, 2012) on page 63931, that *Mezoneuron* was listed in error as *Caesalpinia kavaiense* in 50 CFR 17.12, because at the time of the listing (51 FR 24672; July 8, 1986), this was the accepted name applied to the taxon. The peer reviewer stated that it is important to emphasize that names of taxa typically may change during the course of standard taxonomic investigations, and these changes do not affect the validity of conservation concerns for the taxon in question.

Our Response: We wish to clarify the error described in the October 17, 2012 (77 FR 63928), proposed rule regarding *Mezoneuron kavaiense.* The error described in the proposed rule refers to the entry in the 1989 List of Endangered and Threatened Plants (50 CFR 17.12), where this taxon was revised and the specific epithet was misspelled as *Caesalpinia kavaiense* (instead of *Caesalpinia kavaiensis*). Subsequent taxonomic revision resulted in the currently recognized scientific name for the listed entity, *Mezoneuron kavaiense,* which we accept in this final rule.

(9) *Comment:* One peer reviewer pointed out that under our description of the lowland dry ecosystem, we incorrectly wrote ‘‘high rates of diversity and endemism’’ when technically it should read ‘‘high levels of diversity and endemism,’’ as rate is a process occurring over time.

Our Response: We agree with the peer reviewer.

Peer Review Comments on the Picture-Wing Fly

(10) *Comment:* One peer reviewer provided additional information regarding the host plants for *Drosophila digressa.* Although *D. digressa* has only been reared from *Charpentiera* spp., at Manuka, *D. digressa* was found in a *Pisonia sandwicensis* treefall with a considerable number of rotten branches. A large number of individuals of *D. digressa* were found in a small area, indicating a local breeding group rather than vagrant individuals. The only *Charpentiera* spp. in this area are a few trees in a pit crater, over 0.62 mi (1 km) from the known location of *D. digressa* on *Pisonia sandwicensis.* This reviewer further stated that many native *Drosophila* species that breed in either *Charpentiera* spp. or *Pisonia* spp. are also able to use both plants. According to the reviewer, while this ability of *D. digressa* to use both tree species as host plants expands its potential habitat slightly, it does not do so by a great deal, as *Pisonia sandwicensis* and *P. brunoniana* [two of the three species of *Pisonia* on Hawaii Island] are only found on Hawaii Island at the sites where *D. digressa* is already known (Olaa and Manuka), or where the forest is currently too open and dry to support this species of picture-wing fly (Kipuka Pualulu and Puu Waawaa cone). *Pisonia umbellifera* can be found at lower elevations on the windward side of the island, such as gulches on the east slopes of Kohala and Mauna Kea below 1,500 ft (457) m, but *D. digressa* has never been recorded from these areas or elevation. Species of *Pisonia* face most of the same threats as species of *Charpentiera* (i.e., goat and cattle browsing of leaves and seedlings, pig rooting of seedlings, and desiccation of habitat from drought and subsequent fires at Manuka). The reviewer concludes that even if *Pisonia* spp. at Manuka survive the [ongoing] drought, the habitat will likely be too dry to support *D. digressa.*

Our Response: We appreciate this information regarding *Drosophila digressa* and have incorporated this new information, as appropriate, in this final rule (see above, Description of the 15 Species; see below, Summary of Changes from Proposed Rule, ‘‘Habitat Destruction and Modification by Introduced Ungulates’’ (*Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range*), ‘‘Predation and Herbivory’’

(*Factor C. Disease or Predation*), and ''Loss of Host Plants'' (*Factor E. Other Natural or Manmade Factors Affecting Their Continued Existence*)).

(11) *Comment:* One peer reviewer stated that the drought-associated ohia [*Metrosideros polymorpha*] dieback occurring at Manuka adversely affects *Drosophila digressa* by allowing more sunlight into the understory, increasing the temperature and lowering humidity. This increases the stress on the picture-wing flies and their host plants, as well as increasing opportunities for invasive plants to become established. The extraordinary amount of dead wood accumulation at Manuka means that any fire that occurs there likely would be extremely damaging. A fire resulting from a similar scenario at Kealakekua Ranch a year or two ago produced smoke that covered most of the island and burned for weeks because it is nearly impossible to fight fire in such dense brush.

Our Response: We appreciate the additional information provided regarding the drought-associated ohia dieback at Manuka and *Drosophila digressa,* and we have included this new information in our final rule, as appropriate, in ''Habitat Destruction and Modification Due to Rockfalls, Treefalls, Landslides, Heavy Rain, Inundation by High Surf, Erosion, and Drought'' (*Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range*) in this final rule (see below).

Peer Review Comments on the Anchialine Pool Shrimp

(12) *Comment:* One peer reviewer commented that the field surveys cited in our proposed rule are not adequate, and that more surveys should be conducted at other sites such as Manuka, Hawaii. The peer reviewer also recommended that the analysis of listing *Vetericaris chaceorum* as endangered should be based on the number of field surveys conducted, the number of pools surveyed, the number of locations surveyed, trapping surveys, day and night surveys, and seasonal surveys.

Our Response: We are required to make listing determinations solely on the basis of the best scientific and commercial data available, and, for the reasons described here, we have concluded that the number and locations of surveys are adequate to determine that *Vetericaris chaceorum* appears to be restricted to a limited number of pools in the southern portion of the island of Hawaii, and that *V. chaceorum* faces threats from habitat degradation and destruction and from predation such that it is in danger of extinction throughout its range. There are between 600 and 700 anchialine pools in the Hawaiian Islands and approximately 80 percent (approximately 520 to 560) occur on Hawaii Island. Over 400 pools have been surveyed on Hawaii Island alone since the 1970s, and *V. chaceorum* has only been documented from two locations: Lua o Palahemo and Manuka, where *V. chaceorum* was recently (between 2009 and 2010) discovered in a series of pristine shallow anchialine pool complexes within and adjacent to Manuka NAR (Holthius 1973, pp. 1–128 cited in Sakihara 2012, pp. 83, 91, and 93; Maciolek and Brock 1974, pp. 1–73; Maciolek 1983, pp. 606–618; Maciolek 1987, pp. 1–23; Chai *et al.* 1989, pp. 1–37; Chan 1995, pp. 1–31; Brock and Kam 1997, pp. 1–109; Brock 2004, pp. 1–60; Sakihara 2009, pp. 1–35; Sakihara 2012, pp. 83–95; Wada *et al.* 2012, pp. 1–2). This reviewer was apparently unaware that Hawaii State biologists conducted surveys at Manuka between 2008 and 2009, and again between 2009 and 2010 (Sakihara 2009, pp. 1–35; Sakihara 2012, pp. 83–95). Several other peer reviewers stated that the Service used the best available scientific and commercial data to document the presence or absence of *V. chaceorum* in anchialine pools around Hawaii Island.

Under the Act, we determine whether a species is an endangered species or a threatened species because of any of five factors (see Summary of Factors Affecting the 15 Species, below), and we are required to make listing determinations solely on the basis of the best scientific and commercial data available, pursuant to section 4(b)(1)(A) of the Act. Based on the best available information we determined that *V. chaceorum* faces threats from habitat destruction and modification by feral goats and cattle at Lua o Palahemo; dumping of trash and introduction of nonnative fish at Lua o Palahemo; and introduction of nonnative fish at the pools at Manuka (see Summary of Factors Affecting the 15 Species, below).

(13) *Comment:* One peer reviewer questioned the importance of flushing to the functioning of the anchialine pool ecosystem and its relationship to the effects of excessive siltation and sedimentation on the population of *Vetericaris chaceorum* and its associated species and the anchialine pool ecosystem at Lua o Palahemo. The commenter referenced the occurrence of large numbers of individuals of *Halocaridina rubra, Procaris hawaiiana,* and *V. chaceorum* during the 1985 survey (Kensley and Williams 1985, pp. 417–426) despite a reduction in visibility (few centimeters) as a result of the disturbance of ceiling sediments caused by exhalation bubbles during an exit phase of a dive. The commenter also stated that ''there is no reason to discount the opposite idea that increased flushing has mobilized the sediment, allowed the movement of native predators and competitors into the system, and resulted in the decline or perhaps extirpation of *Vetericaris.''* The commenter then suggested that the thick sediment cone just below the opening was not a problem for the dense populations of native species detected directly beneath the surface of the pool during the 1985 surveys.

Our Response: We acknowledge the peer reviewer's statement that *Vetericaris chaceorum* and other native species may be able to coexist with a certain level sedimentation in the anchialine pool ecosystem at Lua o Palahemo. However, the water clarity has declined since earlier surveys (Kensley and Williams 1986, pp. 417–437; Bozanic 2004, pp. 1–3; Wada 2010, in litt.; Wada et al. 2012, in litt.; Wada 2012, pers. comm.; Wada 2013, in litt.), which took place in the 1970s and 1980s, despite the presence of silt in the system at that time. Further, we disagree that the reduced visibility created by a diver's exhalation bubbles or similar human-initiated disturbance during those early surveys is comparable to the low visibility levels apparent in recent surveys before surveyors even enter the water. Flushing is necessary for the successful functioning of an anchialine pool ecosystem (Brock 2004, pp. 11, 35–36). We have concluded that continued excessive siltation into and additional collapse of the lava tube system at Lua o Palahemo is causing degradation of the anchialine pool ecosystem. These factors, combined with the system's diminished ability to flush, have resulted in the degradation of water quality, which has also led to the drastic decline in two of the other hypogeal shrimp species within the pool (i.e., *Procaris hawaiiana* numbered in the thousands, and *Halocaridina* numbered in the tens of thousands (Kensley and Williams 1986, p. 418), and the most recent survey counted 7 *Procaris hawaiiana* and zero *Halocaridina* (Wada *et al.* 2012, in litt.; Wada 2013, pers. comm.)). These shrimp are considered food sources for *V. chaceorum,* and their decline may affect the survival of *V. chaceorum.*

(14) *Comment:* One peer reviewer requested that the discussion of Lua o Palahemo clarify land ownership and the attitude of the landowner toward the anchialine pool and its fauna.

Our Response: Lua o Palahemo is located on land owned by the State of

Hawaii Department of Hawaiian Homelands (DHHL). We hope to work with DHHL to address the threats to *Vetericaris chaceorum* and the anchialine pool ecosystem at Lua o Palahemo from ungulates, recreational vehicles, dumping of trash, the intentional introduction of nonnative fish, and sedimentation, as identified in this final rule.

(15) *Comment:* One peer reviewer suggested that additional data on phylogenetic or biogeographical relationships on the ancestor(s) to *Vetericaris chaceorum* could have very important implications about the spatial extent of potential habitat, specific features of the habitat that may be critical to the species, and other possible sites where the species may occur. However, the peer reviewer also stated that this information is not currently available.

Our Response: We agree that such information would provide additional insights on the species' distribution and range, as well as the physical and biological habitat features required for the conservation of *Vetericaris chaceorum.* However, as the peer reviewer noted, such information is not currently available. The documented observation of *V. chaceorum* less than 19 mi (25 km) from Lua o Palahemo in the shallow water pools at Manuka, Hawaii, may be explained by Maciolek's (1983, p. 615) hypothesis that habitats may be colonized from long-existing subterranean populations.

(16) *Comment:* One peer reviewer suggested that we add nonnative plants (e.g., *Prosopis pallida* (kiawe)) as a threat to the anchialine pool shrimp *Vetericaris chaceorum,* as any nonnative canopy or peripheral vegetation may result in changes in anchialine habitat conditions such as increased senescence, changes in water quality, and potential increases in nutrient availability that may alter primary production and the community structure of the algae. This peer reviewer further stated that these impacts may primarily affect the predominant endemic faunal species *Halocaridina rubra,* which is considered to be a key species in maintaining the ecological integrity of the anchialine pools, and that this may ultimately lead to an overall degradation of the anchialine pool ecosystem, and therefore impact *V. chaceorum.* However, this peer reviewer also noted that both Lua o Palahemo and Manuka are either very sparse or entirely free of peripheral vegetation, but that this does not preclude the possibility of *P. pallida* or any other type of nonnative vegetation from establishing itself within these areas.

Our Response: The Act and our regulations direct us to consider the ''present'' or ''threatened'' destruction, modification, or curtailment of the species' habitat or range. At this time, there are insufficient data to determine the impacts on *Vetericaris chaceorum* from nonnative plants such as *Prosopis pallida.* Therefore, we cannot address nonnative plants as threats to *V. chaceorum* (i.e., we cannot identify a future condition that may or may not occur as a threat) in this final rule. We will consider the need to address nonnative plants in our future recovery planning efforts for this species, should new information become available indicating nonnative plants are a threat to *V. chaceorum* at Lua o Palahemo or Manuka.

(17) *Comment:* Two peer reviewers suggested that we add native marine fish species (e.g., aholehole (*Kuhlia* sp.) or papio (*Caranx* sp.)) not normally found in anchialine pools as a threat to *Vetericaris chaceorum,* from either natural events (e.g., high surf and storm surges) or deliberate introduction by people to the Lua o Palahemo anchialine pool ecosystem. According to these reviewers, the introduction of native marine fish in anchialine pools could result in the same deleterious impacts to *V. chaceorum* and its pool habitat as the intentional introduction of nonnative fish (see ''Dumping of Trash and Introduction of Nonnative Fish'' under *Factor E. Other Natural or Manmade Factors Affecting Their Continued Existence,* below). One peer reviewer later suggested that it was possible, although unlikely, that native marine fish would be intentionally introduced to the four pools at Manuka.

Our Response: We agree that the introduction of native marine species, normally isolated from the anchialine pool environment, into the anchialine pool at Lua o Palahemo that supports *Vetericaris chaceorum* may be possible. For the reasons described below, we believe it is unlikely that natural events such as high surf and storm surges will introduce native marine fish to either location (Lua o Palahemo or Manuka) of *V. chaceorum,* although one peer reviewer suggested that the 2005 earthquake on Hawaii Island may have reopened or improved the connection between the ocean and Lua o Palahemo, thus allowing natural recruitment of native marine fish into and out of the pool (Kinzie 2012, in litt.). The intentional introduction of native marine fish is possible at its two known locations.

Nonnative fish have been intentionally introduced to Lua o Palahemo in the past (see ''Dumping of Trash and Introduction of Nonnative Fish'' under *Factor E. Other Natural or Manmade Factors Affecting Their Continued Existence,* below), and it is not unreasonable to assume that native marine fish may be deliberately introduced to the pool. In our 2012 snorkel survey of this pool, we observed a tropical marine goby in the pool (Wada *et al.* 2012, in litt.). However, it is unclear how this fish gained access to the pool. The accidental introduction or natural recruitment of native marine fish due to natural events such as storm surge and high surf is unlikely at Lua o Palahemo due to its elevation above the coast (approximately 25 ft (8 m)) and its distance from the coast (490 ft (150 m)) (Kensley and Williams 1986, p. 418). Although a massive landslide or earthquake may trigger a local tsunami that generates waves that may sweep over and deposit native marine fish in the pool, these events are purely speculative.

The intentional introduction of native marine fish is possible at the Manuka pools that support *V. chaceorum* because there is evidence that at least one pool in this area harbors nonnative freshwater poeciliids (see Factors Affecting the 15 Species, below) and marine fish, likely introduced by fishermen. This pool is located near a popular coastal fishing spot. Three of the four pools that support *V. chaceorum* at Manuka are located between 10 and 33 ft (3 and 10 m) from a jeep road that provides access to coastal fishing and recreational locations frequented by the public (Sakihara 2013, in litt.). The fourth pool is approximately 60 ft (18 m) from the jeep road (Sakihara 2013, in litt.). However, the accidental introduction or natural recruitment of native marine fish, due to natural events such as storm surge and high surf, is unlikely at the four pools that support *V. chaceorum* at Manuka because these pools are located at least 98 ft (30 m) from the coast (Sakihara 2013, in litt.), and storm surge and high surf that would cover this distance is improbable. Although a massive landslide or earthquake may trigger a tsunami that generates waves that may sweep over and deposit native marine fish in the pools, these events are purely speculative.

On Maui, both aholehole and papio have been found in the larger anchialine pools closest to the ocean at Ahihi Kinau NAR, where high surf and storm waves appear to wash those and other native marine fish into the pools (Wada 2013, in litt.). However, these pools are subject to coastal influences due to natural events such as storm surge and high surf due to their proximity to the ocean. We are unaware of any data documenting the impacts of native marine fish that may be swept into the pools at Ahihi Kinau NAR on native anchialine pool shrimp.

Native marine fish species have a purely marine (pelagic) larval stage, so a population of native fishes in an anchialine pool is likely to be individuals that are introduced to pools post larvae-stage (Sakihara 2013, in litt.). According to Brock (2004, p. 9), native marine fish are typically found in pools in close proximity to the ocean and it is believed that the biological status of these pools changes with successful colonization or mortality of marine fishes in these pools. The presence of native fish in Hawaiian anchialine pools usually signals the lack of hypogeal shrimp (Brock 2004, p. 9). Brock (2004, p. 29) also states that native marine fish are not able to complete their life cycles in anchialine pools, so the impacts to hypogeal shrimp are temporary (i.e., only as long as the fish occupy the pool) and that hypogeal shrimp may successfully hide in crevices from predatory fish and thus possibly recolonize a pool after the fish die off. Therefore, although *V. chaceorum* is a hypogeal shrimp and three species upon which it is known to feed in Lua o Palahemo are hypogeal shrimp, we are unable to determine the impact of marine fish on *V. chaceorum* at this time.

(18) *Comment:* Two peer reviewers mentioned the presence of aggressive biting isopods and an eel at Lua o Palahemo, and the possibility of the eel, specifically, as a predator of *Vetericaris chaceorum.*

Our Response: We are aware that eels have been seen periodically in other anchialine pools, including pools at Manuka NAR on Hawaii Island and Ahihi Kinau on Maui. At this time, however, there are insufficient data to determine the impacts on *Vetericaris chaceorum* from biting isopods and an unidentified eel at Lua o Palahemo. Therefore, we are unable to address these animals as threats to *V. chaceorum* in this final rule. We will consider the need to address biting isopods and eels in our future recovery planning efforts for this species, should new information become available indicating these animals are threats to *V. chaceorum.*

(19) *Comment:* Two peer reviewers suggested that earthquakes and subsequent landslides and rockfalls are threats to *Vetericaris chaceorum,* due to destruction or degradation of its pool habitat. This peer reviewer believes that given a large enough earthquake, the Lua o Palahemo anchialine pool could potentially lose its connection to the ocean by boulder ''chokes'' that block off movement of ocean water to and from the pool, or by a complete or partial collapse of the tube itself. This peer reviewer then added that we would need an engineer to make a more definitive assessment regarding the pool's vulnerability to collapse.

Our Response: We agree that earthquakes and subsequent landslides and rockfalls are potential threats to *Vetericaris chaceorum* and its habitat. We also agree that an engineer or other professional with the necessary skills is needed to assess the vulnerability of the lava tubes within the Lua o Palahemo anchialine pool to the threat of earthquakes. We do not have enough data to include earthquakes as a threat at this time.

(20) *Comment:* Two peer reviewers commented that our analysis of the threats to *Vetericaris chaceorum* seemed too focused on the surface of the anchialine pool rather than on the depths within Lua o Palahemo (where *V. chaceorum* is reported to occur). One of the peer reviewers questioned the relevance of threats at the opening when the species is so far below the surface, while the other peer reviewer stated that any impacts at the surface of the pool may lead to degradation of the habitat within the recesses of the lava tube by causing shifts in water quality, physical conditions, and flushing, and therefore causing shifts in biological characteristics (i.e., benthic algae and primary consumer abundance and assemblage). As such, these threats may extend beyond the immediately impacted areas at Lua o Palahemo.

Our Response: Based on the best scientific and commercial data available, we believe *Vetericaris chaceorum* faces threats from habitat loss or degradation from sedimentation in Lua o Palahemo due to degradation of the immediate area surrounding the pool. Feral goats and cattle trample and forage on both native and nonnative plants around and near the pool opening (Magnacca 2012, in litt.; Richardson 2012, in litt.), increasing erosion resulting in sediment entering the pool (see ''Habitat Destruction and Modification by Introduced Ungulates'' under *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range,* below). In addition, *V. chaceorum* faces threats from the intentional dumping of trash (at Lua o Palahemo) and introduction of nonnative fish (at Lua o Palahemo and Manuka NAR), activities which originate at the pool openings and result in impacts to *V. chaceorum* (within the deep recesses of Lua o Palahemo and within the shallower pools at Manuka NAR) (see ''Dumping of Trash and Introduction of Nonnative Fish'' under *Factor E. Other Natural or Manmade Factors Affecting Their Continued Existence,* below).

(21) *Comment:* One peer reviewer commented that the proposed rule presents a good summary of potential threats to the shrimp and its habitat, and it clearly makes the point that the population at Lua o Palahemo is exceedingly small and probably declining, if not extinct.

Our Response: We appreciate this reviewer's concurrence and have considered that the shrimp may no longer be extant at Lua o Palahemo; however, since anchialine pool shrimp are known to spend much of their time within the crevices of pools, we believe the species may still be present in the pool, but in very low numbers.

(22) *Comment:* One peer reviewer commented that they had observed items that humans dumped into Lua o Palahemo, including a bicycle, boom box, and large cement block, but that they were uncertain whether or not these items had a deleterious or observable effect on *V. chaceorum.*

Our Response: The impact of human dumping of trash into an anchialine pool is directly related to the proportion between the size of the pool and the amount and type of trash dumped. For example, a large trash bag in a small, shallow anchialine pool will negatively impact habitat quality, whereas the negative effect from same trash bag in a larger, deeper anchialine pool will not reach the same magnitude of effect. In addition, if the boom box had decaying batteries in it, contaminants such as lead, mercury and cadmium could have leached into the pool (Center for Disease Control—Agency for Toxic Substances and Disease Registry (CDC–ATSDR) 2011—*Toxic Substance Database*). In addition, there is risk from exposure to general electronic waste contaminants, which contain various hazardous materials and are harmful to the environment (e.g., polyvinyl chloride, polychlorinated biphenyls, and chromium) (CDC–ATSDR 2011—*Toxic Substance Database*). These toxins produce varying effects on biological organisms that include, but are not limited to, deoxyribose nucleic acid (DNA) damage, mucous membrane damage, cancer, and organ failure (CDC–ATSDR 2011—*Toxic Substance Database*).

(23) *Comment:* Five peer reviewers commented on the likelihood of

whether or not *Vetericaris chaceorum* has a niched habitat deep within the darkness of the lava tube at Lua o Palahemo where it was observed in 1985, or whether it has a broader habitat that extends throughout the matrix of the lava tube of Lua o Palahemo. The first of these peer reviewers commented that, due to insufficient data and the challenging conditions of assessing the particular habitat(s) of Lua o Palahemo, it would be difficult to determine whether this species would likely occur throughout Lua o Palahemo or only be limited to the area where it was originally collected from within the lava tube. The second peer reviewer commented that literature suggested that *Vetericaris chaceorum* did not have a uniform distribution throughout Lua o Palahemo when it was first observed and collected, so that would suggest that it does have a limited niche and that it is highly likely that it would be still limited to the area where it was originally collected within the lava tube. The third of these peer reviewers commented that it has been confirmed that the range of *Vetericaris chaceorum* extends beyond Lua o Palahemo, although only approximately 25 km away. Therefore, it is plausible that its distribution within Lua o Palahemo also extends beyond where it was originally collected. Furthermore, the habitat in which *Vetericaris chaceorum* was found at Manuka is considerably different than that of Lua o Palahemo, which was characterized by shallow (less than 0.5 m deep), open pools dispersed throughout barren basaltic terrain. Accordingly, its range does not seem to be limited to the deep recesses of the anchialine habitat, but may also roam freely throughout shallow exposed areas. The fourth peer reviewer commented that *Vetericaris chaceorum* likely has a wider lateral distribution in the Lua o Palahemo lava tube and that it is likely found in adjacent hypogeal habitat. The fourth peer reviewer also commented that it is unclear if *Vetericaris chaceorum* venture into the lighted, mixohaline portion of Lua o Palahemo. The fifth peer reviewer commented that there is no reason to believe that the shrimp's range did not extend, at least, to the ends of that lava tube, and possibly into other openings connecting to it. As the boundaries of Lua o Palahemo were not defined in the proposed rule, an answer to the question about ''throughout Lua o Palahemo'' is not clear.

Our Response: We agree and are aware that it is difficult to know exactly where this species occurs within Lua o Palahemo, and whether or not it favors the depth at which it was observed or if it utilizes the greater part of the lava tube. The newly discovered occurrence in the shallow pools at Manuka suggests that the habitat is not limited to the area it was originally collected from deep within the lava tube at Lua o Palahemo, and that it is likely *Vetericaris chaceorum* occupies areas along the matrices of Lua o Palahemo at varying depths. Because hypogeal shrimp often spend much of their time in crevices, and it is possible that *V. chaceorum* can occur throughout the lava tube, we retain the status of extant for the population of *V. chaceorum* at this location, despite the fact that *V. chaceorum* was not observed in recent surveys. Regarding the boundaries of Lua o Palahemo, we do not currently have any data that lay out the entire matrix of the lava tube, nor are we aware that such data exist.

(24) *Comment:* Three peer reviewers commented that the threats to the habitat of Lua o Palahemo expand throughout the entire lava tube matrix. One of these three peer reviewers also said that the historical differences documented for Lua o Palahemo, primarily in water clarity and quality, and the absence of other shrimp species that were common (such as *Halocaridina*) suggests the habitat has undergone serious degradation in the last 30 to 40 years that is likely to get worse if actions are not taken.

Our Response: We agree that the threats to the species' habitat at Lua o Palahemo are not limited to any particular area and span the scope of the entire lava tube matrix. We also agree that more surveys and monitoring efforts are needed to determine how best to recover this habitat. The Service has conducted surveys in 2010 and 2012 (Wada 2012, pers. comm.; Wada et al. 2012, in litt.), and will continue to monitor and research this habitat in the future, in addition to conservation methodologies to recover *Vetericaris chaceorum* at this site.

(25) *Comment:* One peer reviewer commented that it is unclear that the best available scientific data and methodologies currently available can determine rarity vs. human accessibility to the *Vetericaris chaceorum.* This commenter also stated that a dark-adapted organism could potentially be found anywhere within the hypogeal environment of the Hawaiian Islands, and that the Service may be drawing its listing conclusion of this species based on lack of biological knowledge. In addition, this reviewer commented that the lack of information may not enable practical management decisions.

Our Response: We agree that it is difficult to determine the entire range that is occupied by *Vetericaris chaceorum* on Hawaii Island or elsewhere in the Hawaiian Islands. We have based our determination on the number of estimated pools throughout the Hawaiian Islands and the percentage of these pools that have been surveyed. Despite surveys throughout the islands, *Vetericaris chaceorum* has only been observed in two pool complexes on Hawaii Island: Lua o Palahemo and Manuka. In addition, the fact that these two habitats are so different informs us that *Vetericaris chaceorum* is not solely a dark-adapted organism, but that it is has a range of suitable habitat that also includes shallow pools in full sunlight. This increase in suitable habitat types, the number of surveys throughout the Hawaiian Islands, and the fact that in total only 12 shrimp (5 at Lua o Palahemo and 7 at Manuka) have ever been observed suggest that *Vetericaris chaceorum* is not occurring in high numbers. We do not currently have methodologies that afford us the opportunity to search cracks and crevices within the anchialine pool environment; however, if this type of survey technology equipment becomes available, it will certainly enhance our understanding of the population dynamics of hypogeal shrimp, including *Vetericaris chaceorum.* The Service agrees that additional information will benefit management decisions.

(26) *Comment:* Two peer reviewers commented on the connection of Lua o Palahemo to the marine environment. One of these reviewers commented that the further collapse of the lava tube and increased siltation may have the effect of decreasing the slight flow of colder water into the depth of the lava tube, and that the further collapse may actually have a beneficial effect, such as isolation from human access. The second peer reviewer commented that the lava tube may be connected to a deep water marine habitat and associated fauna.

Our Response: Kensley and Williams (1986, p. 435) state that it is probable that neither temperature nor salinity imposes a barrier to the dispersal of hypogeal shrimp. They reported a surface temperature of 24 degrees Celsius, but they did not report the temperature at the depth they observed *Vetericaris chaceorum* (Kensley and Williams 1986, p. 418). During the surveys conducted by the Service in 2012, the temperature of the water at a depth of 7.5 m from the surface ranged from 23.8 degrees Celsius at noon to 26.4 Celsius at 4:50 a.m. (Wada *et al.* 2012, in litt.). The data suggest temperature is not currently a determining factor in the presence or absence of *Vetericaris chaceorum* at Lua o Palahemo.

The definition of an anchialine pool includes being tidally influenced due to a subterranean connection to the ocean, so we agree that the lava tube is connected to a marine habitat and fauna, although to what extent and what depth is not known at this time. The size (i.e., a smaller cracks versus a wide diameter lava tube) of the connection to the marine environment will determine to some extent the species present in a given anchialine pool; the better the connection to the sea, the more likely a pool will have marine organisms (Brock 2004, p. 9). For example, the unusual ecotypic variant of the moray eel (*Gymnothorax pictus,* puhi) is often found in pools with better connections to the sea (Brock 2004, p. 9). Regarding relationship between a further collapse of the lava tube and human access, we have no data to support or deny a benefit from limiting human access to the depths of Lua o Palahemo.

(27) *Comment:* One peer reviewer commented that since so little is known about *Vetericaris chaceorum,* most considerations of threats are conjectural, and that because no apparent observations have been made of this species in the upper reaches of Lua o Palahemo, purported threats to other anchialine species may not be a limiting factor or relevant to life in the lightless marine environment.

Our Response: As described earlier, *Vetericaris chaceorum* was initially discovered in 1985, in complete darkness within one of the lava tubes at Lua o Palahemo, at a location 180 m (590 ft) from the opening, at a depth of 30 m (98 ft). We agree that there is still much to be learned about *V. chaceorum's* life history and biology. It was recently confirmed that the species is not confined to the dark depths of Lua o Palahemo. In addition, Sakihara (2013, in litt.) observed *V. chaceorum* feeding on other anchialine pool shrimp species. Considering the new information, threats to other anchialine pool shrimp at varying depths are directly relevant to the survival of *V. chaceorum.* If the food supply of *V. chaceorum* is declining or diminished, it will have a direct impact on the health and survival of *V. chaceorum.* Further, the threats of dumping nonnative fish and trash can directly negatively impact the ecosystem at either Lua o Palahemo or Manuka; this is confirmed by observations at other anchialine pools around the Hawaiian Islands where nonnative fish and trash have caused the degradation of pools (Brock 2004, pp. 12–15).

(28) *Comment:* One peer reviewer questioned the value of comparing *Vetericaris chaceorum* with the anchialine pool shrimp *Halocaridina rubra.* This peer reviewer commented that *Vetericaris chaceorum* is likely much more specialized and that its lack of eyes, limited swimming option, and, as far as is known, very limited distribution makes comparisons between the two species uninformative for the most part. This peer reviewer further stated that the observations on the behavior of *V. chaceorum* suggests it may prey on smaller organisms by capturing them in the basket formed by its pereiopods as it swims in the dark; if this is true, the species would require large volumes of open water. The reviewer further elaborates that Kensley and Williams (1986) note the species is a strong swimmer and apparently stays in midwater, avoiding the solid walls, consistent with the filter-basket feeding hypothesis. If true, this makes this species somewhat different from other anchialine shrimp, which are generally associated with the substratum, although Maciolek observed *H. rubra* feeding in midwater ''presumably grazing only on phytoplankton.'' Similarly *V. chaceorum* does not appear to be very similar to the more well-studied anchialine shrimp. Its troglobitic (more correctly stygobitic) habit, large size, possibly its specialized trophic role and potentially unique evolutionary history should make comparisons with other anchialine shrimp suspect.

Our Response: We appreciate this reviewer's comments regarding the value of comparing *Vetericaris chaceorum* and *Halocaridina rubra.* We agree that these two shrimp are not exactly the same; however, *H. rubra* is the most well-studied anchialine pool shrimp in the Hawaiian Islands, and, therefore, we used it as a surrogate species in some examples for *V. chaceorum* in regards to the negative impacts associated with human dumping of nonnative fish and trash, in addition to recognizing it as a potential food source for *V. chaceorum.* The newly discovered population of *V. chaceorum* in the four shallow pools at Manuka has broadened our understanding of the range and habitat for this species, debunking the thoughts that this species is niched to the dark depths of Lua o Palahemo. Further, this challenges the above hypothesis that this species may require large volumes of open water. As stated in the comments above, we have much to learn about *V. chaceorum,* and we base our action in this rule on the fact that the habitat is threatened by sedimentation, recreational off-road vehicles, human dumping of nonnative fish, and human dumping of trash.

(29) *Comment:* One peer reviewer commented that poeciliids are not only introduced illegally in Hawaii, State agencies introduce mosquito fish to freshwater and anchialine habitats as mosquito control. While perhaps legal, the effects are just as detrimental. However, the peer reviewer did not think that mosquito control is a concern for a site like Lua o Palahemo.

Our Response: We agree that mosquito control is not a concern at Lua o Palahemo, and we have no information that would indicate that State agencies are introducing nonnative fish at Manuka for mosquito control.

(30) *Comment:* The proposed rule states that reduced flushing in the pool portion of Lua o Palahemo may allow an accumulation of sediment and detritus in the pool, reducing food productivity and the ability of *Vetericaris chaceorum* to move between the pool and water table. One peer reviewer commented there is no reason to discount the opposite idea that increased flushing has mobilized the sediment, allowed the movement of native predators and competitors into the system, and resulted in the decline or perhaps extirpation of *V. chaceorum.* In support of this is the statement in the October 17, 2012, proposed rule at 77 FR 63939: ''During those dives, researchers made five observations of *Vetericaris chaceorum* in total darkness at a depth of 108 ft (33 m) and 590 ft (180 m) from the opening, collecting two specimens. Kensley and Williams (1986, p. 418) noted, however, that the area surveyed directly beneath the surface of the pool contained the highest density of animals (e.g., shrimps and crustaceans).'' This suggests the very thick sediment cone just below the opening was not a problem for the dense populations of native species. All this just shows that there is an exceedingly limited understanding of how the system functions, and specifically what physical, chemical, and hydrologic aspects of the system promote sustaining *V.* chaceorum and its associated species. This commenter suggested that a high level of sediment is not, per se, deleterious to the shrimp, other anchialine pool species, and, by inference, the entire pool.

Our Response: We agree it is possible that increased flushing allowed the movement of native predators and competitors into the system, resulting in the decline or perhaps extirpation of *Vetericaris chaceorum* at Lua o

Palahemo; however, we are unaware of any data to support this hypothesis. Recent surveys by the Service and State (Wada 2012, pers. comm.; Wada *et al.* 2012, in litt.) have found the degradation of habitat of Lua o Palahemo is a result of excessive siltation and sedimentation of the anchialine pool system, combined with the diminished ability of the system to flush, which Brock (2004, pp. 11, 35–36) described as necessary for a functioning anchialine pool system. Long-term sedimentation accumulation leads to the senescence of anchialine pools (Ramsey 2013, in litt.). Suspended sediment within the water column of Lua o Palahemo likely reduces the capacity of the pool to produce adequate cyanobacteria and algae to support some of the pool's herbivorous hypogeal species. A decreased food supply (i.e., a reduction in cyanobacteria and algae) would likely lead to a lower abundance of herbivorous hypogeal shrimp species, as well as a lower abundance of the known carnivorous species (i.e., *Vetericaris chaceorum*). Because lower numbers of the herbivorous hypogeal shrimp have been observed over time, the data indicate this is a contributing to, but not necessarily the sole factor in, the lack of detection of *Vetericaris chaceorum* at Lua o Palahemo.

(31) *Comment:* One peer reviewer commented that Lua o Palahemo should not be treated as a typical anchialine pool. Rather it is a singular system, or perhaps somewhat like Lake Kauhako. Extrapolating from the little we know about typical anchialine systems will probably not be productive.

Our Response: Anchialine pools are land-locked bodies of water that have indirect underground connections to the sea, contain varying levels of salinity, and show tidal fluctuations in water level. Lua o Palahemo meets this definition. Further, Lua o Palahemo has floral and faunal characteristics of an anchialine pool ecosystem (see *Hawaii Island Ecosystems* and Description of the 15 Species, above). Lake Kauhako is situated in the crater of an extinct, late Pleistocene volcano on the north shore of Molokai, Hawaii, and reportedly not tidally influenced, although early data suggested it may have been at one time and anchialine pool shrimp were observed here in 1982 (Maciolek 1982, p. 12; Donachie *et al.* 1999, p. 93). Lake Kauhako is considered one of the deepest lakes in the United States with a depth of 814 ft (248 m) (Donachie *et al.* 1999, p. 93). Lake Kauhako is also meromictic (has layers of water that do not intermix) and anoxic (lacking dissolved oxygen) below 6 ft (2 m); Lua o Palahemo has not been classified as meromictic and is not noted as anoxic until a depth of 98 ft (30 m) and a distance of 180 m into one of the branches of the lava tube from the base of the surface opening (Kensley and Williams 1986, pp. 417–20). Both Lake Kauhako and Lua o Palahemo do have comparable surface dissolved oxygen and salinity and temperature gradients; however, the shape and depth of each water body, in addition to the presence or absence of tidal influence and meromictic properties, provide some distinction for these two bodies of water.

(32) *Comment:* One peer reviewer commented that the reproductive mode of *Vetericaris chaceorum* would play an important role in determining if populations could recolonize neighboring habitats after a local extirpation. Maciolek postulates that these habitats are colonized from long-existing subterranean populations, and Kensley and Williams (1986) state: ''Given the relative youth of the Lua o Palahemo lava tube, the above-mentioned and unexplained absences and occurrences, and the presence of some of these shrimps in modern wells and quarries, Maciolek's postulate (1983: 615) that these habitats are colonized from long-existing subterranean populations, must be strengthened.'' If this is true, the main habitat of *V. chaceorum* may be completely different from what we know about Lua o Palahemo.

Our Response: We agree it would be beneficial to know the reproductive mode for *Vetericaris chaceorum;* however, the complete life history for this species is not known at this time. Hypogeal shrimp by definition occupy subterranean habitat. The fact that *V. chaceorum* is described as a primitive species, combined with the depth within Lua o Palahemo in which *V. chaceorum* was observed and the recent discovery of *V. chaceorum* in very different habitat at Manuka, together appear to support Maciolek's hypothesis that hypogeal shrimp colonized anchialine pool habitats from long-existing subterranean populations, but this is only conjecture at this time. The newly discovered population at Manuka supports the thought that the main habitat of *V. chaceorum* at Lua o Palahemo is likely different from what we previously thought.

Comments From the State of Hawaii

(33) *Comment:* The Hawaii Department of Business, Economic Development, and Tourism's Hawaii Housing Finance and Development Corporation challenged our proposal to list *Bidens micrantha* ssp. *ctenophylla* as an endangered species, stating that the lowland dry ecosystem covers a very large area on Hawaii Island and that the Service did not have enough studies regarding the absence or abundance of this species within this ecosystem. According to this agency, without knowing the absence or prevalence of this species, it cannot be determined whether or not this species should be designated as endangered, and the Service's findings are premature with no foundation.

Our Response: We disagree that there is a lack of information regarding the presence or abundance of *Bidens micrantha* ssp. *ctenophylla* in the lowland dry ecosystem on the island of Hawaii and that our determination to list this species as an endangered species is premature and without foundation. Lowland dry ecosystems in the Hawaiian Islands have undergone sweeping changes over the last 100 years due to development, agriculture, and nonnative plants and animals that have resulted in the loss of over 90 percent of Hawaii's dry forests (Bruegmann 1996, pp. 26–27; Cabin *et al.* 2000, pp. 439–453; Sakai *et al.* 2002, pp. 276–302; Cordell *et al.* 2008, pp. 279–284); however, the actual extent of native dry forest cover may be as low as 1 percent (Pau 2011, in litt.). Forty-five percent of Hawaii's dry forest plant species are at risk of endangerment (Pau *et al.* 2009, p. 3,167). Twenty-five percent of the endangered plant species in the Hawaiian Islands are dry forest species, and approximately 20 percent of Hawaii's dry land plant species are believed to be extinct (Cabin *et al.* 2000, pp. 439–453; Sakai *et al.* 2002, pp. 276–302). One of the last remaining areas of lowland dry forest in the Hawaiian Islands is in the north Kona region of Hawaii Island, where only patches or scattered individuals of native plants remain amidst a sea of the highly flammable, nonnative fountain grass (*Pennisetum setaceum*), where over 200,000 ac (80,939 ha) of land are covered with fountain grass (HISC 2013, in litt.). North Kona is also a rapidly growing, urban area with a steady flow of new housing, roads, commercial, and industrial developments. Surveys and observations conducted over the last 90 years have detected *Bidens micrantha* ssp. *ctenophylla* from only six locations, totaling fewer than 1,000 individuals in north Kona (see Description of the 15 Species, above) (Sherff 1920, p. 97; Degener and Wiebke 1926, in litt.; Scottsberg 1926, in litt.; Borges and Degener 1929, in litt.; Degener and Iwasaki 1930, in litt.; Nishina 1931, in litt.; Krajina 1961, in litt.; Gillett 1965, in litt.; Nagata and Ganders 1983, pp. 1–16; Pratt and Abbott 1996, p. 26; Ganders and Nagata 1999, pp. 271, 273; TNC 2007–*Ecosystem Database of ArcMap Shapefiles,* unpublished; Whistler 2007, pp. 1–18; Bio 2008, in litt.; Whistler 2008, pp. 1–11; Hawaii Forest Institute 2009, in litt.; Beavers 2010, in litt.; Faucette 2010, pp. 1–27; HBMP 2010b; Giffin 2011, pers. comm.; Pau 2011, in litt.; Wagner 2011, in litt.; Zimpfer 2011, in litt.; Kaahahui O Ka Nahelehele 2013, in litt.).

Under the Act, we determine whether a species is an endangered species or a threatened species because of any of five factors (see Summary of Factors Affecting the 15 Species, below), and we are required to make listing determinations solely on the basis of the best available scientific and commercial data *available* [emphasis ours] (sections 4(a)(1) and 4(b)(1)(A)). The threats to *B. micrantha* ssp. *ctenophylla,* as well as those that impact lowland dry ecosystems in the Hawaiian Islands, are well documented. This plant species faces threats from habitat degradation from development and nonnative ungulates (feral pigs and goats), predation by nonnative ungulates (feral pigs and goats) and rats, competition with nonnative plants, fire, drought, hurricanes, and hybridization; it also faces threats from the synergistic effects that may arise from any combination of these threats (see Summary of Factors Affecting the 15 Species, below). Therefore, in this final rule, we have made our determination to list *Bidens micrantha* ssp. *ctenophylla* as an endangered species based on the best scientific and commercial data available.

Comments From Federal Agencies

All of the comments we received from Federal agencies have been incorporated, as appropriate, in the Description of the 15 Species, above, and Summary of Changes from Proposed Rule, below.

Public Comments on the Proposed Listing of 15 Species

(34) *Comment:* One commenter, representing Laiopua 2020, stated that none of the 15 species proposed for listing occurs on parcels proposed for development of the Laiopua Community Center (Tax Map Key parcels 3–7–4–021:002, 003, and 023). The commenter provided a 2008 botanical survey report (Gerrish and Leonard Bisel Associates, LLC, 2008, entire) to confirm the absence of the 15 species on the three parcels.

Our Response: We appreciate the information provided by the commenter and have taken it into consideration in this final listing determination. The botanical survey published by Gerrish and Leonard Bisel Associates, LLC, in 2008 was one of multiple surveys and botanical expert reports used by the Service to determine the range of *Bidens micrantha* ssp. *ctenophylla* in North Kona. Since *Bidens micrantha* ssp. *ctenophylla* is known to occur in the area of Laiopua, the Service considered this area as habitat for this species. In addition, there is likely a seed bank in the soil of the surrounding area that, if given the opportunity, can contribute toward the recovery of this species.

Summary of Changes From Proposed Rule

In preparing this final rule, we reviewed and fully considered comments from the peer reviewers and public on the proposed listing for 15 species. This final rule incorporates the following substantive changes to our proposed listing, based on the comments we received:

(1) We added inundation by high surf as a threat to the newly listed plant *Bidens hillebrandiana* ssp. *hillebrandiana* in the following locations in this final rule: Table 3 (below) and ''Habitat Destruction and Modification Due to Rockfalls, Treefalls, Landslides, Heavy Rain, Inundation by High Surf, Erosion, and Drought'' under *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range* (below), based on a peer review comment.

(2) We added the nonnative understory plant species *Sphagneticola trilobata* [*Wedelia trilobata*] (wedelia) as a threat to the plant *Bidens hillebrandiana* ssp. *hillebrandiana* in the coastal and dry cliff ecosystem, and to ''Specific Nonnative Plant Species Impacts'' (below), based on a peer review comment.

(3) We added the nonnative vine *Paederia foetida* (skunk weed) as a threat to the newly listed plant *Cyrtandra nanawaleensis* in the lowland wet ecosystem and to ''Specific Nonnative Plant Species Impacts'' (below), based on a peer review comment.

(4) We added the nonnative canopy plant species *Psidium cattleianum* (strawberry guava) as a threat to *Cyanea tritomantha* in the wet cliff ecosystem, based on a peer review comment that we include this nonnative plant species as a threat to this species in its known locations, in this final rule.

(5) We added *Pisonia* spp. as a host plant for the picture-wing fly *Drosophila digressa,* in the following locations in this final rule: Description of the 15 Species (above); ''Habitat Destruction and Modification by Introduced Ungulates'' and ''Habitat Destruction and Modification Due to Rockfalls, Treefalls, Landslides, Heavy Rain, Inundation by High Surf, Erosion, and Drought'' under *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range* (below); ''Predation and Herbivory'' under *Factor C. Disease or Predation* (below); and ''Loss of Host Plants'' under *Factor E. Other Natural or Manmade Factors Affecting Their Continued Existence* (below), based on a peer review comment.

(6) Hawaii State biologists discovered a population of *Vetericaris chaceorum* at Manuka NAR between 2009 and 2010. We solicited public comments on the new location in the **Federal Register** in our April 30, 2013, document announcing the availability of the draft economic analysis and reopening the comment period on the proposed rule (78 FR 25243). The new location information has been incorporated in the following sections in this final rule: Description of the 15 Species (above), ''Habitat Destruction and Modification by Sedimentation'' under *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range* (below), and ''Dumping of Trash and Introduction of Nonnative Fish'' (below) under *Factor E. Other Natural or Manmade Factors Affecting Their Continued Existence,* and we reassessed whether listing was warranted for *V. chaceorum* based on this additional information.

(7) We revised the statement that incorrectly indicated that the outplanted individuals of *Bidens micrantha* ssp. *ctenophylla* within KHNHP are fenced in Description of the 15 Species, above, based on a comment we received.

Summary of Factors Affecting the 15 Species

Section 4 of the Act (16 U.S.C. 1533) and its implementing regulations (50 CFR part 424) set forth the procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. A species may be determined to be an endangered or threatened species due to one or more of the five factors described in section 4(a)(1) of the Act: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors affecting its continued existence. Listing actions may be warranted based on any of the above threat factors, singly or in combination.

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 listed as endangered or threatened. The Act defines an endangered species as ''in danger of extinction throughout all or a significant portion of its range,'' and a threatened species as ''likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.'' The threats to each of the individual 15 species are summarized in Table 3, and discussed in detail below.

TABLE 3–SUMMARY OF PRIMARY THREATS IDENTIFIED FOR EACH OF THE 15 HAWAII ISLAND SPECIES

Species	Ecosystem	Factor A						Factor B	Factor C				Factor D	Factor E
		Agriculture and urban development	Ungulates	Non native plants	Fire	Stochastic events	Climate change	Over-utilization	Disease	Predation/ herbivory by ungulates	Predation/ herbivory by other NN vertebrates	Predation/ herbivory by NN invertebrates	Inadequate existing regulatory mechanisms	Other species-specific threats
Plants:														
Bidens hillebrandiana ssp. *hillebrandiana*.	CO, DC		P, G	X		H, RF, L, HS, E.	Pt			P, G	R		X	LN
Bidens micrantha ssp. *ctenophylla*.	LD	X	P, G	X	X	H, DR	Pt			P, G	R		X	HY
Cyanea marksii	LW, MW		P, C, M	X		H, RF, L	Pt			P, C, M	R	S	X	LN
Cyanea tritomantha	LW, MW, WC		P, C	X		H, TF	Pt			P, C	R	S	X	NR
Cyrtandra nanawaleensis	LW		P	X		H	Pt			P	R	S	X	HY
Cyrtandra wagneri	LW		P	X		H, HR, E	Pt			P	R	S	X	LN, HY
Phyllostegia floribunda	LW, MM, MW		P	X	X	H	Pt			P			X	
Pittosporum hawaiiense	LM, MM, MW		P, C, M	X		H	Pt			P, C, M	R		X	NR
Platydesma remyi	LW, MW		P	X		H	Pt			P			X	LN, NR
Pritchardia lanigera	LM, LW, MW, WC.		P, G, M, C	X		H	Pt	X		P, G, M	R	LH, B	X	NR
Schiedea diffusa ssp. *macraei*.	MW		P, C	X		H	Pt			P, C	R		X	LN
Schiedea hawaiiensis	MD		P, G, SH, M.	X	X	H, DR	Pt			P, G, SH, M	R		X	LN
Stenogyne cranwelliae	MW, WC		P	X		H	Pt			P	R	S	X	
Animals														
Drosophila digressa (Picture-wing fly).	LM, MM, MW		P, G, C, M	X	X	H, DR	Pt					W, A	X	LN, LOH, F
Vetericaris chaceorum (Anchialine pool shrimp).	AP		G, C				Pt						X	REC, SD, D

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
MD = Montane Dry
MM = Montane Mesic
MW = Montane Wet
DC = Dry Cliff
WC = Wet Cliff
P = Pigs
G = Goats
C = Cattle
SH = Sheep
M = Mouflon
R = Rats
S = Slugs
W = Wasps
A = Ants
LH = Leafhopper
B = Beetles
H = Hurricane
DR = Drought
RF = Rockfalls
L = Landslides
HR = Heavy Rain
HS = High Surf
E = Erosion
TF = Tree Fall
D = Dumping (i.e., Human dumping of nonnative fish and trash)
LN = Limited Numbers
HY = Hybridization
NR = No Regeneration
F = Flies
LOH = Loss of Host
REC = Recreational vehicles
SD = Sedimentation
Pt = Potential
X = Threat
Blank = Not a Threat

The following constitutes a list of ecosystem-scale threats that affect the species in this final rule in one or more of the 10 described ecosystems on Hawaii Island:

(1) Foraging and trampling of native plants by feral pigs (*Sus scrofa*), goats (*Capra hircus*), cattle (*Bos taurus*), sheep (*Ovis aries*), or mouflon sheep (*Ovis gmelini musimon*), which results in severe erosion of watersheds because these mammals inhabit terrain that is often steep and remote (Cuddihy and Stone 1990, p. 63). Foraging and trampling events destabilize soils that support native plant communities, bury or damage native plants, and have adverse water quality effects due to runoff over exposed soils.

(2) Ungulate destruction of seeds and seedlings of native plant species via foraging and trampling (Cuddihy and Stone 1990, pp. 63, 65) facilitates the conversion of disturbed areas from native to nonnative vegetative communities.

(3) Disturbance of soils by feral pigs from rooting can create fertile seedbeds for alien plants (Cuddihy and Stone 1990, p. 65), some of them spread by ingestion and excretion by pigs.

(4) Increased nutrient availability as a result of pigs rooting in nitrogen-poor soils, which facilitates establishment of alien weeds. Introduced vertebrates are known to enhance the germination of alien plants through seed scarification in digestive tracts or through rooting and fertilization with feces of potential seedbeds (Stone 1985, p, 253). In addition, alien weeds are more adapted to nutrient-rich soils than native plants (Cuddihy and Stone 1990, p. 65), and rooting activity creates open areas in forests allowing alien species to completely replace native stands.

(5) Rodent damage to plant propagules, seedlings, or native trees, which changes forest composition and structure (Cuddihy and Stone 1990, p. 67).

(6) Feeding or defoliation of native plants from alien insects, which reduces geographic ranges of some species because of damage (Cuddihy and Stone 1990, p. 71).

(7) Alien insect predation on native insects, which affects pollination of native plant species (Cuddihy and Stone 1990, p. 71).

(8) Significant changes in nutrient cycling processes because of large numbers of alien invertebrates, such as earthworms, ants, slugs, isopods, millipedes, and snails, resulting in changes to the composition and structure of plant communities (Cuddihy and Stone 1990, p. 73).

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

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

The Hawaiian Islands are located over 2,000 mi (3,200 km) from the nearest continent. This isolation has allowed the few plants and animals that arrived in the Hawaiian Islands to evolve into many highly varied and endemic species (species that occur nowhere else in the world). The only native terrestrial mammals in the Hawaiian Islands are two bat taxa, the extant Hawaiian hoary bat (*Lasiurus cinereus semotus*) and an extinct, unnamed, insectivorous bat (Ziegler 2002, p. 245). The native plants of the Hawaiian Islands, therefore, evolved in the absence of mammalian predators, browsers, or grazers. As a result, many of the native species have lost unneeded defenses against threats such as mammalian predation and competition with aggressive, weedy plant species that are typical of continental environments (Loope 1992, p. 11; Gagne and Cuddihy 1999, p. 45; Wagner *et al.* 1999d, pp. 3–6). For example, Carlquist (in Carlquist and Cole 1974, p. 29) notes that ''Hawaiian plants are notably free from many characteristics thought to be deterrents to herbivores (toxins, oils, resins, stinging hairs, coarse texture).''

Native Hawaiian plants are therefore highly vulnerable to the impacts of introduced mammals and alien plants. In addition, species restricted and adapted to highly specialized locations (e.g., *Bidens hillebrandiana* ssp. *hillebrandiana*) are particularly vulnerable to changes (e.g., nonnative species, hurricanes, fire, and climate change) in their habitat (Carlquist and Cole 1974, pp. 28–29; Loope 1992, pp. 3–6; Stone 1992, pp. 88–102).

Habitat Destruction and Modification by Agriculture and Urban Development

The consequences of past land use practices, such as agricultural or urban development, have resulted in little or no native vegetation below 2,000 ft (600 m) throughout the Hawaiian Islands (TNC 2007–*Ecosystem Database of ArcMap Shapefiles,* unpublished), largely impacting the coastal, lowland dry, lowland mesic, and lowland wet ecosystems. Although agriculture has been declining in importance, large tracts of former agricultural lands are being converted into residential areas or left fallow (TNC 2007–*Ecosystem Database of ArcMap Shapefiles,* unpublished). In addition, Hawaii's population has increased almost 7 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 (HDBEDT) 2010).

Development and urbanization of the lowland dry ecosystem on Hawaii Island is a threat to one species in this rule, *Bidens micrantha* ssp. *ctenophylla. Bidens micrantha* ssp. *ctenophylla* is currently found in an area less than 10 sq mi (26 sq km) on the leeward slopes of Hualalai volcano in the lowland dry ecosystem. This area encompasses the increasingly urbanized region of north Kona, where there is very little undisturbed habitat (Pratt and Abbott 1997, p. 25). Approximately 25 percent (119 individuals of 475) of the largest of the 6 occurrences of this species is in the right-of-way of the Ane Keohokalole Highway Project (USFWS 2010, in litt.) and Kaloko Makai Development, although 154 ac (62 ha) will be set aside as a lowland dry forest preserve (Kaloko Makai Dryland Forest Preserve) to compensate for the loss of these individuals as a result of highway construction and prior to the Kaloko Makai Development. Individuals of *Bidens micrantha* ssp. *ctenophylla* also occur in areas where the development of the Villages of Laiopua at Kealakehe and of the Keahuolu affordable housing project (Whistler 2007, pp. 1–18; DHHL 2009, p. 15) is a threat to the species.

Habitat Destruction and Modification by Introduced Ungulates

Introduced mammals have greatly impacted the native vegetation, as well as the native fauna, of the Hawaiian Islands. The presence of introduced alien mammals is considered one of the primary factors underlying the alteration and degradation of native plant communities and habitats on the island of Hawaii. The destruction or degradation of habitat due to nonnative ungulates (hoofed mammals), including pigs, goats, cattle, sheep, and mouflon, is currently a threat to the 10 ecosystems (lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, coastal, anchialine pool, dry cliff, and wet cliff) on Hawaii Island and their associated species. Habitat degradation or destruction by ungulates is also a threat to all 13 plant species and the picture-wing fly in this final rule (Table 3). Habitat degradation or destruction by ungulates is a threat to the anchialine pool shrimp at Lua o Palahemo, but is not reported to pose a threat to the four pools that support this species at Manuka.

The destruction or degradation of habitat due to pigs is currently a threat to nine of the Hawaii Island ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, dry cliff, and wet cliff) and their associated species. In Hawaii, pigs have been described as the most pervasive and disruptive nonnative influence on the unique native forests of the Hawaiian Islands, and are widely recognized as one of the greatest current threats to forest ecosystems (Aplet *et al.* 1991, p. 56; Anderson and Stone 1993, p. 195).

These feral animals 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 sq yards (yd) (1.7 sq m) per minute, with only 4 hours of foraging a day, a single pig could disturb over 1,600 sq yd (1,340 sq m) (or approximately 0.3 ac, or 0.12 ha) of groundcover per week (Anderson *et al.* 2007, p. 2).

Pigs reduce or eliminate plant regeneration by damaging or eating seeds and seedlings (further discussion of predation by nonnative ungulates is provided under *Factor C. Disease or Predation,* below). Pigs are a major vector for the establishment and spread of competing invasive, nonnative plant species by dispersing plant seeds on their hooves and fur, and in their feces (Diong 1982, pp. 169–170), which also serves to fertilize disturbed soil (Matson 1990, p. 245; Siemann *et al.* 2009, p. 547). Pigs feed on the fruits of many nonnative plants, such as *Passiflora tarminiana* (banana poke) and *Psidium cattleianum* (strawberry guava), spreading the seeds of these invasive species through their feces as they travel in search of food. Pigs also feed on native plants, such as Hawaiian tree ferns that they root up to eat the core of the trunk (Baker 1975, p. 79). In addition, rooting pigs contribute to erosion by clearing vegetation and creating large areas of disturbed soil, especially on slopes (Smith 1985, pp. 190, 192, 196, 200, 204, 230–231; Stone 1985, pp. 254–255, 262–264; Medeiros *et al.* 1986, pp. 27–28; Scott *et al.* 1986, pp. 360–361; Tomich 1986, pp. 120–126; Cuddihy and Stone 1990, pp. 64–65; Aplet *et al.* 1991, p. 56; Loope *et al.* 1991, pp. 1–21; Gagne and Cuddihy 1999, p. 52; Nogueira-Filho *et al.* 2009, pp. 3,677–3,682; Dunkell *et al.* 2011, pp. 175–177). Erosion impacts native plant communities by watershed degradation and alteration of plant nutrient status due to associated outcomes such as sediment build up in waterways and top soil run off, respectively, as well as damage to individual plants from landslides (Vitousek *et al.* 2009, pp. 3074–3086; Chan-Halbrendt *et al.* 2010, p. 252).

Pigs have been cited as one of the greatest threats to the public and private lands within the Olaa Kilauea Partnership (an area of land that includes approximately 32,000 ac (12,950 ha) in the upper sections of the Olaa and Waiakea forests above Volcano village) that comprise the lowland mesic, lowland wet, montane mesic, and montane wet ecosystems that support individuals of three of the plant species in this final rule (*Cyanea tritomantha, Phyllostegia floribunda,* and *Pittosporum hawaiiense*) (Olaa Kilauea Partnership Area Feral Animal Monitoring Report 2005, pp. 1–4; Perlman 2007, in litt.; Pratt 2007a, in litt.; Pratt 2007b, in litt.; Benitez *et al.* 2008, p. 58; HBMP 2010f; HBMP 2010h; PEPP 2010, p. 60, TNC 2012, in litt.). Impacts from feral pigs are also a threat to the coastal, lowland mesic, lowland wet, montane wet, dry cliff, and wet cliff ecosystems in the northern Kohala Mountains and adjacent coastline. These ecosystems support occurrences of seven of the plant species in this final rule (*Bidens hillebrandiana* ssp. *hillebrandiana, Cyanea tritomantha, Cyrtandra wagneri, Platydesma remyi, Pritchardia lanigera, Schiedea diffusa* ssp. *macraei,* and *Stenogyne cranwelliae*) (Wood 1995, in litt.; Wood 1998, in litt.; Perlman *et al.* 2001, in litt.; Wagner *et al.* 2005d, pp. 31–33; Kohala Mountain Watershed Partnership (KMWP) 2007, pp. 54–56; Lorence and Perlman 2007, pp. 357–361; HBMP 2010a; HBMP 2010c; HBMP 2010f; HBMP 2010i; HBMP 2010j; HBMP 2010k; PEPP 2010, pp. 63, 101, 106; Bio 2011, pers. comm.). In addition, feral pigs are a threat to the lowland wet and montane wet ecosystems in south Kona, Kau, and Puna districts that support the plants *Cyanea marksii, Cyrtandra nanawaleensis,* and *Pritchardia lanigera* (Bio 2011, pers. comm.; Magnacca 2011b, pers. comm.; Maui Forest Bird Recovery Project 2011, in litt.; Crysdale 2013, pers. comm.). Feral pigs have also been reported in the lowland dry ecosystem that supports the plant *Bidens micrantha* ssp. *ctenophylla* (Bio 2011, pers. comm.) and the montane dry ecosystem that supports habitat for the only known occurrence of the plant *Schiedea hawaiiensis* (Mitchell *et al.* 2005c; U.S. Army Garrison 2006, pp. 27, 34, 95–97, 100–107, 112). Although we do not have direct evidence of feral pigs threatening the particular species on Hawaii Island that are in this final rule, those threats have been documented on other islands where pigs have been introduced (Mitchell *et al.* 2005c; U.S. Army Garrison 2006, pp. 27, 34, 95–97, 100–107, 112). We find it is reasonable to infer that feral pig threats to these species that have been observed on other Hawaiian islands would act in a similar manner on Hawaii Island, where those species interact.

Many of the most important host plants of Hawaiian picture-wing flies (*Charpentiera, Pisonia, Pleomele, Reynoldsia, Tetraplasandra, Urera,* and the lobelioids (e.g., *Cyanea* spp.)) are also among the most susceptible to damage from feral ungulates, such as pigs (Foote and Carson 1995, p. 370; Kaneshiro and Kaneshiro 1995, pp. 8, 39; Magnacca *et al.* 2008, p. 32; Magnacca 2013, in litt.). Feral pig browsing alters the essential microclimate in picture-wing fly (*Drosophila digressa*) habitat by opening up the canopy, leading to increased desiccation of soil and host plants (*Charpentiera* spp. and *Pisonia* ssp.), which disrupts the host plants' life cycle and decay processes, resulting in disruption of the picture-wing fly's life cycle, particularly oviposition and larvae substrate (Magnacca *et al.* 2008, pp. 1, 32). Foote and Carson (1995, p. 369) have experimentally demonstrated the above detrimental effects of feral pigs on *Drosophila* spp. in wet forest habitat on the island of Hawaii. In addition, Montgomery (2005, in litt.; 2007, in litt.) and Foote (2005, pers. comm.) have observed feral pig damage to host plants (e.g., *Charpentiera* sp., *Cheirodendron* sp., *Pleomele* sp., *Tetraplasandra* sp., *Urera kaalae*) of Hawaiian picture-wing flies on the island of Hawaii (Foote 2005, pers. comm.) and throughout the main Hawaiian Islands (Montgomery 2005, in litt.; 2007, in litt.). Magnacca (2012, pers. comm.) has observed the lack of regeneration of picture-wing fly host plants due to destruction of seedlings caused by pig rooting and herbivory.

The destruction or degradation of habitat due to goats is currently a threat to all 10 of the described ecosystems on Hawaii Island (anchialine pool, coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, dry cliff, and wet cliff) and their associated species. Goats occupy a wide variety of habitats on Hawaii Island, where they consume native vegetation, trample roots and seedlings, accelerate erosion, and promote the invasion of alien plants (van Riper and van Riper 1982, pp. 34–35; Stone 1985, p. 261; Kessler 2011, pers. comm.). Goats are able to access, and forage in, extremely rugged terrain, and they have a high reproductive capacity (Clarke and Cuddihy 1980, pp. C–19, C–20; Culliney 1988, p. 336; Cuddihy and Stone 1990, p. 64). Because of these factors, goats have completely eliminated some plant species from islands (Atkinson and Atkinson 2000, p. 21).

Goats are be highly destructive to native vegetation, and contribute to erosion by eating young trees and young shoots of plants before they can become established, creating trails that damage native vegetative cover, promoting erosion by destabilizing substrate and creating gullies that convey water, and dislodging stones from ledges that can cause rockfalls and landslides and damage vegetation below (Cuddihy and Stone 1990, pp. 63–64). A recent study by Chynoweth *et al.* (2011, in litt.), which deployed GPS (global positioning system) satellite collars on 12 feral goats to track movement patterns every 2 hours for 1 year in Pohakuloa Training Area, found that goats prefer native-dominated shrublands in the montane dry ecosystem during the day and barren lava at night. Pohakuloa Training Area supports one of the few montane dry forest ecosystems on Hawaii Island that supports native plants in the montane dry ecosystem, including the only occurrence of the plant *Schiedea hawaiiensis* (U.S. Army Garrison 2006, pp. 27, 34; Evans 2011, in litt.). In addition, one of the two occurrences of the plant *Pritchardia lanigera* is known from an unfenced area of the Kohala Mountains, where herds of wild goats and other ungulates occur (Maly and Maly 2004 *in* KMWP 2007, p. 55; KMWP 2007, pp. 54–55; Warshauer *et al.* 2009, pp. 10, 24; Laws *et al.* 2010, in litt.; Ikagawa 2011, in litt.). Maly and Maly (2004 *in* KMWP 2007, p. 55) report that ''herds of wild goats roam throughout this region, trampling, grubbing, and rending, grinding the bark of old trees and eat the young ones . . . which will destroy the beauty and alter the climate of the mountainous region of Hawaii.'' There are direct observations that goats are also altering the coastal ecosystem along the Kohala Mountains, the location of the only known wild individuals of the plant *Bidens hillebrandiana* ssp. *hillebrandiana* (Warshauer *et al.* 2009, p. 24; Bio 2011, pers. comm.). Goats are also found in North Kona and have been observed browsing in the lowland dry ecosystem that supports the plant *B. micrantha* ssp. *ctenophylla* (Bio 2011, pers. comm.; Knoche 2011, in litt.). Fresh seedlings from native plants attract goats to the dry and rough lava (Bio 2011, pers. comm.). Further, the host plants (*Charpentiera* spp. and *Pisonia* spp.) of the picture-wing fly in this final rule appear to be decreasing throughout their ranges due to impacts from browsing goats (Foote and Carson 1995, p. 369; Science Panel 2005, pp. 1–23; Magnacca *et al.* 2008, p. 32; Magnacca 2013, in litt.). Feral goat browsing alters the picture-wing fly's (*Drosophila digressa*) essential microclimate by opening up the canopy, leading to increased desiccation of soil and host plants, which disrupts the host plants' life cycle and decay processes, resulting in the disruption of the picture-wing fly's life cycle, particularly oviposition and larvae substrate (Magnacca *et al.* 2008, pp. 1, 32). Based on observations of goats and their scat (Magnacca 2012, pers. comm.) within the Ka Lae region where the Lua o Palahemo anchialine pool is located, the Service concludes that goats contribute to the degradation of the anchialine pool habitat and, thus, are a threat to the anchialine pool shrimp *Vetericaris chaceorum.* Feral goats trample and forage on both native and nonnative plants around and near the pool opening at Lua o Palahemo, and increase erosion around the pool and sediment entering the pool.

The destruction or degradation of habitat due to cattle is currently a threat to five of the described ecosystems (anchialine pool, lowland mesic, lowland wet, montane mesic, and montane wet) on Hawaii Island and their associated species. 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 in their feces and on their bodies. The forest in areas grazed by cattle degrades to grassland pasture, and plant cover is reduced for many years following removal of cattle from an area. In addition, several alien grasses and legumes purposely introduced for cattle forage have become noxious weeds (Tomich 1986, pp. 140–150; Cuddihy and Stone 1990, p. 29).

The wet forests of Kohala Mountain are reported to have a feral cattle population of at least 100 individuals that are causing forest degradation by trampling and browsing, which leads to subsequent increased nitrogen availability through deposition of feces (Stone 1985, p. 253), all of which contribute to the influx of nonnative plant and animal species (KMWP 2007, pp. 54–55; Laws 2010, in litt.). Feral cattle are reported from remote regions on Hawaii Island, including the back of both Pololu and Waipio Valleys (KMWP 2007, p. 55). Feral cattle are a threat to the lowland wet and montane wet ecosystems on Kohala Mountain where individuals of *Cyanea tritomantha, Pittosporum hawaiiense,* and *Pritchardia lanigera,* and the last wild individual of *Schiedea diffusa* ssp. *macraei,* are reported (PEPP 2010, pp. 59–60; Bio 2011, pers. comm.). According to a 2010 Service report (USFWS 2010, pp. 3–15, 4–86), a herd of 200 to 300 feral cattle roams the Kona unit of the Hakalau Forest NWR, where individuals of *Cyanea marksii* are reported (USFWS 2010, pp. 3–15, 4–86). Field biologists have observed cattle-induced habitat degradation at all elevations in this refuge unit, including within the montane wet ecosystem that supports individuals of *Cyanea marksii* (PEPP 2007, p. 61; USFWS 2010, pp. 1–15, 2–13, 4–10, 4–58–4–59, 4–82, 4–86; Bio 2011, pers. comm.; Krauss 2012, pers. comm.). In addition, the host plants (*Charpentiera* spp. and *Pisonia* spp.) of the picture-wing fly *Drosophila digressa* have decreased throughout their ranges due to impacts from cattle browsing in the lowland mesic and montane mesic ecosystems (Science Panel 2005, pp. 1–23; Magnacca 2011b, in litt.; Magnacca 2013, in litt.). Feral cattle browsing alters the picture-wing fly's essential microclimate by opening up the canopy, leading to increased desiccation of soil and host plants, which disrupts the host plants' life cycle and decay processes, resulting in the disruption of the picture-wing fly's life cycle, particularly oviposition and larvae substrate (Magnacca *et al.* 2008, pp. 1, 32). According to Palikapu Dedman with the Pele Defense Fund, observations of feral cattle in the Ka Lae region where the Lua o Palahemo anchialine pool is located contribute to the degradation of the anchialine pool habitat (Richarson 2012, in litt.). Feral cattle trample and forage on both native and nonnative plants around and near the pool opening at Lua o Palahemo, and increase erosion around the pool and sediment entering the pool. We therefore conclude that feral cattle are a threat to the anchialine pool shrimp *Vetericaris chaceorum* (Richardson 2012, in litt., pp. 1–2). Further, cattle carcasses have been observed within the pool at Lua o Palahemo (Kinzie 2012, in litt.). Due to the steep sides of the pool, animals may fall into the water, and if they die there, their decomposing bodies could have a negative impact on the ability of the pool habitat to support *V. chaceorum* (Kinzie 2012, in litt.).

The destruction or degradation of habitat due to feral sheep is currently a threat to the montane dry ecosystem on Hawaii Island and its associated species. 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 erodes top soil, which alters moisture regimes and micro-environments, and results in the loss of native plant and animal taxa (Tomich 1986, pp. 156–163; Cuddihy and Stone 1990, pp. 65–66). In addition, nonnative opportunistic plant seeds get dispersed to disturbed forest sites by adhering to sheep wool coats (Hawaii Division of Forestry and Wildlife (HDOFAW) 2002, p. 3).

In 1962, game hunters intentionally crossbred feral sheep with mouflon sheep and released them on Mauna Kea (Tomich 1986, pp. 156–163). In *Palila* v. *Hawaii Department of Land and Natural Resources* (471 F. Supp. 985 (Haw. 1979)), the Federal court ordered complete removal of feral sheep from Mauna Kea in 1979, because they were harming the endangered palila (*Loxioides bailleui*) by degrading and destroying palila habitat in the montane dry ecosystem. Throughout the past 30 years, attempts to protect the vegetation of Mauna Kea and the saddle from sheep have only been sporadically effective (Scowcroft and Conrad 1992, p. 628). Currently, a large feral population surrounds Mauna Kea and extends into the saddle and northern part of Mauna Loa, including the State forest reserves, where they trample and browse endangered plants (Hess 2008, p. 1). At the U.S. Army's Pohakuloa Training Area, located in the saddle area of the island, biologists have reported that feral sheep are a threat to the last occurrence of the plant species *Schiedea hawaiiensis,* which occurs in the montane dry ecosystem (Mitchell *et al.* 2005a; U.S. Army Garrison 2006, pp. 27, 34).

Five of the described ecosystems (lowland mesic, lowland wet, montane dry, montane mesic, and montane wet) on Hawaii Island, and their associated species are currently threatened by the destruction or degradation of habitat due to mouflon sheep. The mouflon sheep (mouflon), native to Asia Minor, was introduced to the islands of Lanai and Hawaii in the 1950s, as a managed game species, and has become widely established on these islands (Tomich 1986, pp. 163–168; Cuddihy and Stone 1990, p. 66; Hess 2008, p. 1). In 1968, mouflon were introduced to Kahuku Ranch (now a unit of HVNP) on Mauna Loa for trophy hunting. By 2008, mouflon ranged over the southern part of Mauna Loa in the Kahuku area on adjacent public and private lands (Hess 2008, p. 1). According to Ikagawa (2011, in litt.), mouflon are found on the slopes of both Mauna Loa and Mauna Kea. Ikagawa (2011, in litt.) also notes that mouflon and mouflon-sheep hybrids are found from sea level to over 3,280 ft (1,000 m) elevation. Mouflon have high reproduction rates; for example, the original population of 11 individuals on the island of Hawaii has increased to more than 2,500 in 36 years, even though mouflon are hunted as a game animal (Hess 2008, p. 3). Mouflon only gather in herds when breeding, thus limiting control techniques and hunting efficiency (Hess 2008, p. 3; Ikagawa 2011, in litt.). Mouflon are both grazers and browsers, and have decimated vast areas of native forest and shrubland through browsing and bark stripping (Stone 1985, p. 271; Cuddihy and Stone 1990, pp. 63, 66; Hess 2008, p. 3). Mouflon also create trails and pathways through thick vegetation, leading to increased runoff and erosion through soil compaction. In some areas, the interaction of browsing and soil compaction has led to a change from native rainforest to grassy scrublands (Hess 2008, p. 3). Field biologists have observed habitat degradation in five of the described ecosystems (lowland mesic, lowland wet, montane dry, montane mesic, and montane wet) that support four plants (*Cyanea marksii, Pittosporum hawaiiense, Pritchardia lanigera,* and *Schiedea hawaiiensis*) (Bio 2011, pers. comm.; Ikagawa 2011, in litt.; Pratt 2011d, in litt.), and the picture-wing fly (*Drosophila digressa*) (Magnacca 2011b, pers. comm.), in this final rule. Many of the current and proposed fenced exclosures on Hawaii Island are only 4 ft (1.3 m) in height, as they are designed to exclude feral pigs, goats, and sheep. However, a fence height of at least 6 ft (2 m) is required to exclude mouflon sheep, as they can easily jump a 4-ft (1.3-m) fence (Ikagawa 2011, in litt.). Both the increased range of mouflon, as well as the lack of adequately protected habitat, increase the threat of mouflon sheep to additional ecosystems on Hawaii Island.

Between 2010 and 2011, an unauthorized introduction of axis deer (*Axis axis*) occurred on Hawaii, for purposes of big game hunting (Kessler 2011, in litt.; Aila 2012a, in litt.). Axis deer are primarily grazers, but also browse numerous palatable plant species, including those grown as commercial crops (Waring 1996, in litt., 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 1998–2001 on Maui (Medeiros 2010, pers. comm.)), axis deer move into urban and forested areas in search of food (Waring 1996, in litt., 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, creating trails that can damage native vegetative cover, promoting erosion by destabilizing substrate and creating gullies that convey water, and by dislodging stones from ledges that cause rockfalls and landslides and damage vegetation below (Cuddihy and Stone 1990, pp. 63–64). The unauthorized introduction of axis deer on Hawaii Island is a concern due to the devastating impacts of habitat destruction by axis deer in nine ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, dry cliff, and wet cliff) on the islands of Kahoolawe, Lanai, and Maui (Mehrhoff 1993, p. 11; Anderson 2002, poster; Swedberg and Walker 1978, cited in Anderson 2003, pp. 124–125; Perlman 2009, in litt., pp. 4–5; Hess 2008, p. 3; Hess 2010, pers. comm.; Kessler 2010, pers. comm.; Medeiros 2010, pers. comm.). As reported on the islands of Kahoolawe, Lanai, and Maui, the spread of axis deer into nine of the described ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, dry cliff, and wet cliff) on Hawaii Island will lead to similar habitat degradation and destruction if the deer are not controlled. The results from the studies above, in addition to the confirmed sightings of axis deer on Hawaii Island, suggest that axis deer will significantly alter these ecosystems and directly damage or destroy native plants if they become established. Although habitat degradation due to axis deer has not yet been observed on Hawaii Island, we believe it is reasonable to assume similar habitat effects on this island. Based on the prevailing evidence of the documented impacts to native ecosystems and individual plants on the other islands, we determine that the expanding population of axis deer on the Island of Hawaii, while not currently resulting in population-level effects to native plants, is expected to do so in the future if the deer are not managed or controlled. See Factor D for further information regarding State efforts to eradicate this species.

In summary, the 15 species dependent upon the 10 ecosystems identified in this final rule (anchialine pool, coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, dry cliff, and wet cliff) are exposed to the ongoing threat of feral ungulates (pigs, goats, cattle, sheep, and mouflon sheep). Additionally, if not adequately managed or controlled, impacts from axis deer may also become a threat to these ecosystems in the future. These negative impacts result in the destruction and degradation of habitat for these 15 native species on Hawaii Island. The effects of these nonnative animals include the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance and sedimentation; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; alteration of soil nitrogen availability; and creation of open, disturbed areas conducive to further invasion by nonnative pest plant species. All of these impacts lead to the subsequent conversion of a plant community dominated by native species to one dominated by nonnative species (see ''Habitat Destruction and Modification by Nonnative Plants,'' below). In addition, because these mammals inhabit terrain that is often steep and remote (Cuddihy and Stone 1990, p. 59), foraging and trampling contributes to severe erosion of watersheds and degradation of streams (Dunkell *et al.* 2011, pp. 175–194). As early as 1900, there was increasing concern expressed about the integrity of island watersheds, due to effects of ungulates and other factors, leading to the establishment of a professional forestry program emphasizing soil and water conservation (Nelson 1989, p. 3).

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, the deliberate introduction of nonnative plants and animals, and agricultural development (Cuddihy and Stone 1990, pp. 27, 58). The original native flora of Hawaii (species that were present before humans arrived) consisted of about 1,000 taxa, 89 percent of which were endemic (species that occur only in the Hawaiian Islands). Over 800 plant taxa have been introduced from elsewhere, and nearly 100 of these have become pests (e.g., injurious plants) in Hawaii (Smith 1985, p. 180; Cuddihy and Stone 1990, p. 73; Gagne and Cuddihy 1999, p. 45). Of these 100 nonnative pest plant species, over 35 species have altered the habitat of 14 of the 15 species in this final rule (only the anchialine pool shrimp is not directly impacted by nonnative plants (see Table 3)).

The most-often cited effects of nonnative plants on native plant species are competition and displacement. Competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Alien plants displace native species of plants by preventing their reproduction, usually by shading and taking up available sites for seedling establishment. Alien plant invasions alter entire ecosystems by forming monotypic stands, changing fire characteristics of native communities, altering soil-water regimes, changing nutrient cycling, or encouraging other nonnative organisms (Smith 1989, pp. 61–69; Vitousek *et al.* 1987, pp. 224–227).

Nonnative plants pose serious and ongoing threats to 14 of the 15 species (not the anchialine pool shrimp) in this final rule throughout their ranges by destroying and modifying habitat. They can adversely impact microhabitat by modifying the availability of light and nutrient cycling processes, and by altering soil-water regimes. They can also alter fire regimes affecting native plant habitat, leading to incursions of fire-tolerant nonnative plant species into native habitat. Alteration of fire regimes clearly represents an ecosystem-level change caused by the invasion of nonnative grasses (D'Antonio and Vitousek 1992, p. 73). The grass lifeform supports standing dead material that burns readily, and grass tissues have large surface-to-volume ratios and can dry out quickly (D'Antonio and Vitousek 1992, p. 73). The flammability of biological materials is determined primarily by their surface-to-volume ratio and moisture content, and secondarily by mineral content and tissue chemistry (D'Antonio and Vitousek 1992, p. 73). The finest size classes of material (mainly grasses) 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 structural tissue, so almost all new tissue fixes carbon and contributes to growth (D'Antonio and Vitousek 1992, p. 73). Grass canopies also support a microclimate in which surface temperatures are hotter, vapor pressure deficits are larger, and the drying of tissues more rapid than in forests or woodlands (D'Antonio and Vitousek 1992, p. 73). Thus, conditions that favor fire are much more frequent in grasslands (D'Antonio and Vitousek 1992, p. 73).

Nonnative plants outcompete native plants by growing faster, and some may release chemicals that inhibit the growth of other plants. Nonnative plants may also displace native species by preventing their reproduction, usually by shading and taking up available sites for seedling establishment (Vitousek *et al.* 1987, pp. 224–227). These competitive advantages allow nonnative plants to convert native-dominated plant communities to nonnative plant communities (Cuddihy and Stone 1990, p. 74; Vitousek 1992, pp. 33–35).

In summary, nonnative plants adversely impact native habitat in Hawaii, including 9 of the described Hawaii Island ecosystems that support 14 of the 15 species (not the anchialine pool shrimp), and directly adversely impact the 13 plant species, by: (1) Modifying the availability of light through alterations of the canopy structure; (2) altering soil-water regimes; (3) modifying nutrient cycling; (4) altering the fire regime affecting native plant communities (e.g., successive fires that burn farther and farther into native habitat, destroying native plants and removing habitat for native species by altering microclimatic conditions to favor alien species); and (5) 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).

A summary of the specific impacts of nonnative plant species is included below. Please refer to the proposed rule (77 FR 63928; October 17, 2012) for a list of nonnative plants organized by their ecosystems, a detailed discussion of their specific negative effects on the 14 affected Hawaii Island species, and the literature cited for each nonnative plant species. In particular, we note that we provide discussions of nonnative plants in coastal, lowland wet, dry cliff, and wet cliff ecosystems in this rule (below), but the discussions for nonnative plants in the lowland dry, lowland mesic, montane dry, montane mesic, and montane wet ecosystems can be found in the October 17, 2012, proposed rule (77 FR 63928). Based on comments we received on the proposed rule, we have also added information below regarding the nonnative plants wedelia, strawberry guava, and skunk weed that pose threats to three plants, *Bidens hillebrandiana* ssp. *hillebrandiana* (threats from wedelia), *Cyanea tritomantha* (threats from strawberry guava), and *Cyrtandra nanawaleensis* (threats from skunk weed), in this final rule.

- *Andropogon virginicus* may release allelopathic substances that dramatically decrease native plant reestablishment, and has become dominant in areas subjected to natural or human-induced fires.
- *Anemone hupehensis* var. *japonica* has wind-distributed seeds, and resists grazing because of toxic chemicals that induce vomiting when ingested.
- *Angiopteris evecta* forms dense stands that displace and shade out native plants.
- *Axonopus fissifolius* can outcompete other grasses in wet forests and bogs and outcompetes native plants for moisture.
- *Buddleia asiatica* can tolerate a wide range of habitats, forms dense thickets, and is rapidly spreading into wet forest and lava and cinder substrate areas in Hawaii, displacing native vegetation.
- *Casuarina equisetifolia* forms monotypic stands under which little else grows. It is thought that the roots and needle litter exude a chemical that kills other plants.
- *Clidemia hirta* forms a dense understory, shades out native plants, and prevents their regeneration.
- *Delairea odorata* covers and suppresses growth and germination of native species by carpeting the ground and rooting down at leaf nodes. This species can also grow in the canopy, where it smothers native trees.
- *Digitaria setigera* propagates by seeds and runners; a single flowering stem produces hundreds of seeds.
- *Ehrharta stipoides* creates a thick mat in which other species cannot regenerate; its seeds are easily dispersed by awns (slender, terminal bristle-like process found at the spikelette in many grasses) that attach to fur or clothing.
- *Erigeron karvinskianus* spreads rapidly by stem layering and regrowth of broken roots to form dense mats, crowding out and displacing ground-level plants.
- *Falcataria moluccana* can quickly establish in disturbed and nondisturbed mesic to wet areas. Its rapid growth habit enables it to outcompete slow-growing native trees by reducing light availability, and its abundant, high-quality litter alters nutrient dynamics in the soil.
- *Grevillea* spp. leaves produce an allelopathic substance that inhibits the establishment of all other plant species underneath the canopy.
- *Hedychium* spp. form vast, dense colonies, displacing other plant species, and reproduce by rhizomes where already established. In addition to outcompeting native plants, *Hedychium* spp. reduce the amount of nitrogen in the *Metrosideros* forest canopy in Hawaii, impacting the availability of nutrients for native plants.
- *Heterotheca grandiflora* is an opportunistic colonizer that grows quickly, forms dense stands, and inhibits recruitment of native plants.
- *Juncus effusus* spreads by seeds and rhizomes, and forms dense mats that crowd out native plants.
- *Juncus* is a weedy colonizer that can tolerate environmental stress and outcompete native species.
- *Juncus planifolius* forms dense mats and has the potential to displace native plants by preventing establishment of native seedlings.
- *Lantana camara* is aggressive, thorny, and forms thickets, crowding out and preventing the establishment of native plants.
- *Leucaena leucocephala* is an aggressive competitor that often forms the dominant element of the vegetation in low-elevation, dry, disturbed areas in Hawaii.
- Plants in the genus *Melastoma* have high germination rates, exhibit rapid growth, have possible asexual reproduction, and are efficient at seed dispersal, especially by birds that are attracted by copious production of berries. These characteristics enable the plants to be aggressive competitors in Hawaiian ecosystems.
- *Melinis repens* invades disturbed dry areas from coastal regions to subalpine forest; dense stands of this species can contribute to recurrent fires.
- *Miconia calvescens* reproduces in dense shade, eventually shading out all other plants to form a monoculture.
- *Omalanthus populifolius* has the potential to colonize entire gulches, displacing and inhibiting the regeneration of native plants.
- *Paederia foetida* (skunk weed) is a perennial climbing or trailing vine in the coffee family (Rubiaceae) that can grow to 30 ft (9 m) long and occurs on Kauai, Oahu, Maui, and Hawaii Island (Center for Invasive Species and Ecosystem Health (CISEH 2010, in litt.; U.S. Forest Service 2013, in litt.). It reproduces vegetatively or by seed, and can invade natural and disturbed areas in Hawaii. It completely covers and smothers understory vegetation, outcompetes low-growing plants and small shrubs for light and space, and can form mat-like sheaths that may cover several acres (CISEH 2010, in litt.; U.S. Forest Service 2013, in litt.).
- *Paspalum conjugatum* has small, hairy seeds are easily transported on humans and animals, or are carried by the wind through native forests, where it establishes and displaces native vegetation.
- *Passiflora edulis* is a vigorous vine that overgrows and smothers the forest canopy; its fruit encourages rooting and trampling by feral pigs.
- *Passiflora tarminiana* is now a serious pest in mesic forest, where it overgrows and smothers the forest canopy. Seeds are readily dispersed by humans, birds, and feral pigs; fallen fruit encourage rooting and trampling by pigs.
- *Pennisetum setaceum* is an aggressive colonizer that outcompetes most native species by forming widespread, dense, thick mats. This species is also fire-adapted and burns swiftly and hot, causing extensive damage to the surrounding habitat.
- *Pluchea* spp. are adapted to a wide variety of soils and sites, tolerate excessively well-drained to poorly drained soil conditions, the full range of soil textures, acid and alkaline reactions, salt and salt spray, and compaction. They quickly invade burned areas, but being early successional, they are soon replaced by other species. These adaptive capabilities increase the species' competitive abilities over native plants.
- *Polygonum punctatum* forms dense patches that prohibit the establishment of native plants after disturbance events.
- *Prosopis pallida* overshadows other vegetation and has deep tap roots that significantly reduce available water for native dryland plants. This plant fixes nitrogen and can outcompete native species.
- *Psidium cattleianum* forms dense stands in which few other plants can grow, displacing native vegetation through competition. The fruit is eaten by feral pigs and birds that disperse the seeds throughout the forest.
- *Rubus argutus* displaces native vegetation through competition.
- *Rubus ellipticus* smothers smaller plants, including native species.
- *Rubus rosifolius* forms dense thickets and outcompetes native plant species. It easily reproduces from roots left in the ground, and seeds are spread by birds and feral animals.
- *Schefflera actinophylla* is shade tolerant and can spread deep into undisturbed forests, forming dense thickets, as its numerous seeds are readily dispersed by birds. It grows epiphytically, strangling its host tree.
- *Schinus terebinthifolius* forms dense thickets in all habitats, and its red berries are attractive to and dispersed by birds. The seedlings grow very slowly and can survive in dense shade, exhibiting vigorous growth when the canopy is opened after a disturbance, allowing it to displace native vegetation through competition.

- *Senecio madagascariensis* can produce abundant seeds each year that are easily distributed by wind. This combination of long-range dispersal of its seeds and its allelopathic properties enables this species to successfully outcompete native plants.
- *Setaria palmifolia* is resistant to fire and recovers quickly after being burned, outcompeting native vegetation.
- *Sphagneticola trilobata* is a creeping, mat-forming, fast-growing perennial herb in the sunflower (Asteraceae) family. It is found on all of the main Hawaiian Islands (Thaman 1999, pp. 1–10) and is considered one of Hawaii's most invasive horticultural plants. It has spread throughout the Pacific and in many cases has become a noxious weed, covering extensive areas in agricultural lands, along roadsides and trailsides, in open lots, in waste places and garbage dumps, and at other disturbed sites (Thaman 1999, pp. 1–10; HEAR 2013). This species can also be found in relatively undisturbed sites along coastlines, often out-competing native coastal herbaceous species, like *Bidens hillebrandiana* ssp. *hillebrandiana* (Thaman 1999, pp. 1–10).
- *Cyathea cooperi* can achieve high densities in native Hawaiian forests and displace native species. Understory disturbance by feral pigs facilitates the establishment of this species, which has been known to spread over 7 mi (12 km) through windblown dispersal of spores from plant nurseries.
- *Tibouchina* spp. is naturalized and abundant in disturbed mesic to wet forest on the islands of Molokai, Lanai, Maui, and Hawaii. It forms dense thickets, crowding out all other plant species, and inhibits regeneration of native plants.
- *Ulex europaeus* spreads numerous seeds by explosive opening of the pods. It can rapidly form extensive dense and impenetrable infestations, and competes with native plants, preventing their establishment.

Nonnative Plants in the Coastal Ecosystem

Nonnative plant species that pose a threat to *Bidens hillebrandiana* ssp. *hillebrandiana,* the only plant species in this final rule that inhabits the coastal ecosystem on Hawaii Island, include the understory and subcanopy species *Pluchea carolinensis* (sourbush), *P. indica* (Indian fleabane), *Lantana camara* (lantana), *Melastoma* spp., and *Sphagneticola trilobata* (wedelia) (Perlman and Wood 2006, in litt.; Bio 2011, pers. comm.; Perry 2012, in litt.). These nonnative plants species are fast growing, and form either thickets or dense mats that crowd out and prevent establishment of individuals of *Bidens hillebrandiana* ssp. *hillebrandiana.* Nonnative canopy species that pose a threat to *B. hillebrandiana* ssp. *hillebrandiana* include *Casuarina equisetifolia* (ironwood), which form monotypic stands that prevent the growth of *B. hillebrandiana* ssp. *hillebrandiana* below by over shading and accumulation of pine needle litter (Perlman and Wood 2006, in litt.). In addition, the nonnative grass *Pennisetum setaceum* (fountain grass) is a threat to *B. hillebrandiana* ssp. *hillebrandiana* (Perlman and Wood 2006, in litt.; Bio 2011, pers. comm.) because fountain grass forms dense mats that cover very large areas, thus outcompeting *B. hillebrandiana* ssp. *hillebrandiana,* in addition to being a notorious fire-adapted plant that burns swiftly and hot, causing extensive damage to surrounding habitat. These nonnative plant species pose serious and ongoing threats to the species *B. hillebrandiana* ssp. *hillebrandiana,* which depends on this ecosystem.

Nonnative Plants in the Dry Cliff Ecosystem

Nonnative plant species that are a threat to *Bidens hillebrandiana* ssp. *hillebrandiana,* the only plant species in this final rule that inhabits the dry cliff ecosystem on Hawaii Island, include the understory and subcanopy species *Lantana camara, Melastoma* spp., *Pluchea carolinensis,* and *Sphagneticola trilobata* (Perlman and Wood 2006, in litt.; Bio 2011, pers. comm.; Perry 2012, in litt.). These nonnative plants species are fast growing, and form either thickets or dense mats that crowd out and prevent establishment of individuals of *Bidens hillebrandiana* ssp. *hillebrandiana.* Nonnative canopy species that pose a threat to *B. hillebrandiana* ssp. *hillebrandiana* include *Casuarina equisetifolia* and *Psidium cattleianum* (Perlman and Wood 2006, in litt.; Bio 2011, pers. comm.), which form monotypic stands that prevent the growth of *B. hillebrandiana* ssp. *hillebrandiana* below by over shading and crowding out. In addition, *Casuarina equisetifolia* accumulates high levels of pine needle litter that further prevent understory growth. The nonnative grasses *Digitaria setigera* and *Pennisetum setaceum* pose a threat to this ecosystem (Perlman and Wood 2006, in litt.; Bio 2011, pers. comm.). Fountain grass forms dense mats that cover very large areas, thus outcompeting *Bidens hillebrandiana* ssp. *hillebrandiana,* in addition to being a notorious fire adapted plant that burns swiftly and hot, causing extensive damage to surrounding habitat. *Digitaria setigera* propagates by seeds and runners, and a single flower stem produces hundreds of seeds, which crowds out *Bidens hillebrandiana* ssp. *hillebrandiana,* thus preventing regeneration. These nonnative plant species pose serious and ongoing threats to *Bidens hillebrandiana* ssp. *hillebrandiana,* which depends on this ecosystem.

Nonnative Plants in the Lowland Wet Ecosystem

Nonnative plant species that are a threat to the 7 of the 13 plant species (*Cyanea marksii, Cyanea tritomantha, Cyrtandra nanawaleensis, Cyrtandra wagneri, Phyllostegia floribunda, Platydesma remyi,* and *Pritchardia lanigera*) in this final rule that inhabit the lowland wet ecosystem on Hawaii Island include the understory and subcanopy species *Clidemia hirta* (Koster's curse), *Erigeron karvinskianus* (daisy fleabane), *Hedychium gardnerianum, Juncus effusus* (Japanese mat rush), *J. ensifolius* (dagger-leaved rush), *J. planifolius* (bog rush), *Melastoma* spp., *Paederia foetida* (skunk weed), *Passiflora edulis* (passion fruit), *P. tarminiana* (banana poka), *Polygonum punctatum* (water smartweed), *Rubus argutus* (prickly Florida blackberry), *R.ellipticus* (yellow Himalayan raspberry), *R. rosifolius, Cyathea cooperi* (Australian tree fern), *Tibouchina herbacea* (glorybush), and *T. urvilleana* (princess flower) (Wood 1995, in litt.; Perlman *et al.* 2001, in litt.; Perlman and Wood 2006, in litt.; Perlman and Perry 2003, in litt.; Lorence and Perlman 2007, pp. 357–361; PEPP 2007, pp. 1–65; PEPP 2008, pp. 87–111; Perlman and Bio 2008, in litt.; Perlman *et al.* 2008, in litt.; HBMP 2010c; HBMP 2010e; HBMP 2010f; HBMP 2010g; HBMP 2010h; HBMP 2010i; PEPP 2010, pp. 33–121; Perry 2012, in litt.). These understory nonnative plant species overcrowd, displace, smother, or shade out the seven plant species listed as endangered species in this rule (see above) that occupy the lowland wet ecosystem. Nonnative canopy species that are a threat to the seven species include *Angiopteris evecta* (mule's foot fern), *Falcataria moluccana* (albizia), *Miconia calvescens* (miconia), *Psidium cattleianum,* and *Schefflera actinophylla* (octopus tree) (Palmer 2003, p. 48; HBMP 2010c; HBMP 2010e; HBMP 2010f; HBMP 2010g; HBMP 2010h; HBMP 2010i; PEPP 2010, p. 62; Lau 2011, in litt.; Magnacca 2011b, pers. comm.; Pratt 2011a, in litt.; Price 2011, in litt.). These nonnative canopy species form dense stands that shade out and over crowd the 7 plant species listed as endangered species in this rule (see above) that inhabit the lowland wet ecosystem. Nonnative grasses that pose a threat to this ecosystem are *Ehrharta stipoides* and *Setaria palmifolia* (palmgrass) (Lorence and Perlman 2007, pp. 357–361; PEPP 2007, pp. 1–65; HBMP 2010c; HBMP 2010f; HBMP 2010g), because they form thick mats that prevent growth and regeneration of the seven plant species listed as endangered species (see above) in this rule that occupy the lowland wet ecosystem.These nonnative plant species pose serious and ongoing threats to the seven species that depend on this ecosystem.

Nonnative Plants in the Wet Cliff Ecosystem

Nonnative plant species that pose a threat to the three plant species (*Cyanea tritomantha, Pritchardia lanigera,* and *Stenogyne cranwelliae*) in this final rule that inhabit the wet cliff ecosystem on Hawaii Island include the canopy, understory and subcanopy species *Hedychium coronarium, H. gardnerianum, Juncus effusus, Passiflora tarminiana, Psidium cattleianum, Rubus rosifolius, Tibouchina herbacea,* and *T. urvilleana* (HBMP 2010c; HBMP 2010f; HBMP 2010k; Perry 2012, in litt.). These understory nonnative plant species overcrowd, displace, smother, or shade out the three plant species listed as endangered species in this rule (see above) that occupy the wet cliff ecosystem. The nonnative grasses *Axonopus fissifolius, Ehrharta stipoides, Paspalum conjugatum,* and *Setaria palmifolia* also pose a threat to the three species in this ecosystem (HBMP 2010c; HBMP 2010f; HBMP 2010k), because they form thick mats that prevent growth and regeneration. These nonnative plant species pose serious and ongoing threats to the three species that depend on this ecosystem.

Habitat Destruction and Modification by Fire

Fire is an increasing, human-exacerbated threat to native species and native ecosystems in Hawaii. The historical fire regime in Hawaii was characterized by infrequent, low severity fires, 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 and inflammable in wet plant communities and seasonally flammable in mesic and dry plant communities. The primary ignition sources were volcanism and lightning (Baker *et al.* 2009, p. 43). Natural fuel beds were often discontinuous, and rainfall in many areas on most islands was, and is, moderate to high. Fires inadvertently or intentionally ignited by the original Polynesians in Hawaii 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 later 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. Pasturage and ranching, in particular, created high fire-prone areas of nonnative grasses and shrubs (D'Antonio and Vitousek 1992, p. 67). Although fires were historically infrequent in mountainous regions, extensive fires have recently occurred in lowland dry and lowland mesic areas, leading to grass-fire cycles that convert forest to grasslands (D'Antonio and Vitousek 1992, p. 77).

Because several Hawaiian plants show some tolerance of fire, Vogl proposed that naturally occurring fires may have been important in the development of the original Hawaiian flora (Vogl 1969 in Cuddihy and Stone 1990, p. 91; Smith and Tunison 1992, p. 394). However, Mueller-Dombois (1981 in Cuddihy and Stone 1990, p. 91) points out that most natural vegetation types in Hawaii would not carry fire before the introduction of alien grasses, and Smith and Tunison (1992, p. 396) state that native plant fuels typically have low flammability. Because of the greater frequency, intensity, and duration of fires that have resulted from the introduction of nonnative plants (especially grasses), fires are now destructive to native Hawaiian ecosystems (Brown and Smith 2000, p. 172), and a single grass-fueled fire can kill most native trees and shrubs in the burned area (D'Antonio and Vitousek 1992, p. 74).

Fire represents a threat to four of the species found in the lowland dry, lowland mesic, lowland wet, montane dry, and montane mesic ecosystems addressed in this final rule: the plants *Bidens micrantha* ssp. *ctenophylla, Phyllostegia floribunda,* and *Schiedea hawaiiensis;* and the picture-wing fly (see Table 3). Fire can destroy dormant seeds of these species as well as plants themselves, even in steep or inaccessible areas. Successive fires that burn farther and farther into native habitat destroy native plants and remove habitat for native species by altering microclimate conditions favorable to alien plants. Alien plant species most likely to be spread as a consequence of fire are those that produce a high fuel load, are adapted to survive and regenerate after fire, and establish rapidly in newly burned areas. Grasses (particularly those that produce mats of dry material or retain a mass of standing dead leaves) that invade native forests and shrublands provide fuels that allow fire to burn areas that would not otherwise easily burn (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 from fire to some degree, but fire shifts the competitive balance toward alien species (National Park Service (NPS) 1989, in Cuddihy and Stone 1990, p. 93). On a post-burn survey at Puuwaawaa on Hawaii Island, an area of native *Diospyros* forest with undergrowth of the nonnative grass *Pennisetum setaceum,* Takeuchi noted that ''no regeneration of native canopy is occurring within the Puuwaawaa burn area'' (Takeuchi 1991, p. 2). Takeuchi (1991, pp. 4, 6) also stated that ''burn events served to accelerate a decline process already in place, compressing into days a sequence that would ordinarily take decades,'' and concluded that in addition to increasing the number of fires, the nonnative *Pennisetum* acted to suppress the establishment of native plants after a fire.

For decades, fires have impacted rare or endangered species and their habitat (HDOFAW 2002, pp. 1, 4–6; Dayton 2007, in litt.; Joint Fire Science Program (JFSP) 2009, pp. 1–12; Weise *et al.* 2010, pp. 199–220; Kakesako 2011, in litt.). On the island of Hawaii, wildfires are caused primarily by lava flows, humans, and lightning, all of which are exacerbated by severe drought and nonnative grasses (e.g., *Pennisetum setaceum*) (Dayton 2007, in litt.; JFSP 2009, pp. 1–6; Armstrong and Media 2010, in litt.; Weise *et al.* 2010, pp. 199–216; Adkins *et al.* 2011, p. 17; Hawaii County Major.com–accessed September 7, 2011; Burnett 2010, in litt.; KHON2, June 6, 2011). Between 2002 and 2003, three successive lava-ignited wildfires in the east rift zone of HVNP affected native forests in lowland dry, lowland mesic, and lowland wet ecosystems (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 in the burned areas and encroached upon rainforests (i.e., forests in the lowland wet ecosystem) that were previously thought to have low susceptibility or even be relatively immune to wildfires (JFSP 2009, pp. 2–3; Wildfire News, June 9, 2003). After the fires, nonnative ferns were reported in the higher elevation rainforests where they had not previously been observed, and were believed to inhibit the ability of the dominant native *Metrosideros polymorpha* (ohia) trees to recover (JFSP 2003, pp. 1–2). Nonnative flammable grasses also spread in the area, under the dead ohia trees (Ainsworth 2011, in litt.), increasing the risk of fire in surrounding native forested areas. In 2011, the Napau Crater wildfire, ignited by an eruption at the Kamoamoa fissure in HVNP, consumed over 2,076 ac (840 ha), including 100 ac (40 ha) of the 2,750-ac (1,113-ha) east rift zone's special ecological area (Ainsworth 2011, in litt.; Kakesako 2011, in litt.). Special ecological areas (SEA) are HVNP's most intact and intensively managed natural systems (Tunison and Stone 1992, pp. 781–798). The plant *Phyllostegia floribunda,* in this final rule, is known from the east rift zone's Napau Crater, in the lowland wet ecosystem (Belfield 1998, pp. 9, 11–13, 23; Pratt 2007b, in litt.; HBMP 2010h). In addition, historical records report that the plant *Cyanea tritomantha,* which is listed as endangered in this rule, also occurred in this area, in the same ecosystem; however, the last survey that reported this occurrence was over 25 years ago (Lamoureux *et al.* 1985, pp. 105, 107–108; HBMP 2010h).

Fire is a threat to the Kona (leeward) side of Hawaii Island. In the past 50 years, there have been three wildfires that burned 20,000 ac (8,094 ha) or more: (1) 20,000 ac (8,094 ha) burned at Puuwaawaa Ranch in 1985; (2) 20,000 acres (8,094 ha) burned at the U.S. Army's PTA in 1994; and (3) 25,000 ac (10,117 ha) burned in Waikoloa in 2005 (Thompson 2005, in litt.). The only known occurrence (25 to 40 individuals) of the plant *Schiedea hawaiiensis,* in this final rule, is found on PTA, and the 1994 fire burned to within 2 mi (4 km) of this species (U.S. Army Garrison 2006, p. 34; Evans 2011, in litt.). Although this fire may seem relatively distant from *S. hawaiiensis,* wildfires can travel from 4 to 8 miles per hour (mph) (6.5 to 13 kilometers per hour (kph)), and burn 2.5 ac (1 ha) to 6 ac (2.5 ha) per minute (the equivalent of 6 to 8 football fields per minute), depending on the fuel type, wind, and slope of land (Burn Institute 2009, p. 4). In 2011, a 500-ac (202-ha) wildfire ignited by lightning and fueled by nonnative *Pennisetum setaceum* burned within the State's Puu Anahulu Game Management Area (GMA) and encroached within a quarter-mile (0.5 km) of PTA (KHON2, June 6, 2011). The Puu Anahulu GMA lies just 3 mi (5 km) northwest of the only known occurrence of *S. hawaiiensis* in the montane dry ecosystem. Also in 2011, a 120-ac (49-ha) wildfire broke out near Kaiminani Street (Jensen 2011, in litt.), just north of Hina Lani Road, in the lowland dry ecosystem, where the largest occurrence of the plant species *Bidens micrantha* ssp. *ctenophylla,* which is listed as endangered in this rule, is found. In addition, the threat of fire to this species is increased by its occurrence in areas bordered by residential developments, schools, and roads, which provide numerous ignition sources from the high volume of human traffic. A recent fire at the Villages of Laiopua subdivision at Kealakehe, known to have been intentionally set, burned close to an area that supports *B. micrantha* ssp. *ctenophylla* (Knoche 2012, in litt.). Although no *B. micrantha* ssp. *ctenophylla* individuals were burned, the immediate proximity of the fire to occupied and unoccupied habitat for this species demonstrates the threat of fire to *B. micrantha* ssp. *ctenophylla* in the lowland dry ecosystem at Kealakehe.

Fire is also a threat to the picture-wing fly *Drosophila digressa* at one of its two known locations (the Manuka NAR) due to the ongoing extreme drought conditions in this region and the resulting accumulation of dead trees (i.e., fuel load), in the lowland mesic and montane mesic ecosystems (Magnacca 2011b, pers. comm.).

Throughout the Hawaiian Islands, increased fuel loads and human-ignited fires caused the average acreage burned to increase five-fold from the early 1900s (1904 to 1939) to the mid-1900s (1940 to 1976) (La Rosa *et al.* 2008, p. 231). In HVNP, fires were three times more frequent and 60 times larger, on average, from the late 1960s to 1995, when compared to data spanning 1934 to the late 1960s (Tunison *et al.* 2001 *in* La Rosa *et al.* 2008, p. 231). The historical fire regimes have been altered from typically rare events to more frequent events, largely a result of continuous fine fuel loads associated with the presence of the fire-tolerant, nonnative fountain grass and the grass-fire feedback cycle that promotes its establishment (La Rosa *et al.* 2008, pp. 240–241; Pau 2009, in litt.). Extreme drought conditions are also contributing to the number and intensity of the wildfires on Hawaii Island (Armstrong and Media 2010, in litt.; Loh 2010, in litt.). In addition, the combination of El Niño conditions (see ''Habitat Destruction and Modification by Climate Change,'' below) in the Pacific, a half-century decline in annual rainfall, and intermittent dry spells has fueled wildfires throughout all of the main Hawaiian Islands (Marcus 2010, in litt.). The entire State is experiencing dry conditions, but Hawaii Island appears to be significantly impacted (Kodama 2010, in litt.; USDA–FSA 2012, in litt.).

Fire is a threat to three plant species (*Bidens micrantha* ssp. *ctenophylla, Phyllostegia floribunda,* and *Schiedea hawaiiensis*), and the picture-wing fly (*Drosophila digressa*), reported from Hawaii Island's lowland dry, lowland mesic, lowland wet, montane dry, and montane mesic ecosystems, because individuals of these species or their habitat are located in or near areas that were burned in previous fires or in areas at risk for fire due to volcanic activity, drought, or the presence of highly flammable nonnative grasses and shrubs.

Habitat Destruction and Modification by Hurricanes

Hurricanes adversely impact native Hawaiian terrestrial habitat and exacerbate the impacts resulting from other threats such as habitat degradation by ungulates and competition with nonnative plants. They do this by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species (see ''Specific Nonnative Plant Species Impacts,'' on page 63952 of our October 17, 2012, proposed rule (77 FR 63928)) (Asner and Goldstein 1997, p. 148; Harrington *et al.* 1997, pp. 539–540). Canopy gaps allow for the establishment of nonnative plant species, which may be present as plants or as seeds incapable of growing under shaded conditions. Because many Hawaiian plant and animal species, including the 15 species in this final rule, persist in low numbers and in restricted ranges, natural disasters, such as hurricanes, can be particularly devastating (Mitchell *et al.* 2005a, pp. 3–4), although we do not consider hurricanes to represent a present threat to *Vetericaris chaceorum.*

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 (161 kph), causing extensive damage, especially on the islands of Niihau, Kauai, 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 (Kitayama and Mueller-Dombois 1995, p. 671). Competition with nonnative plants is a threat to 9 of the 10 ecosystems that support all 13 plant species and the picture-wing fly listed as endangered in this final rule, as described above in ''Habitat Destruction and Modification by Nonnative Plants.'' Nonnative plants also compete with the native host plants of the picture-wing fly.

In addition to habitat destruction and nonnative plant introduction resulting from hurricanes, high winds and intense rains from hurricanes can directly kill individual picture-wing flies to the point of decimating an entire population (Carson 1986, p. 7; Foote and Carson 1995, pp. 369–370). High winds can also dislodge fly larvae from their host plants, destroy host plants, and expose the fly larvae to predation by nonnative yellowjacket wasps (see ''Nonnative Western Yellow-Jacket Wasps,'' under *Factor C. Disease or Predation,* below) (Carson 1986, p. 7; Foote and Carson 1995, p. 371).

Since 1950, 13 hurricanes have passed near but not over Hawaii Island. Eleven of these hurricanes brought heavy rain, strong wind, or high surf to the island, which caused erosion, flash floods, and other damage (Fletcher III *et al.* 2002, pp. 11–17; National Weather Service *et al.* 2010, pp. 1–22). In 1994, tropical depression 1C brought over 14 in (36 cm) of rain in just a few days to windward sections of Hawaii Island (National Oceanic Atmospheric Administration (NOAA) 1994, pp. 4–5; National Weather Service *et al.* 2010, pp. 4–5).

Although there is historical evidence of only one hurricane (1861) that approached from the east and impacted the islands of Maui and Hawaii (Businger 1998, p. 3), damage from future hurricanes could further decrease the remaining native plant-dominated habitat areas that support the 13 plant species and the picture-wing fly (*Drosophila digressa*) listed as endangered in this final rule, in 9 of the described ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, dry cliff, and wet cliff).

Habitat Destruction and Modification Due to Rockfalls, Treefalls, Landslides, Heavy Rain, Inundation by High Surf, Erosion, and Drought

Rockfalls, treefalls, landslides, heavy rain, inundation by high surf, and erosion damage and destroy individual plants, destabilize substrates, and alter hydrological patterns that result in changes to native plant and animal communities. In the open sea near Hawaii, rainfall averages 25 to 30 in (635 to 762 mm) per year, yet the islands may receive up to 15 times this amount in some places, caused by orographic features (physical geography of mountains) (Wagner *et al.* 1999a, pp. 36–44). 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, causing destructive flash-flooding in streams and narrow gulches (Wagner *et al.* 1999a, pp. 36–44). Due to the steep topography of some areas on Hawaii Island where 4 of the 13 plants listed as endangered in this final rule remain, erosion and disturbance caused by introduced ungulates exacerbates the potential for rockfalls, treefalls, and landslides, which in turn are a threat to native plants. Such events have the potential to eliminate all individuals of a population, or even all populations of a species, resulting in a greater likelihood of extinction due to the lack of redundancy and resilience of the species caused by their reduced numbers and geographic range.

Rockfalls, treefalls, landslides, heavy rain, inundation by high surf, and subsequent erosion are a threat to four of the plant species (*Bidens hillebrandiana* ssp. *hillebrandiana, Cyanea marksii, Cyanea tritomantha,* and *Cyrtandra wagneri*) listed as endangered in this rule (Lorence and Perlman 2007, p. 359; PEPP 2010, p. 52; Bio 2011, pers. comm.). Monitoring data from PEPP and other field biologists and surveyors indicate that these four species are threatened by these events as they are found in landscape settings susceptible to these events (e.g., lava tubes, stream banks, steep slopes and cliffs). Field survey data presented by PEPP and other field biologists document that individuals of *Bidens hillebrandiana* ssp. *hillebrandiana* that occur on steep sea cliffs are threatened by rockfalls, landslides, inundation by high surf, and subsequent erosion; 1 of the 27 known individuals of *Cyanea marksii* is threatened by falling rocks and landslides; and individuals of *Cyanea tritomantha* are threatened by treefalls (PEPP 2007, p. 52; Bio 2011, pers. comm.; Perry 2012, in litt.). Field survey data presented by Lorence and Perlman (2007, p. 359) indicate that heavy rains and subsequent erosion threaten the only known location of *Cyrtandra wagneri* on a stream bank in the Laupahoehoe NAR. As *Cyrtandra wagneri* is currently only known from a total of eight individuals along the steep banks of Kilau Stream, heavy rains and erosion could lead to near extirpation or even extinction of this species by direct destruction of the individual plants, mechanical damage to individual plants that could lead to their death, or destabilization of the stream bank habitat leading to additional erosion.

Two plant species, *Bidens micrantha* ssp. *ctenophylla* and *Schiedea hawaiiensis,* and the picture-wing fly (*Drosophila digressa*), which are listed as endangered in this final rule, may also be affected by habitat loss or degradation associated with droughts, which are not uncommon in the Hawaiian Islands (HDLNR 2009, pp. 1–6; Hawaii State Civil Defense 2011, pp. 14–1—14–12; U.S. National Drought Mitigation Center (NDMC) 2012—*Online Archives*). Between 1901 and 2011, there have been at least 18 serious or severe droughts that have impacted Hawaii Island, including the current drought that began in 2008, and has led to the island's first ever drought exceptional designation (the highest drought level rating on the scale) (between March and December of 2010) (HDLNR 2009, pp. 1–6; Hawaii Civil Defense 2011, pp. 14–1—14–12). According to the NDMC's drought rating system, most of the island has been rated as in severe drought since 2008, with extreme drought ratings intermittently in some portions of the island (NDMC 2012—*Online Archives*). Giambelluca *et al.* (1991, pp. 3–4) compiled descriptive accounts of drought throughout the Hawaiian Islands between 1860 and 1986, and found that 87 episodes of drought occurred on Hawaii Island between those years, although some of those episodes occurred for periods as short as one month. The 2011 winter weather system brought periods of heavy rain from Kauai to Maui; however, these systems weakened or moved away from Hawaii Island, leaving the typically wet windward slopes of the island under moderate drought conditions (NOAA 2011—*Online Climate Data Center*). The entire windward side of Hawaii Island is currently in an abnormally dry state (NDMC 2011—*Online Archives;* NDMC 2012—*Online Archives*). As of March 2013, the U.S. Drought Monitor (USDM) (USDM 2013—*Online Database;* USDM 2013—*Online Archives*) continues to report severe drought (a D2 rating-on a scale ranging from D0 (abnormally dry), D1 (moderate), D3 (extreme), to D4 (exceptional)) along the entire leeward side of Hawaii Island, with extreme drought in some areas of North Kona and South Kohala. Drought conditions are expected to continue on Hawaii Island (NOAA 2013, in litt.).

Pohakuloa Training Area (the location of the only known individuals of the plant *Schiedea hawaiiensis*) was rated as experiencing extreme drought during the spring of 2011 (Hawaii State Civil Defense 2011, pp. 14–1—14–12), and in 2010, as well as most of north and south Kona. North Kona, including the lowland dry ecosystem that supports the largest occurrence of the plant *Bidens micrantha* ssp. *ctenophylla,* has been experiencing conditions of extreme to severe drought over the past few years. One of the two known extant populations of the picture-wing fly *Drosophila digressa* is found in the lowland mesic and montane mesic ecosystems in south Kona, in an area that has also experienced extreme to severe drought over the past few years. Drought alters the decay processes of the picture-wing fly's host plants (*Charpentiera* spp. and *Pisonia* spp.) and the entire plant community on which the fly depends. The ongoing drought in south Kona has resulted in an increasing accumulation of dead trees in the Manuka NAR, which increases the fuel load and threat of wildfires in the area where one of the two known occurrences of the picture-wing fly is found (Magnacca 2011b, pers. comm.). According to Magnacca (2013, in litt.) almost the entire ohia (*Metrosideros polymorpha*) canopy at the Manuka NAR has died over the past 10 to 20 years, due to prolonged drought. This area previously received most of its water input from fog interception by the tall ohia trees rather than rainfall (Magnacca 2013, in litt.). Although the dominant host plant of the picture-wing fly at this site, *Pisonia* spp., is temporarily experiencing a growth spurt due to increase in sunlight caused from the ohia dieback, Magnacca believes this increase in *Pisonia* spp. seedlings and juveniles is unlikely to be sustained over time. If these plants survive to maturity, Magnacca doubts the much drier habitat conditions will be suitable to support the picture-wing fly (Magnacca 2013, in litt.). Monitoring data collected in HVNP during a drought period between 1981 and 1982 suggest that drought was associated with a reduction in the number of picture-wing flies one year following the drought (Carson 1986, pp. 4, 7).

Severe episodes of drought cannot only directly kill individuals of a species or entire populations, but drought frequently leads to an increase in the number and intensity of forest and brush fires (see ''Habitat Destruction and Modification by Fire,'' above), causing a reduction of native plant cover and habitat, an increase in nonnative plant and animal species, and a reduction in availability of host plants for the picture-wing fly (Giambelluca *et al.* 1991, p. v; D'Antonio and Vitousek 1992, pp. 77–79; HDLNR 2009, pp. 1–6; Hawaii Civil Defense 2011, pp. 14–1—14–12). Ecosystems altered by drought and subsequent fires are further altered by the introduction of nonnative species that outcompete native species for basic life-cycle requirements (see ''Habitat Destruction and Modification by Nonnative Plants,'' above). To further exacerbate the situation, nonnative ungulate patterns may be altered as observed on Maui, where recent episodes of drought have driven axis deer farther into urban and forested areas for food, increasing their negative impacts to native vegetation from herbivory and trampling (Waring 1996, in litt., p. 5; Nishibayashi 2001, in litt.; Medeiros 2010, pers. comm.). Due to the recent widespread increase in frequency and intensity of drought on the island of Hawaii, even the wettest forests on the windward side of the island may be threatened by long-term drought (JFSP 2009, pp. 1–12). Prolonged periods of water deprivation caused by drought can also lead to the direct death of the remaining individuals of the plants *Schiedea hawaiiensis* and *Bidens micrantha* ssp. *ctenophylla,* and the picture-wing fly, possibly leading to extinction of one or more of these species. Drought is a direct threat to two of the plant species (*Bidens micrantha* ssp. *ctenophylla* and *Schiedea hawaiiensis*), and the picture-wing fly (*Drosophila digressa*), which are listed as endangered in this final rule, as discussed above.

Habitat Destruction and Modification by 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 (Le Treut *et al.* 2007, pp. 93–127). 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 (Le Treut *et al.* 2007, pp. 93–127). 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 2005, pp. 325–326). The synergistic implications of climate change and habitat fragmentation are the most threatening facet of climate change for biodiversity (Hannah *et al.* 2005, p. 4).

The magnitude and intensity of the impacts of global climate change and increasing temperatures on native Hawaiian ecosystems are unknown. Currently, there are no climate change studies that specifically address impacts to the Hawaii Island ecosystems discussed here or the 15 species at issue in this rule. Based on the best available information, climate change impacts could lead to the loss of native species that comprise the communities in which the 15 species occur (Pounds *et al.* 1999, pp. 611–612; Still *et al.* 1999, p. 610; Benning *et al.* 2002, pp. 14,246–14,248; Allen *et al.* 2010, pp. 660–662; Sturrock *et al.* 2011, p. 144; Towsend *et al.* 2011, p. 15; Warren 2011, pp. 221–226). In addition, weather regime changes (droughts, floods) will likely result from increased annual average temperatures related to more frequent El Niño episodes in Hawaii (Giambelluca *et al.* 1991, p. v). Future changes in precipitation and the forecast of those changes are highly uncertain because they depend, 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). The 15 species in this final rule may be especially vulnerable to extinction due to anticipated environmental changes that may result from global climate change, due to their small population size and highly restricted ranges. Environmental changes that may affect these species are expected to include habitat loss or alteration and changes in disturbance regimes (e.g., storms and hurricanes). The probability of a species going extinct as a result of these factors increases when its range is restricted, habitat decreases, and population numbers decline (IPCC 2007, p. 8). The 15 species have limited environmental tolerances, limited ranges, restricted habitat requirements, small population sizes, and low numbers of individuals. Therefore, we would expect these species to be particularly vulnerable to projected environmental impacts that may result from changes in climate, and subsequent impacts to their habitats (e.g., Pounds *et al.* 1999, pp. 611–612; Still *et al.* 1999, p. 610; Benning *et al.* 2002, pp. 14,246–14,248). We believe changes in environmental conditions that may result from climate change may impact these 15 species and their habitat, and we do not anticipate a reduction in this potential threat in the near future.

Climate Change and Ambient Temperature

The average ambient air temperature (at sea level) is projected to increase by about 4.1 degrees Fahrenheit (°F) (2.3 degrees Centigrade (°C)) with a range of 2.7 °F to 6.7 °F (1.5 °C to 3.7 °C) by 2100 worldwide (Trenberth *et al.* 2007, pp. 235–336). 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 and 86 °F (25 °C and 30 °C). Historically, temperature has been rising over the last 100 years, with the greatest increase after 1975 (Alexander *et al.* 2006, pp. 1–22; Giambelluca *et al.* 2008, p. 1). The rate of increase at low elevation (0.16 °F; 0.09 °C) per decade is below the observed global temperature rise of 0.32 °F (0.18 °C) per decade (Trenberth *et al.* 2007, pp. 235–336). However, at high elevations, the rate of increase (0.48 °F (0.27 °C) per decade) greatly exceeds the global rate (Trenberth *et al.* 2007, pp. 235–336).

Overall, the daily temperature range in Hawaii is decreasing, resulting in a warmer environment, especially at higher elevations and at night. In the main Hawaiian Islands, predicted changes associated with increases in temperature include a shift in vegetation zones upslope, 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 number of hurricanes (Loope and Giambelluca 1998, pp. 514–515; U.S. Global Change Research Program (US–GCRP) 2009, pp. 1–188). In addition, weather regime changes (e.g., droughts, floods) will likely result from increased annual average temperatures related to more frequent El Niño episodes in Hawaii (Giambelluca *et al.* 1991, p. v). However, despite considerable progress made by expert scientists toward understanding the impacts of climate change on many of the processes that contribute to El Niño variability, it is not possible to say whether or not El Niño activity will be affected by climate change (Collins *et al.* 2010, p. 391).

Globally, the warming atmosphere is creating a plethora of anticipated and unanticipated environmental changes such as melting ice caps, decline in annual snow mass, sea-level rise, ocean acidification, increase in storm frequency and intensity (e.g., hurricanes, cyclones, and tornadoes), and altered precipitation patterns that contribute to regional increases in floods, heat waves, drought, and wildfires that also displace species and alter or destroy natural ecosystems (Pounds *et al.* 1999, pp. 611–612; IPCC AR4 2007, pp. 26–73; Marshall *et al.* 2008, p. 273; U.S. Climate Change Science Program 2008, pp. 1–164; Flannigan *et al.* 2009, p. 483; US–GCRP 2009, pp. 1–188; Allen *et al.* 2010, pp. 660–662; Warren 2011, pp. 221–226). These environmental changes are predicted to alter species' migration patterns, lifecycles, and ecosystem processes, such as nutrient cycles, water availability, and decomposition (IPCC AR4 2007, pp. 26–73; Pounds *et al.* 1999, pp. 611–612; Sturrock *et al.* 2011, p. 144; Townsend *et al.* 2011, p. 15; Warren 2011, pp. 221–226). The species extinction rate is predicted to increase congruent with ambient temperature increase (US–GCRP 2009, pp. 1–188). In Hawaii, these environmental changes associated with a rise in ambient temperature can directly and indirectly impact the survival of native plants and animals, including the 15 species in this final rule, and the ecosystems that support them.

Climate Change and Precipitation

As global surface temperature rises, the evaporation of water vapor increases, resulting in higher concentrations of water vapor in the atmosphere, further resulting in altered global precipitation patterns (U.S. National Science and Technology Council (US–NSTC) 2008, pp. 69–94; US–GCRP 2009, pp. 1–188). While annual global precipitation has increased over the last 100 years, the combined effect of increases in evaporation and evapotranspiration is causing land surface drying in some regions leading to a greater incidence and severity of drought (US–NSTC 2008, pp. 69–94; US–GCRP 2009, pp. 1–188). Over the past 100 years, the Hawaiian Islands have experienced an annual decline in precipitation of just over 9 percent (US–NSTC 2008, p. 70). Other data on precipitation in Hawaii, which include sea-level precipitation and the added orographic effects, show a steady and significant decline of about 15 percent over the last 15 to 20 years (Chu and Chen 2005, pp. 4,881–4,900; Diaz *et al.* 2005, pp. 1–3). Exact future changes in precipitation in Hawaii and the forecast of those changes are uncertain because they depend, in part, on how the El Niño-La Niña weather cycle might change (State of Hawaii 1998, pp. 2–10).

In the oceans around Hawaii, the average annual rainfall at sea level is about 25 in (63.5 cm). The orographic features of the islands increase this annual average to about 70 in (177.8 cm) but can exceed 240 in (609.6 cm) in the wettest mountain areas. Rainfall is distributed unevenly across each high island, and rainfall gradients are extreme (approximately 25 in (63.5 cm) per mile), creating both very dry and very wet areas. Global climate modeling predicts that, by 2100, net precipitation at sea level near the Hawaiian Islands will decrease in winter by about 4 to 6 percent, with no significant change during summer (IPCC AR4 2007, pp. 1–73). Downscaling of global climate models indicates that wet-season (winter) precipitation will decrease by 5 percent to 10 percent, while dry-season (summer) precipitation will increase by about 5 percent (Timm and Diaz 2009, pp. 4,261–4,280). These data are also supported by a steady decline in stream flow beginning in the early 1940s (Oki 2004, p. 1). Altered seasonal moisture regimes can have negative impacts on plant growth cycles and overall negative impacts on natural ecosystems (US–GCRP 2009, pp. 1–188). Long periods of decline in annual precipitation result in a reduction in moisture availability; an increase in drought frequency and intensity; and a self-perpetuating cycle of nonnative plants, fire, and erosion (US–GCRP 2009, pp. 1–188; Warren 2011, pp. 221–226) (see ''Habitat Destruction and Modification by Fire,'' above). These impacts may negatively affect the 15 species in this final rule and the 10 ecosystems that support them.

Climate Change, and Tropical Cyclone Frequency and Intensity

A tropical cyclone is the generic term for a medium-scale to large-scale, low-pressure storm system over tropical or subtropical waters with organized convection (i.e., thunderstorm activity) and definite cyclonic surface wind circulation (counterclockwise direction in the Northern Hemisphere) (Holland

1993, pp. 1–8). In the Northeast Pacific Ocean, east of the International Date Line, once a tropical cyclone reaches an intensity of winds of at least 74 mi per hour (33 m per second), it is considered a hurricane (Neumann 1993, pp. 1–2). Climate modeling has projected changes in tropical cyclone frequency and intensity due to global warming over the next 100 to 200 years (Vecchi and Soden 2007, pp. 1,068–1,069, Figures 2 and 3; Emanuel *et al.* 2008, p. 360, Figure 8; Yu *et al.* 2010, p. 1,371, Figure 14). The frequency of hurricanes generated by tropical cyclones is projected to decrease in the central Pacific (e.g., the main and Northwestern Hawaiian Islands) while storm intensity (strength) is projected to increase by a few percent over this period (Vecchi and Soden 2007, pp. 1,068–1,069, Figures 2 and 3; Emanuel *et al.* 2008, p. 360, Figure 8; Yu *et al.* 2010, p. 1,371, Figure 14). There are no climate model predictions for a change in the duration of Pacific tropical cyclone storm season (which generally runs from May through November).

For more information on this topic, see ''Habitat Destruction and Modification by Hurricanes,'' above.

Climate Change, and Sea-Level Rise and Coastal Inundation

On a global scale, sea level is rising as a result of thermal expansion of warming ocean water; the melting of ice sheets, glaciers, and ice caps; and the addition of water from terrestrial systems (Climate Institute 2011, in litt.). Sea level rose at an average rate of 0.1 in (1.8 mm) per year between 1961 and 2003 (IPCC 2007, pp. 30–73), and the predicted increase by the end of this century, without accounting for ice sheet flow, ranges from 0.6 ft to 2.0 ft (0.18 m to 0.6 m) (IPCC AR4 2007, p. 30). When ice sheet and glacial melt are incorporated into models the average estimated increase in sea level by the year 2100 is approximately 3 to 4 ft (0.9 to 1.2 m), with some estimates as high as 6.6 ft (2.0 m) to 7.8 ft (2.4 m) (Rahmstorf 2007, pp. 368–370; Pfeffer *et al.* 2008, p. 1,340; Fletcher 2009, p. 7; US–GCRP 2009, p. 18). The species *Bidens hillebrandiana* ssp. *hillebrandiana* occurs within the coastal ecosystem. Although there is no specific data available on how sea-level rise and coastal inundation will impact this species, its occurrence in close proximity to the coastline places it at risk of the threat of sea-level rise and coastal inundation due to climate change. In addition, the anchialine pool ecosystem lies within the coastal ecosystem, and although there are no specific data available on how sea-level rise and coastal inundation will impact the anchialine pool shrimp, it is reasonable to conclude that potential impacts from sea-level rise and coastal inundation may include: (1) Complete inundation of pools and therefore elimination of entire anchialine pool habitats, particularly at Manuka; (2) an increase in the likelihood of exposure to predatory native marine fish not normally found in the anchialine pool ecosystem; and (3) powerful storm surf and rubble resulting from the predicted increase in storm intensity that can obliterate pools, create blockage and seal off the connection to the ocean, or interfere with the subterranean passages below.

In summary, increased interannual variability of ambient temperature, precipitation, hurricanes, and sea-level rise and inundation would provide additional stresses on the 10 ecosystems and the 15 associated species in this final rule because they are highly vulnerable to disturbance and related invasion of nonnative species. The probability of a species going extinct as a result of such factors increases when its range is restricted, habitat decreases, and population numbers decline (IPCC 2007, pp. 8–11). In addition, these 15 species are at a greater risk of extinction due to the loss of redundancy and resiliency created by their limited ranges, restricted habitat requirements, small population sizes, or low numbers of individuals. Therefore, we expect these 15 species to be particularly vulnerable to projected environmental impacts that may result from changes in climate and subsequent impacts to their habitats (e.g., Loope and Giambelluca 1998, pp. 504–505; Pounds *et al.* 1999, pp. 611–612; Still *et al.* 1999, p. 610; Benning *et al.* 2002, pp. 14,246–14,248; Giambelluca and Luke 2007, pp. 13–18). Based on the above information, we conclude that changes in environmental conditions that result from climate change have the potential to negatively impact the 15 species in this final rule, and exacerbate other threats. We have concluded from the available data that this potential threat will likely increase in the near future.

Habitat Destruction and Modification by Sedimentation

Anchialine pool habitats can gradually disappear when organic and mineral deposits from aquatic production and 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 are known to 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 groundwater flow (Maciolek and Brock 1974, p. 3; Brock 2004, pp. 11, 35–36).

Based upon what we know about healthy anchialine pool systems (Brock 2004, pp. 11, 35–36), one or more factors, combined with increased sedimentation, are degrading the health of the Lua o Palahemo pool system, one of the two known locations of *Vetericaris chaceorum.* First, sedimentation in the water column is reducing the capacity of the pool to produce adequate cyanobacteria and algae to support some of the pool's herbivorous hypogeal species. A decreased food supply (i.e., a reduction in cyanobacteria and algae) will lead to a lower abundance of herbivorous hypogeal shrimp species as well as a lower abundance of the known carnivorous species, *Metabetaeus lohena,* and possibly *V. chaceorum.*

Second, increased sedimentation in Lua o Palahemo is overloading the capacity of the pool and lava tube below to adequately flush water to maintain the water quality needed to support the micro-organisms that are fed upon by several of the pool's shrimp species (e.g., *Calliasmata pholidota, Halocaridina palahemo, Halocaridina rubra,* and *Procaris hawaiiana*) and their associated shrimp predators, *Antecaridina lauensis* and *V. chaceorum* (Brock 2004, pp. 10–11, 16).

Third, increased sedimentation and the inability of the pool system to adequately flush its waters are either diminishing or preventing migration and recolonization of the pool by the hypogeal shrimp species from the surrounding porous watertable bedrock. In other words, this lack of porosity is affecting the movement of shrimp to and from food resources, and the accumulating sediment and detritus reduce productivity within the pool. This reduction in productivity reduces the carrying capacity of the habitat to support hypogeal shrimp like *V. chaceorum,* which is listed as endangered in this final rule (Brock 2004, p. 10). Indeed, Brock (2004, p. 16) has established that pool productivity and shrimp presence are interdependent. In some cases, a pool that loses its shrimp populations due, for example, to the introduction of nonnative fish, more quickly loses its capacity to support shrimp in the future as a result of excessive buildup of algae and cyanobacterial mats that block and impede the pool's ability to flush and maintain necessary water quality (Brock 2004, p. 16).

During a dive survey in 1985, visibility within the lava tube portion of Lua o Palahemo was as great as 20 m (66 ft) (Kinsley and Williams 1986, pp. 417–437). During this dive survey, Kensley and Williams (1986, p. 418) estimated that other species of hypogeal shrimp co-occurring with *V. chaceorum* numbered in the tens of thousands for *Halocaridina* sp., in the thousands for *Procaris hawaiiana,* and less than 100 for *Calliasmata* sp. By 2010, visibility had been reduced to 8 cm (3 in) within the pool itself, and underwater video taken during the survey shows continuous clouds of thick sediment and detritus within the water column below the pool (Wada 2010, in litt.). During this survey, only one *P. hawaiiana* individual was trapped, and seven others were observed in the video footage. No other species of shrimp, including *V. chaceorum,* were observed during the 2010 survey (Wada 2010, in litt.). Kensley and Williams (1986, p. 426) reported fragments of crustaceans, including *P. hawaiiana,* in the gut contents of *V. chaceorum.* While *P. hawaiiana* occurs in other anchialine pool habitats on Hawaii Island and Maui, *V. chaceorum* is currently only known from Lua o Palahemo and four pools at Manuka. A reduction in the abundance of *P. hawaiiana* in one of the two known locations of *V. chaceorum* indicates a loss of food resources for *V. chaceorum,* although further research is needed to confirm this.

During the 2010 survey, it was discovered that a possible partial collapse of the interior rock walls of Lua o Palahemo pool had occurred, and this collapse caused the difficulty experienced by the survey team to survey (via snorkeling) to any depth below the pool's surface (Wada 2010, in litt.). This collapse also contributed to the reduced flushing in the pool portion of Lua o Palahemo, leading to an accumulation of sediment and detritus in the pool. This accumulation of sediment is reducing both food productivity (i.e., reduce the abundance and availability of other species of hypogeal shrimp co-occurring with *V. chaceorum*) and the ability of *V. chaceorum* and other species of hypogeal shrimp co-occurring with *V. chaceorum* to move between the pool and the water table, thus leading to a reduction of their numbers within the pool. Although a recent 2012 survey conducted at Lua o Palahemo (Wada *et al* 2012, in litt.) reported that water visibility had improved since 2010 (Wada 2010, in litt.), particularly from 11 ft (3.5 m) below the surface, neither *V. chaceorum* nor species of *Halocaridina,* which were reported in the tens of thousands in 1985, were observed (Wada *et al.* 2012, in litt.). The Service concludes that degradation of Lua o Palahemo by senescence from sedimentation is an ongoing threat to the continued existence of *V. chaceorum* by degrading the conditions of one of only two known locations of anchialine pools that support this species and by reducing available food resources (Brock 2004, pp. 10–11, 16; Sakihara 2012, in litt.). Sedimentation is not reported to pose a threat to *V. chaceorum* in the pools at Manuka.

Conservation Efforts To Reduce Habitat Destruction, Modification, or Curtailment of Habitat or Range

There are no approved habitat conservation plans (HCPs), candidate conservation agreements (CCAs), or safe harbor agreements (SHAs) that specifically address these 15 species and threats from habitat destruction or modification. We acknowledge that in the State of Hawaii there are several voluntary conservation efforts that may be helping to ameliorate the threats to the 15 species listed as endangered in this final rule due to habitat destruction and modification by nonnative species, fire, natural disasters, and climate change, and the interaction of these threats. However, these efforts are overwhelmed by the number of threats, the extent of these threats across the landscape, and the lack of sufficient resources (e.g., funding) to control or eradicate them from all areas where these 15 species occur now or occurred historically. Some of the voluntary conservation efforts include the 11 island-based watershed partnerships, including the 3 partnerships on Hawaii Island (Three Mountian Alliance (TMA), Kohala Watershed Partnership (KWP), and the Mauna Kea Watershed Alliance (MKWA)). These partnerships are voluntary alliances of public and private landowners ''committed to the common value of protecting forested watersheds for water recharge, conservation, and other ecosystem services through collaborative management'' (*http://hawp.org/partnerships*). Most of the ongoing conservation management actions undertaken by the watershed partnerships address threats to upland habitat from nonnative species (e.g., feral ungulates, nonnative plants) and may include fencing, ungulate removal, and outplanting of native as well as rare, native species on lands within the partnership. Funding for the watershed partnerships is provided through a variety of State and Federal sources, public and private grants, and in-kind services provided by the partners or volunteers.

Current watershed partnership projects on Hawaii Island that will benefit one or more of the 15 species listed as endangered in this final rule include both the building of new fenced exclosures and the maintenance of existing exclosures to exclude feral ungulates. The TMA is preparing to build a fenced exclosure of approximately 12,000 ac (4,856 ha) in the Kau FR bordering the Kahuku Unit of HVNP (Big Island Video News, May 23, 2012) in an area where several occurrences of *Pittosporum hawaiiense* are known (Pratt 2011d, in litt.). At least some individuals of *P. hawaiiense* will be protected from direct impacts from feral pigs, cattle, mouflon, and axis deer, although the exact number of *P. hawaiiense* individuals that will be within the exclosure is unknown. In addition, control of nonnative plants (e.g., *Clidemia hirta, Hedychium gardnerianum, Psidium cattleianum, Rubus ellipticus, Setaria palmifolia, Cyathea cooperi,* and *Tibouchina* spp.) will be conducted within the fenced exclosure (Cole 2013, in litt.). The TMA is also working with the Plant Extinction Prevention Program (see below) on nonnative ungulate and nonnative plant removal in a 270-ac (109-ha) exclosure in the Puu Makaala NAR where one occurrence of *Cyanea tritomantha* and the last individual of *Schiedea diffusa* ssp. *macraei* are known (Ball 2013, pers. comm.). The KWP is constructing a 700-ac (283-ha) fenced exclosure in the Kohala Mountains in an area where individuals of *Pritchardia lanigera* are known. Completion of this fence is expected in 2016 (Ball 2013, pers. comm.; Purell 2013, in litt.). This exclosure will provide protection to individuals of *P. lanigera* from ungulates once the fence is completed and ungulates are removed within the fence. In addition, the KWP plans to control nonnative plants (i.e., *Hedychium gardnerianum* and *Psidium cattleianum*) within the exclosure (Purell 2013, in litt.).

The State of Hawaii's Plant Extinction Prevention (PEP) Program supports conservation of plant species by securing seeds or cuttings (with permission from the State, Federal, or private landowners) from the rarest and most critically endangered native species for propagation and outplanting (*http://pepphi.org*). The PEP Program focusses primarily on species that have fewer than 50 plants remaining in the wild. Funding for this program is from the State of Hawaii, Federal agencies (e.g., Service), and public and private grants. The PEP Program collects, propagates, and outplants rare plant species on State, Federal, and private lands (with permission) in areas where the species currently and historically occurred, and in species-appropriate habitat. The PEP Program collects, propagates, or outplants eight plant species that are listed as endangered in this final rule (*Cyanea marksii, Cyrtandra wagneri, Phyllostegia floribunda, Pittosporum hawaiiense, Platydesma remyi, Schiedea diffusa* ssp. *macraei, S. hawaiiensis,* and *Stenogyne cranwelliae*) (PEPP 2012, pp. 1–6, 37–43). However, only 2 of these 8 species (*Cyrtandra wagneri* and *Platydesma remyi*) were monitored and checked for possible collection material in 2012 (PEPP 2012, pp. 55, 89). The PEP program is currently assisting TNC by maintaining sections of the Kona Hema Preserve (see below) (Yoshioka 2013, pers. comm.). Overall, the program has not yet been able to directly address broad-scale habitat threats to plants by invasive species.

Voluntary conservation actions undertaken by TNC on one (Kona Hema Preserve) of their three preserves on Hawaii Island provide a conservation benefit to individuals of the plants *Phyllostegia floribunda* and *Pittosporum hawaiiense,* which are listed as endangered in this final rule, that are in a fenced exclosure (the fence provides protection from mouflon, feral pigs, and cattle) (Ball 2013, pers. comm.). In addition, TNC is a member of two watershed partnerships, KWP and TMA.

Voluntary conservation actions undertaken by several private landowners (Kamehameha Schools; Kaloko Properties Corporation, Stanford Carr Development (SCD)—Takeshi Sekiguchi Associates (TSA) Kaloko Makai, LLC, and Takeshi Sekiguchi Associates (TSA) Corporation; Lanihau Properties; Palamanui Global Holdings, LLC; and DHHL) are described in our October 17, 2012, proposed rule (77 FR 63928). These conservation actions provide a conservation benefit and ameliorate some of the threats from nonnative species and wildfire to the plant *Bidens micrantha* ssp. *ctenophylla,* which is listed as endangered in this final rule. In addition, at least 400 individuals of *B. micrantha* ssp. *ctenophylla* have been propagated for the privately owned Koloko Makai Dryland Forest Preserve, and there are currently 300 surviving outplanted individuals (Hawaii Forest Institute 2013, in litt.). Other private landowners are engaged in, or initiating, voluntary conservation actions on their lands, including fencing to exclude ungulates, controlling nonnative plants, and propagation and outplanting of native plant species including *B. micrantha* ssp. *ctenophylla.* These private landowners include the Queen Liliuokalani Trust and the Waikoloa Village Association in partnership with the Waikoloa Dry Forest Initiative (Waikoloa Village Outdoor Circle 2009; Queen Liliuokalani Trust 2013, pers. comm.). The conservation actions provided by these landowners ameliorate some of the threats from nonnative plant species, ungulates, and fire to *B. micrantha* ssp. *ctenophylla.* In addition, with help from the Hawaii Forest Industry Association (HFIA), individuals of *Bidens micrantha* ssp. *ctenophylla* have been propagated and outplanted within the privately owned 70-ac (28-ha) Kaupulehu Dry Forest Preserve, as well as at Koloko-Honokohau National Historical Park (Ball 2013, pers. comm.). According to HFIA (2009, p. 2) and DHHL (2013, in litt.), DHHL's Aupaka Preserve and Uhiuhi Preserve, two of four described in the Laiopua Plant Mitigation and Preserve Restoration Plan, will benefit several listed plant species as well as *B. micrantha* ssp. *ctenophylla,* which is listed as endangered in this final rule, by removing nonnative plant species, outplanting associated native plant species found in the lowland dry ecosystem, and maintaining a system of firebreaks (Leonard Bisel Associates, LLC, and Geometrician Associates 2008, pp. 36–46).

Summary of Habitat Destruction and Modification

The threats to the habitats of each of the 15 species in this final rule are occurring throughout the entire range of each of the species, except where noted above. These threats include land conversion by agriculture and urbanization, nonnative ungulates and plants, fire, natural disasters, environmental changes resulting from climate change, sedimentation, and the interaction of these threats. While the conservation measures described above are a step in the right direction toward addressing the threats to the 15 species, due to the pervasive and expansive nature of the threats resulting in habitat degradation, these measures are insufficient across the landscape and in effort to eliminate these threats to any of the 15 species in this final rule.

Development and urbanization of lowland dry habitat on Hawaii Island represents a serious and ongoing threat to *Bidens micrantha* ssp. *ctenophylla* because of loss and degradation of habitat.

The effects from ungulates are ongoing because ungulates currently occur in all of the 10 ecosystems that support the 15 species in this final rule. The threat posed by introduced ungulates to the species and their habitats in this final rule that occur in these 10 ecosystems (see Table 3) is serious, because they cause: (1) Trampling and grazing that directly impact the plant communities, which include all 13 of the plant species listed as endangered in this rule, and impact the host plants used by the picture-wing fly for shelter, foraging, and reproduction; (2) increased soil disturbance, leading to mechanical damage to individuals of the 13 plant species listed as endangered in this final rule, and also plants used by the picture-wing fly for shelter, foraging, and reproduction; (3) creation of open, disturbed areas conducive to weedy plant invasion and establishment of alien plants from dispersed fruits and seeds, which results over time in the conversion of a community dominated by native vegetation to one dominated by nonnative vegetation (leading to all of the negative impacts associated with nonnative plants, listed below); and (4) increased erosion, followed by sedimentation, affecting the anchialine pool habitat of *V. chaceorum* at Lua o Palahemo. These threats are expected to continue or increase without ungulate control or eradication.

Nonnative plants represent a serious and ongoing threat to 14 of the 15 species listed as endangered in this final rule (all 13 plant species and the picture-wing fly (see Table 3)) through habitat destruction and modification, 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 characteristics of native plant habitat, leading to incursions of fire-tolerant nonnative plant species into native habitat; (5) outcompete, and possibly directly inhibit the growth of, native plant species; and (6) create opportunities for subsequent establishment of nonnative vertebrates and invertebrates. Each of these threats can convert native-dominated plant communities to nonnative plant communities (Cuddihy and Stone 1990, p. 74; Vitousek 1992, pp. 33–35). This conversion has negative impacts on all 13 plant species listed as endangered here, as well as the native plant species upon which the picture-wing fly depends for essential life-history needs.

The threat from fire to 4 of the 15 species in this final rule that depend on lowland dry, lowland mesic, lowland wet, montane dry, and montane mesic ecosystems (the plants *Bidens micrantha* ssp. *ctenophylla, Phyllostegia* *floribunda,* and *Schiedea hawaiiensis,* and the picture-wing fly; see Table 3) is serious and ongoing because fire damages and destroys native vegetation, including dormant seeds, seedlings, and juvenile and adult plants. Many nonnative, invasive plants, particularly fire-tolerant grasses, 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 native plants and remove habitat for native species by altering microclimatic conditions and creating conditions favorable to alien plants. The threat from fire is unpredictable but increasing in frequency in ecosystems that have been invaded by nonnative, fire-prone grasses and that are experiencing abnormally dry to severe drought conditions.

Natural disasters, such as hurricanes, are a threat to native Hawaiian terrestrial habitat, including 9 of the 10 ecosystems (all except the anchialine pool ecosystem) addressed here, and the 13 plant species listed as endangered in this final rule, because they result in direct impacts to ecosystems and individual plants by opening the forest canopy, modifying available light, and creating disturbed areas that are conducive to invasion by nonnative pest plants (Asner and Goldstein 1997, p. 148; Harrington *et al.* 1997, pp. 346–347). In addition, hurricanes are a threat to the picture-wing fly species in this rule because strong winds and intense rainfall can kill individual host plants, and can dislodge individual flies and their larvae from their host plants and deposit them on the ground, where they may be crushed by falling debris or eaten by nonnative wasps and ants. The impacts of hurricanes and other stochastic natural events can be particularly devastating to 14 of the 15 species (all except the anchialine pool shrimp) because, as a result of other threats, they now persist in low numbers or occur in restricted ranges and are therefore less resilient to such disturbances, rendering them highly vulnerable. Furthermore, a particularly destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event. Hurricanes pose an ongoing and ever-present threat because they are unpredictable and can happen at any time.

Rockfalls, treefalls, landsides, heavy rain, inundation by high surf, and erosion are a threat to four of the species in this final rule (the plants *Bidens hillebrandiana* ssp. *hillebrandiana, Cyanea marksii, Cyanea tritomantha,* and *Cyrtandra wagneri;* see Table 3) by destabilizing substrates, damaging and destroying individual plants, and altering hydrological patterns, which result in habitat destruction or modification and changes to native plant and animal communities. Drought adversely impacts two plant species (*Bidens micrantha* ssp. *ctenophylla* and *Schiedea hawaiiensis*) and the picture-wing fly (*Drosophila digressa*) by the loss or degradation of habitat due to death of individual native plants and host tree species, as well as an increase in forest and brush fires. These threats are serious and unpredictable, and have the potential to occur at any time.

Changes in environmental conditions that may result from global climate change include increasing temperatures, decreasing precipitation, increasing storm intensities, and sea-level rise and coastal inundation. The consequent impacts on the 15 species listed as endangered in this final rule are related to changes in microclimatic conditions in their habitats. These changes have the potential to cause the loss of native species, including the 15 species being listed as endangered in this final rule, due to direct physiological stress, the loss or alteration of habitat, or changes in disturbance regimes (e.g., droughts, fire, storms, and hurricanes).

Sedimentation of the Lua o Palahemo pool system is a threat to the anchialine pool shrimp (*Vetericaris chaceorum*), which is listed as endangered in this final rule. In particular, the accumulation of sediment and detritus reduces the abundance of food resources, such as *Procaris hawaiiana* and other co-occurring hypogeal shrimp, for *V. chaceorum.*

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

The plant species *Pritchardia lanigera* is threatened by overcollection for commercial and recreational purposes (Hillebrand 1888, pp. 21–27; Chapin *et al.* 2004, pp. 273, 278), as discussed below. We are aware that some species of Hawaiian anchialine pool shrimp are sold and purchased on the Internet. However, we do not believe that the anchialine pool shrimp listed as endangered in this final rule is threatened by overcollection for commercial or recreational purposes for the following reasons: (1) The remoteness of Lua o Palahemo, one of two known locations of *Vetericaris chaceorum,* and the difficulty of accessing this species within the deeper lava tube portions of the anchialine pool; and (2) although a second occurrence has now been confirmed at Manuka throughout the epigeal (open surface) sections of four pools, *V. chaceorum* is still considerably less common and much more elusive than *Halocaridina rubra* and the other anchialine pool shrimp species found in these four pools. In addition, there are prohibitions against collecting from the pools in the natural area reserve, although the State does not actively monitor the site (Hadway 2013, pers. comm.). We are not aware of any threats to the remaining 12 plant species or the picture-wing fly listed as endangered in this final rule that would be attributed to overutilization for commercial, recreational, scientific or educational purposes.

Pritchardia lanigera

The genus *Pritchardia* has 28 known species, 14 of which are endemic to the Hawaiian Islands, and its range is restricted to the Pacific archipelagos of Hawaii, Fiji, the Cook Islands, Tonga, and Tuamotus (Chapin *et al.* 2004, p. 273). *Pritchardia* palms have been valued as collectibles for centuries (Hillebrand 1888, pp. 21–27; Chapin *et al.* 2004, pp. 273, 278). In 1888, botanist Wilhelm Hillebrand noted that, ''. . . one species of *Pritchardia* in Nuuanu, . . . was completely exterminated when natives found that the trees were saleable to amateurs of gardening in Honolulu.'' *Pritchardia* has become one of the most widely cultivated ornamental palm genera in the world (Maunder *et al.* 2001 in Chapin *et al.* 2004, p. 278). There is an international trade in *Pritchardia* seeds and seedlings that has created a market in which individual *Pritchardia* seeds sell for 5 to 35 dollars each (Chapin *et al.* 2004, p. 278; Clark 2010, in litt.; *http://rarepalmseeds.com*). Most seeds sold are cultivated; however, wild collection of some ''highly-threatened'' species does occur (Chapin *et al.* 2004, p. 278). There are over a dozen Internet Web sites that offer Hawaiian *Pritchardi*a plants and seeds for sale, including *Pritchardia lanigera* (e.g., *http://www.eBay.com*). Based on the history of collection of endemic Hawaiian *Pritchardia* plants and seeds, the market for Hawaiian *Pritchardia* plants and seeds, and the vulnerability of the small populations of *Pritchardia lanigera* to the negative impacts of any collection, we consider overcollection of *Pritchardia lanigera* to pose a serious and ongoing threat, because it can occur at any time, although its occurrence is not predictable.

Anchialine Pool Shrimp

While we are aware of two collections of the anchialine pool shrimp

Vetericaris chaceorum for scientific and educational purposes (Kensley and Williams, 1986, pp. 419–429; Sakihara 2013, in litt.), there is no information available that indicates this species has ever been collected for commercial or recreational purposes. Other Hawaiian anchialine pool shrimp (e.g., opaeula (*Halocaridina rubra*)) and the candidate species *Metabetaeus lohena* (NCN) are collected for the aquarium market (e.g., *http://Fuku-Bonsai.com; http://ecosaqua.com; http://www.eBay.com; http://www.seahorse.com*), including self-contained aquariums similar to those marketed by Ecosphere Associates, Inc. (Ecosphere Associates 2011, p. 1). Two of these companies are located in Hawaii (FukuBonsai and Stockly's Aquariums of Hawaii). Although other species are collected, the Service lacks sufficient information to suggest that collection is or is not a threat to *V. chaceorum.*

Conservation Efforts To Reduce Overutilization for Commercial, Recreational, Scientific or Educational Purposes

We are unaware of voluntary conservation efforts to reduce overcollection of Hawaiian *Prichardia* species, including *P. lanigera,* which is listed as endangered in this final rule. There are no approved HCPs, SHAs, CCAs, memoranda of understanding (MOUs), or other voluntary actions that specifically address *P. lanigera* and the threat from overcollection.

Summary of Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

We have no evidence to suggest that overutilization for commercial, recreational, scientific, or educational purposes poses a threat to 12 of the 13 plant species, the picture-wing fly, or the anchialine pool shrimp in this final rule. The plant species *Pritchardia lanigera* is vulnerable to the impacts of overutilization due to collection for trade or market. Based on the history of collection of endemic Hawaiian *Pritchardia* spp., the market for Hawaiian *Pritchardia* trees and seeds, and the inherent vulnerability of the small populations of *Pritcharidia lanigera* to the removal of individuals (seeds), we consider collection to pose a serious and ongoing threat to this species.

Factor C. Disease or Predation

Disease

We are not aware of any threats to the 13 plant species, anchialine pool shrimp, or picture-wing fly listed as endangered in this final rule that are attributable to disease.

Predation and Herbivory

Hawaii's plants and animals evolved in nearly complete isolation from continental influences. Successful colonization of these remote volcanic islands was infrequent, and many organisms never succeeded in establishing populations. As an example, Hawaii lacks any native ants or conifers, has very few families of birds, and has only a single native land mammal—a bat (Loope 1998, p. 748). In the absence of any grazing or browsing mammals, plants that became established did not need mechanical or chemical defenses against mammalian herbivory such as thorns, prickles, and production of toxins. As the evolutionary pressure to either produce or maintain such defenses was lacking, Hawaiian plants either lost or never developed these adaptations (Carlquist 1980, p. 173). Likewise, native Hawaiian birds and insects experienced no evolutionary pressure to develop anti-predator mechanisms against mammals or invertebrates that were not historically present on the island. The native flora and fauna of the islands are thus particularly vulnerable to the impacts of introduced nonnative species, as discussed below.

Introduced Ungulates

In addition to the habitat impacts discussed above (see ''Habitat Destruction and Modification by Introduced Ungulates'' under *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range*), introduced ungulates and their resulting impacts are a threat to the 13 plant species in this final rule by grazing and browsing individual plants (this information is also presented in Table 3): *Bidens hillebrandiana* ssp. *hillebrandiana* (pigs and goats), *B. micrantha* ssp. *ctenophylla* (pigs and goats), *Cyanea marksii* (pigs, cattle, and mouflon), *Cyanea tritomantha* (pigs and cattle), *Cyrtandra nanawaleensis* (pigs), *Cyrtandra wagneri* (pigs), *Phyllostegia floribunda* (pigs), *Pittosporum hawaiiense* (pigs, cattle, and mouflon), *Platydesma remyi* (pigs), *Pritchardia lanigera* (pigs, goats, and mouflon), *Schiedea diffusa* ssp. *macraei* (pigs and cattle), *Schiedea hawaiiensis* (pigs, goats, sheep, and mouflon), and *Stenogyne cranwelliae* (pigs). In addition, introduced ungulates are a threat to the picture-wing fly in this final rule by grazing and browsing individuals of its host plants, *Charpentiera* spp. and *Pisonia* spp. (pigs, goats, cattle, and mouflon).

We have direct evidence of ungulate damage to the 13 plant species listed as endangered species in this final rule, as well as to the two host plants of the picture-wing fly listed as an endangered species in this final rule. Magnacca *et al.* (2008, p. 32) and others (Maui Forest Bird Recovery Project 2011, in litt.) found that native plant species such as the Hawaiian lobelioids (e.g., *Cyanea* spp.) and plants in the African violet family (e.g., *Cyrtandra* spp.) are particularly vulnerable to pig disturbance. 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 60 percent of the pigs' food source consisted of the endemic *Cibotium* (hapuu, tree fern). Pigs were observed to fell plants and remove the bark from native plant species within the genera *Cibotium, Clermontia, Coprosma, Hedyotis, Psychotria,* and *Scaevola,* resulting in larger trees being killed over 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 activities 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, pp. 2–3). In Hawaii, pigs dig up forest ground cover consisting of delicate and rare species of orchids, ferns, mints, lobeliads, and other taxa, including roots, tubers and rhizomes (Stone and Anderson 1988, p. 137).

In addition, there are direct observations of pig herbivory, on either the fresh seedlings, fruits, seeds, or leaves, on each of the 13 plant species in this final rule, including *Bidens hillebrandiana* ssp. *hillebrandiana* (Bio 2011, pers. comm.), *B. micrantha* ssp. *ctenophylla* (Bio 2011, pers. comm.), *Cyanea marksii* (PEPP 2010, p. 52; Bio 2011, pers. comm.), *Cyanea tritomantha* (HBMP 2010f; PEPP 2010, p. 60), *Cyrtandra nanawaleensis* (Bio 2011, pers. comm.), *Cyrtandra wagneri* (Lorence and Perlman 2007, p. 359; PEPP 2010, p. 63), *Phyllostegia floribunda* (Perlman and Wood 1993—*Hawaii Plant Conservation Maps database;* Perry 2006, in litt.; Pratt 2007b, in litt.; USFWS 2010, p. 4–66), *Pittosporum hawaiiense* (Bio 2011, pers. comm.), *Platydesma remyi* (PEPP 2008, p. 107), *Pritchardia lanigera* (Wood

1995, in litt.; HBMP 2010c; Crysdale 2013, pers. comm.), *Schiedea diffusa* ssp. *macraei* (Wagner *et al.* 2005d, p. 32), *Schiedea hawaiiensis* (Mitchell *et al.* 2005a; Wagner *et al.* 2005d, p. 32; Bio 2011, pers. comm.), and *Stenogyne cranwelliae* (HBMP 2010k). According to Magnacca *et al.* (2008, p. 32; 2013, in litt.) several of the host plants of Hawaiian picture-wing flies, including *Charpentiera* spp. and *Pisonia* spp., the two host plants that support the picture-wing fly in this rule, are susceptible to damage from feral ungulates such as pigs. As pigs occur in 9 of the 10 ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, dry cliff, and wet cliff) on Hawaii Island, the results of the studies described above suggest that pigs can also alter these ecosystems and directly damage or destroy the 13 plant species listed as endangered species in this final rule, and the two plants that support the picture-wing fly that is being listed as endangered in this final rule (see above and Table 3).

Feral goats thrive on a variety of food plants, and are instrumental in the decline of native vegetation in many areas (Cuddihy and Stone 1990, p. 64). Feral goats trample roots and seedlings, cause erosion, and promote the invasion of alien plants. They are able to forage in extremely rugged terrain and have a high reproductive capacity (Clarke and Cuddihy 1980, p. C–20; van Riper and van Riper 1982, pp. 34–35; Tomich 1986, pp. 153–156; Cuddihy and Stone 1990, p. 64). Goats were observed to browse on native plant species in the following genera: *Argyroxiphium, Canavalia, Plantago, Schiedea,* and *Stenogyne* (Cuddihy and Stone 1990, p. 64). A study on the island of Hawaii demonstrated that *Acacia koa* seedlings are unable to survive due to browsing and grazing by goats (Spatz and Mueller-Dombois 1973, p. 874). If goats are maintained at constantly high numbers, mature *A. koa* trees will eventually die, and with them the root systems that support suckers and vegetative reproduction. One study demonstrated a positive height-growth response of *A. koa* suckers to the 3-year exclusion of goats (1968–1971) inside a fenced area, whereas suckers were similarly abundant but very small outside of the fenced area (Spatz and Mueller-Dombois 1973, p. 873). Another study at Puuwaawaa demonstrated that prior to management actions in 1985, regeneration of endemic shrubs and trees in the goat-grazed area was almost totally lacking, contributing to the invasion of the forest understory by exotic grasses and weeds. After the removal of grazing animals in 1985, *A. koa* and *Metrosideros* spp. seedlings were observed germinating by the thousands (HDOFAW 2002, p. 52). Based on a comparison of fenced and unfenced areas, it is clear that goats can devastate native ecosystems (Loope *et al.* 1988, p. 277).

Goats seek out seedlings and juveniles of *Bidens* spp. (Bio 2011, pers. comm.), and are known to indiscriminately graze on and eat the seeds of native Hawaiian *Pritchardia* species (Chapin *et al.* 2004, p. 274; Chapin *et al.* 2007, p. 20). The two known occurrences of the plant *Pritchardia lanigera* are found in an unfenced area of the Kohala Mountains, where they are impacted by browsing and grazing by goats and other ungulates (Warshauer *et al.* 2009, pp. 10, 24; Laws *et al.* 2010, in litt.). *Schiedea* spp. are favored by grazing goats, and goat browsing adversely impacts the only known population of the plant species *Schiedea hawaiiensis* (Wagner *et al.* 2005d, p. 32; Chynoweth *et al.* 2011, in litt.). In addition, there are direct observations of goat herbivory, on either the fresh seedlings, fruit, seeds, or leaves, of four of the plant species in this final rule, including *Bidens hillebrandiana* ssp. *hillebrandiana* (Bio 2011, pers. comm.), *B. micrantha* ssp. *ctenophylla* (Bio 2011, pers. comm.; Knoche 2011, in litt.), *Pritchardia lanigera* (Wood 1995, in litt.; Chapin *et al.* 2004, p. 274), and *Schiedea hawaiiensis* (Mitchell *et al.* 2005a). According to Magnacca *et al.* (2008, p. 32) several of the host plants of Hawaiian picture-wing flies, including the host plants of the picture-wing fly listed as endangered in this rule (*Charpentiera* spp. and *Pisonia* spp.), are susceptible to damage from feral ungulates such as goats. As goats occur in nine of the ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, dry cliff, and wet cliff) on Hawaii Island, the results of the studies described above suggest that goats can also alter these ecosystems and directly damage or destroy four of the plant species being listed as endangered in this final rule (*Bidens micrantha* ssp. *ctenophylla, B. hillebrandiana* ssp. *hillebrandiana, Pritchardia lanigera,* and *Schiedea hawaiiensis*), and the two host plants that support the picture-wing fly being listed as an endangered species in this final rule (see above and Table 3).

Four of the plant species listed as endangered in this final rule (*Cyanea marksii, C. tritomantha, Pittosporum hawaiiense,* and *Schiedea diffusa* ssp. *macraei*), and the two host plants that support the picture-wing fly in this rule (*Charpentiera* spp. and *Pisonia* spp.), are impacted by browsing and grazing by feral cattle. Cattle, either feral or domestic, are considered one of the most significant factors in the destruction of Hawaiian forests (Baldwin and Fagerlund 1943, pp. 118–122). Currently, feral cattle are found only on Maui and Hawaii, typically in accessible forests and certain coastal and lowland leeward habitats (Tomich 1986, pp. 140–144).

In HVNP, Cuddihy reported that there were twice as many native plant species as nonnatives found in areas that had been fenced to exclude feral cattle, whereas on the adjacent, nonfenced cattle ranch, there were twice as many nonnative plant species as natives (Cuddihy 1984, pp. 16, 34). Skolmen and Fujii (1980, pp. 301–310) found that *Acacia koa* seedlings were able to reestablish in a moist *A. koa*—*Metrosideros polymorpha* forest on Hawaii Island after the area was fenced to exclude feral cattle (Skolmen and Fujii 1980, pp. 301–310). Cattle eat native vegetation, trample roots and seedlings, cause erosion, create disturbed areas conducive to invasion by nonnative plants, and spread seeds of nonnative plants in their feces and on their bodies. Cattle have been observed accessing native plants in Hakalau NWR by breaking down ungulate exclosure fences (Tummons 2011, p. 4). In addition, there are direct observations of cattle herbivory on three of the plant species in this rule, including *Cyanea marksii* (PEPP 2010, p. 52), *C. tritomantha* (PEPP 2010, p. 60), and *Pittosporum hawaiiense* (Bio 2011, pers. comm.). In addition, although we have no direct observations, we also consider the plant *Schiedea diffusa* ssp. *macraei* to be susceptible to herbivory by cattle because cattle are reported to favor plants in the genus *Schiedea* (Wagner *et al.* 2005d, pp. 31–32) and feral cattle still occur in the Kohala Mountains, the location of the only known individual of this species. Between 1987 and 1994, populations of *Schiedea salicaria* on West Maui were grazed so extensively by cattle, all of the individuals of this species in accessible areas disappeared by 1994 (Wagner *et al.* 2005d, p. 32). Cattle are also known to browse *Charpentiera* spp. and *Pisonia* spp., the two host plants that support the picture-wing fly in this final rule (Magnacca *et al.* 2008, p. 32; Magnacca 2011b, pers. comm.). As feral cattle occur in five of the described ecosystems (anchialine pool, lowland mesic, lowland wet, montane mesic, and montane wet) on Hawaii Island, the results of the studies described above suggest that feral cattle can also alter these ecosystems and directly damage or destroy four of the plant species listed as endangered species in this final rule (*Cyanea marksii, C. tritomantha, Pittosporum hawaiiense,* and *Schiedea diffusa* ssp. *macraei*), and the two host plants that support the picture-wing fly listed as an endangered species in this rule (*Charpentiera* spp. and *Pisonia* spp.) (Table 3).

Feral sheep browse and trample native vegetation, and have decimated large areas of native forest and shrubland (Tomich 1986, pp. 156–163; Cuddihy and Stone 1990, p. 65–66). Large areas of Hawaii Island have been devastated by sheep. For example, sheep browsing reduced seedling establishment of *Sophora chrysophylla* (mamane) so severely that it resulted in a reduction of the tree line elevation on Mauna Kea (Warner 1960 in Juvik and Juvik 1984, pp. 191–202). Currently there is a large sheep-mouflon sheep hybrid population (see ''Habitat Destruction and Modification by Introduced Ungulates'' under *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range,* above) on Mauna Kea that extends into the saddle and northern part of Mauna Loa, and there are reports that these animals are destroying endangered plants (Hess 2008, p. 1). There are direct observations of feral sheep herbivory on individuals of the only known occurrence of the plant species *Schiedea hawaiiensis* at PTA (Mitchell *et al.* 2005a; U.S. Army Garrison 2006, p. 34). As feral sheep occur in one of the described ecosystems (montane dry) on Hawaii Island, the results of the studies described above suggest that sheep can also alter this ecosystem and directly damage or destroy individuals of *Schiediea hawaiiensis* (Table 3).

Mouflon sheep graze native vegetation, trample undergrowth, spread weeds, and cause erosion. On the island of Hawaii, mouflon sheep browsing led to the decline in the largest population of the endangered *Argyroxiphium kauense* (kau silversword, Mauna Loa silversword, or ahinahina) located on the former Kahuku Ranch, reducing it from a ''magnificent population of several thousand'' (Degener *et al.* 1976, pp. 173–174) to fewer than 2,000 individuals (unpublished data in Powell 1992, in litt., p. 312) over a period of 10 years (1974–1984). The native tree *Sophora chrysophylla* is also a preferred browse species for mouflon. According to Scowcroft and Sakai (1983, p. 495), mouflon eat the shoots, leaves, flowers, and bark of this species. Bark stripping on the thin bark of a young tree is potentially lethal. Mouflon are also reported to strip bark from *Acacia koa* trees (Hess 2008, p. 3) and to seek out the threatened plant *Silene hawaiiensis* (Benitez *et al.* 2008, p. 57). In the Kahuku section of HVNP, mouflon jumped the park boundary fence and reduced one population of *S. hawaiiensis* to half its original size over a 3-year period (Belfield and Pratt 2002, p. 8). Other native species browsed by mouflon include *Geranium cuneatum* ssp. *cuneatum* (hinahina, silver geranium), *G. cuneatum* ssp. *hypoleucum* (hinahina, silver geranium), and *Sanicula sandwicensis* (NCN) (Benitez *et al.* 2008, pp. 59, 61). On Lanai, mouflon were once cited as one of the greatest threats to the endangered *Gardenia brighamii* (Mehrhoff 1993, p. 11), although fencing has now proven to be an effective mechanism against mouflon herbivory on this plant (Mehrhoff 1993, pp. 22–23). Due to their high agility and reproductive rates, mouflon sheep have the potential to occupy most ecosystems found on Hawaii Island, from sea-level to very high elevations (Hess 2010, pers. comm.; Ikagawa 2011, in litt.). Further, *Ovis* spp. are known throughout the world for chewing vegetation right down to the soil (Ikagawa 2011, in litt.).

Recent research by Ikagawa (2011, in litt.) suggests that the plant species *Pritchardia lanigera* occurs within the observed range of mouflon, and is potentially impacted by mouflon browsing. In addition, there are direct observations or reports that mouflon sheep browsing and grazing significantly impact the plant species *Cyanea marksii, Pittosporum hawaiiense,* and *Schiedea hawaiiensis* (Bio 2011, pers. comm.; Pratt 2011e, in litt.), which are listed as endangered in this final rule. Further, *Charpentiera* spp., one of the two host plants that support the picture-wing fly in this rule, appears to be decreasing throughout its range due to impacts from mouflon browsing (Science Panel 2005, pp. 1–23; Magnacca 2011b, pers. comm.). As mouflon occur in five of the described ecosystems (lowland wet, lowland mesic, montane dry, montane mesic, and montane wet) on Hawaii Island, the results of the studies described above suggest that mouflon sheep can also alter these ecosystems and directly damage or destroy four plants listed as endangered species in this final rule (*Cyanea marksii, Pittosporum hawaiiense, Pritchardia lanigera,* and *Schiedea hawaiiensis*), and one of the two host plants (see above) that support the picture-wing fly listed as an endangered species in this final rule (Table 3).

The recent introduction of axis deer to Hawaii Island raises a significant concern due to the reported damage axis deer cause on the island of Maui (see *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range,* above). Most of the available information on axis deer in the Hawaiian Islands concerns observations and reports from the island of Maui. On Maui, axis deer were introduced by the State as a game animal, but their numbers have steadily increased, especially in recent years on Haleakala (Luna 2003, p. 44). During the 4-year El Niño drought from 1998 through 2001, Maui experienced an 80 to 90 percent decline in shrub and vine species caused by deer browsing and girdling of young saplings. High mortality of rare and native plant species was observed (Medeiros 2010, pers. comm.). Axis deer consume progressively less palatable plants until no edible vegetation is left (Hess 2008, p. 3). Axis deer are highly adaptable to changing conditions and are characterized as ''plastic'' (meaning flexible in their behavior) by Ables (1977, cited in Anderson 1999, p. 5). They exhibit a high degree of opportunism regarding their choice of forage (Dinerstein 1987, cited in Anderson 1999, p. 5) and can be found in all but the highest elevation ecosystems (subalpine and alpine) and montane bogs, according to Medeiros (2010, pers. comm.).

Axis deer on Maui follow a cycle of grazing and browsing in open lowland grasslands during the rainy season (November–March) and then migrate to the lava flows of montane mesic forests during the dry summer months to graze and browse native plants (Medeiros 2010, pers. comm.). Axis deer are known to favor the native plants *Abutilon menziesii* (an endangered species), *Erythrina sandwicensis* (wiliwili), and *Sida fallax* (ilima) (Medeiros 2010, pers. comm.). During the driest months of summer (July and August), axis deer can even be found along Maui's coastal roads as they search for food. Hunting pressure also appears to drive the deer into native forests, particularly the lower rainforests up to 4,000 to 5,000 ft (1,220 and 1,525 m) in elevation (Medeiros 2010, pers. comm.), and according to Kessler and Hess (2010, pers. comm.), axis deer can be found up to 9,000 ft (2,743 m) elevation. On Lanai, grazing by axis deer has been reported as a major threat to the endangered *Gardenia brighamii* (nau) (Mehrhoff 1993, p. 11). Swedberg and Walker (1978, cited in Anderson

2003, pp. 124–125) reported that in the upper forests of Lanai, the native plants *Osteomeles anthyllidifolia* (ulei) and *Leptecophylla tameiameiae* (pukiawe) comprised more than 30 percent of axis deer rumen volume. On Molokai browsing by axis deer has been reported on *Erythrina sandwicensis* and *Nototrichium sandwicense* (kului) (Medeiros *et al.* 1996, pp. 11, 19). Other native plant species consumed by axis deer include *Achyranthes splendens* (NCN), *Bidens campylotheca* ssp. *pentamera* (kookoolau) and *B. campylotheca* ssp. *waihoiensis* (kookoolau), *Chamaesyce celastroides* var. *lorifolia* (akoko), *Diospyros sandwicensis* (lama), *Geranium multiflorum* (nohoanu; an endangered species), *Lipochaeta rockii* var. *dissecta* (nehe), *Osmanthus sandwicensis* (ulupua), *Panicum torridum* (kakonakona), and *Santalum ellipticum* (laau ala) (Anderson 2002, poster; Perlman 2009, in litt., pp. 4–5). As demonstrated on the Islands of Lanai, Maui, and Molokai, axis deer will spread into nine of the described ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, dry cliff, and wet cliff) on Hawaii Island if not controlled. The newly established axis deer partnership (see *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range,* above) is currently implementing an axis deer response and removal plan, and just recently reported their first confirmed removal on April 11, 2012 (Osher 2012, in litt.). In addition, there is a proposed revision to the State of Hawaii's HRS 91 (see *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range,* above, and *Factor D. The Inadequacy of Existing Regulatory Mechanisms,* below) that would address the gap in the current emergency rules authority and expand the ability of State agencies to adopt emergency rules to include situations that impose imminent threats to natural resources (e.g., axis deer on Hawaii Island). The results from the studies above, combined with direct observations from field biologists, suggest that grazing and browsing by axis deer can impose negative impacts to the nine ecosystems above and their associated native plants, including the 13 plant species listed as endangered species in this final rule, and the two host plants that support the picture-wing fly (see above) listed as an endangered species in this final rule, should this nonnative ungulate increase in number and range on Hawaii Island.

Other Introduced Vertebrates

Rats

There are three species of introduced rats in the Hawaiian Islands: Polynesian rat (*Rattus exulans*), black rat (*R. rattus*), and Norway rat (*R. norvegicus*). The Polynesian rat and the black rat are primarily found in the wild, in dry to wet habitats, while the Norway rat is typically found in manmade habitats, such as urban areas or agricultural fields (Tomich 1986, p. 41). The black rat is widely distributed among the main Hawaiian Islands and can be found in a broad range of ecosystems up to 9,744 ft (2,970 m), but it is most common at low- to mid-elevations (Tomich 1986, pp. 38–40). While Sugihara (1997, p. 194) found both the black and Polynesian rats up to 6,972 ft (2,125 m) elevation on Maui, the Norway rat was not seen at the higher elevations in his study. Rats occur in nine of the described ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, dry cliff, and wet cliff), and predation by rats adversely impacts 11 of the 13 plant species listed as endangered in this final rule (rats are not a reported threat to the picture-wing fly or anchialine pool shrimp listed as endangered in this rule) (see Table 3).

Rats impact native plants by eating fleshy fruits, seeds, flowers, stems, leaves, roots, and other plant parts (Atkinson and Atkinson 2000, p. 23), and can seriously affect regeneration. Research on rats in forests in New Zealand has also demonstrated that, over time, differential regeneration as a consequence of rat predation may alter the 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, cited 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 trees, or in some cases prevent the regeneration of forest species completely (Cuddihy and Stone 1990, pp. 68–69). All three species of rat (black, Norway, and Polynesian) have been reported to be a serious threat to many endangered or threatened Hawaiian plants (Stone 1985, p. 264; Cuddihy and Stone 1990, pp. 67–69). Plants with fleshy fruits are particularly susceptible to rat predation, including some of the species listed as endangered in this rule. For example, the fruits of plants in the bellflower family (e.g., *Cyanea* spp.) appear to be a target of rat predation (Cuddihy and Stone 1990, pp. 67–69). In addition to both species of *Cyanea* (*Cyanea marksii* and *Cyanea tritomantha*), nine other species of plants in this final rule are adversely impacted by rat predation: *Bidens hillebrandiana* ssp. *hillebrandiana, B. micrantha* ssp. *ctenophylla* (Bio 2011, pers. comm.), *Cyrtandra nanawaleensis, Cyrtandra wagneri* (Lorence and Perlman 2007, pp. 357–361; Bio 2011, pers. comm.), *Pittosporum hawaiiense, Pritchardia lanigera, Schiedea diffusa* ssp. *macraei, Schiedea hawaiiensis,* and *Stenogyne cranwelliae* (Cuddihy and Stone 1990, pp. 67–69; Gon III and Tierney 1996, in litt.; Bio 2008, in litt.; Pratt 2008b, in litt.; Bio 2010, pers. comm.; HBMP 2010c; HBMP 2010f; HBMP 2010j; HBMP 2010k; PEPP 2010, pp. 101, 113; Pratt 2011f, in litt.; Crysdale 2013, pers. comm.).

Nonnative Fish

In Hawaii, the introduction of nonnative fish, including bait-fish, into anchialine pools has been a major contributor to the decline of native shrimp (TNC 1987 cited in Chan 1995, p. 1; Chan 1995, pp. 1, 8, 17–18; Brock and Kam 1997, p. 50; Brock 2004, p. 13–17; Kinzie 2012, in litt.). Predation by, and competition with, introduced nonnative fish is considered the greatest threat to native shrimp within anchialine pool ecosystems (Bailey-Brock and Brock 1993, p. 354; Brock 2004, pp. 13–17). These impacts are discussed further under *Factor E. Other Natural or Manmade Factors Affecting Their Continued Existence,* below.

Invertebrates

Nonnative Slugs

Predation by nonnative slugs adversely impacts 5 of the 13 plant species (*Cyanea marksii, Cyanea tritomantha, Cyrtandra nanawaleensis, Cyrtandra wagneri,* and *Stenogyne cranwelliae;* see Table 3) in this final rule through mechanical damage, destruction of plant parts, and mortality (U.S. Army Garrison 2006, p. 3–51; Joe 2006, p. 10; Lorence and Perlman 2007, p. 359; Bio 2008, in litt.; Perlman and Bio 2008, in litt.; HBMP 2010k). On Oahu, slugs have been reported to destroy the endangered plants *Cyanea calycina* and *Cyrtandra kaulantha* in the wild, and have been observed eating leaves and fruit of wild and cultivated individuals of *Cyanea* (Mehrhoff 1995, in litt.; Pratt and Abbott 1997, p. 13; U.S. Army Garrison 2006, pp. 3–34, 3–51). In addition, slugs have damaged individuals of other *Cyanea* and *Cyrtandra* species in the wild (Wood *et al.* 2001, p. 3; Sailer and Keir 2002, in litt., p. 3; PEPP 2007, p. 38; PEPP 2008, pp. 23, 49, 52–53, 57).

Little is known about predation of certain rare plants by slugs; however, information in the U.S. Army's 2005 ''Status Report for the Makua Implementation Plan'' indicates that slugs can be a threat to all species of *Cyanea* (U.S. Army Garrison 2006, p. 3–51). Research investigating slug herbivory and control methods shows that slug impacts on seedlings of *Cyanea* spp. results in up to 80 percent seedling mortality (U.S. Army Garrison 2006, p. 3–51). Slug damage has also been reported on other Hawaiian plants including *Argyroxiphium grayanum* (greensword), *Alsinidendron* sp., *Hibiscus* sp., the endangered plant *Schiedea kaalae* (maolioli), the endangered plant *Solanum sandwicense* (popolo aiakeakua), and *Urera* sp. (Gagne 1983, pp. 190–191; Sailer 2002 cited 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 the individuals of the endangered plants *Cyanea superba* and *Schiedea obovata* had 50 percent higher mortality when exposed to slugs when compared to individuals of the same species that were protected within slug exclosures. Slug damage has been documented on the plant *Stenogyne cranwelliae* (HBMP 2010k). As slugs are found in three of the described ecosystems (lowland wet, montane wet, and wet cliff) on Hawaii Island, the data from the above studies, in addition to direct observations from field biologists, suggest that slugs can directly damage or destroy native plants, including five of the plant species listed as endangered species in this final rule (*Cyanea marksii, C. tritomantha, Cyrtandra nanawaleensis, C. wagneri,* and *Stenogyne cranwelliae*).

Nonnative Western Yellow-Jacket Wasps

The western yellow-jacket wasp (*Vespula pensylvanica*) is a social wasp species native to the mainland of North America. It was first reported from Oahu in the 1930s (Nishida and Evenhuis in Sherley 2000, p. 121), and an aggressive race became established in 1977 (Gambino *et al.* 1987, p. 170). This species is now particularly abundant between 1,969 and 5,000 ft (600 and 1,524 m) in elevation (Gambino *et al.* 1990, pp. 1,088–1,095; Foote and Carson 1995, p. 371) on Kauai, Oahu, Molokai, Maui, Lanai, and Hawaii Island (GISD 2012b). The western yellow-jacket wasp is an aggressive, generalist predator (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 through a second year, allowing them to have larger numbers of individuals and thus a greater impact on prey populations (Gambino *et al.* 1987, pp. 169–170). In Haleakala National Park on Maui, western yellow-jacket wasps were found to forage predominantly on native arthropods (Gambino *et al.* 1987, pp. 169–170; Gambino *et al.* 1990, pp. 1,088–1,095; Gambino and Loope 1992, pp. 15–21). Western yellow-jacket wasps have also been observed carrying and feeding upon recently captured adult Hawaiian *Drosophila* (Kaneshiro and Kaneshiro 1995, pp. 40–45). These wasps are also believed to feed upon picture-wing fly larvae within their host plants (Carson 1986, pp. 3–9). In addition, native picture-wing flies, including the species in this final rule, may be particularly vulnerable to predation by wasps due to their lekking (male territorial defensive displays during courtship and mating) behavior and conspicuous courtship displays that can last for several minutes (Kaneshiro 2006, pers. comm.). The concurrent arrival of the western yellow-jacket wasp and decline of picture-wing fly observations in some areas suggest that the wasp may have played a significant role in the decline of some of the picture-wing fly populations, including populations of the picture-wing fly listed as endangered in this rule (Carson 1986, pp. 3–9; Foote and Carson 1995, p. 371; Kaneshiro and Kaneshiro 1995, pp. 40–45; Science Panel 2005, pp. 1–23). As the western yellow-jacket wasp is widespread within three ecosystems (lowland mesic, montane mesic, and montane wet) on Hawaii Island in which the two known occurrences of the picture-wing fly listed as endangered in this final rule occur, the results from the studies above, in addition to observations by field biologists, suggest that western yellow-jacket wasps can directly kill individuals of the picture-wing fly (Foote and Carson 1995, p. 371; Kaneshiro and Kaneshiro 1995, pp. 40–45; Science Panel 2005, pp. 1–23).

Nonnative Parasitoid Wasps

The number of native parasitic Hymenoptera (parasitic wasps) in Hawaii is limited, and only species in the family Eucoilidae are known to use Hawaiian picture-wing flies as hosts (Montgomery 1975, pp. 74–75; Kaneshiro and Kaneshiro 1995, pp. 44–45). However, several species of small parasitic wasps (Family Braconidae), including *Diachasmimorpha tryoni* (NCN), *D. longicaudata* (NCN), *Opius vandenboschi* (NCN), and *Biosteres arisanus* (NCN), were purposefully introduced into Hawaii to control nonnative pest tephritid fruit flies (Funasaki *et al.* 1988, pp. 105–160). These parasitic wasps are also known to attack other species of flies, including native flies in the family Tephritidae. While these parasitic wasps have not been recorded parasitizing Hawaiian picture-wing flies and, in fact, may not successfully develop in Drosophilidae, females will indiscriminately sting any fly larvae in their attempts to oviposit (lay eggs), resulting in mortality (Evans 1962, pp. 468–483). Because of this indiscriminate predatory behavior, we consider nonnative parasitoid wasps to represent a threat to the picture-wing fly listed as an endangered species in this final rule.

Nonnative Ants

Ants are not a natural component of Hawaii's arthropod fauna, and native species evolved in the absence of predation pressure from ants. Ants can be particularly destructive predators because of their high densities, recruitment behavior, aggressiveness, and broad range of diet (Reimer 1993, pp. 13–17). Ants can prey directly upon native arthropods, exclude them through interference or exploitation competition for food resources, or displace them by monopolizing nesting or shelter sites (Krushelnychy *et al.* 2005, p. 6). The threat of ant predation on the picture-wing fly species in this final rule is amplified by the fact that most ant species have winged reproductive adults (Borror *et al.* 1989, p. 738) and can quickly establish new colonies in additional suitable habitats (Staples and Cowie 2001, p. 55). These attributes allow some ants to destroy otherwise geographically isolated populations of native arthropods (Nafus 1993, pp. 19, 22–23).

At least 47 species of ants are known to be established in the Hawaiian Islands (Krushelnycky 2008, pp. 1–11), and at least 4 particularly aggressive species (the big-headed ant (*Pheidole megacephala*), the long-legged ant (also known as the yellow crazy ant) (*Anoplolepis gracilipes*), *Solenopsis papuana* (NCN), and *Solenopsis geminata* (NCN)) have severely impacted the native insect fauna, likely including native picture-wing flies (Reimer 1993, pp. 13–17). Numerous other species of ants are recognized as threats to Hawaii's native invertebrates, and an unknown number of new species are established every few years (Staples and Cowie 2001, p. 53). As a group, ants occupy most of Hawaii's habitat types, from coastal to subalpine ecosystems;

however, many species are still invading mid-elevation montane mesic forests, and few species have been able to colonize undisturbed montane wet ecosystems (Reimer 1993, pp. 13–17). The lowland forests are a portal of entry to the montane and subalpine ecosystems, and, therefore, because ants are actively invading increasingly elevated ecosystems, ants are more likely to occur in high densities in the lowland mesic and montane mesic ecosystems currently occupied by the picture-wing fly (Reimer 1993, pp. 13–17).

The big-headed ant originated in central Africa (Krushelnycky *et al.* 2005, p. 24) and was first reported in Hawaii in 1879 (Krushelnycky *et al.* 2005, p. 24). This species is considered one of the most invasive and widely distributed ants in the world (Holway *et al.* 2002, pp. 181–233; Krushelnycky *et al.* 2005, p. 5). In Hawaii, this species is the most ubiquitous ant species found, from coastal to mesic habitat up to 4,000 ft (1,219 m) in elevation, including within the habitat areas of the picture-wing fly listed as endangered in this rule. With few exceptions, native insects have been eliminated in habitats where the big-headed ant is present (Gagne 1979, p. 81; Gillespie and Reimer 1993, p. 22). Consequently, big-headed ants represent a threat to the picture-wing fly, in the lowland mesic and montane mesic ecosystems (Reimer 1993, pp. 14, 17; Holway *et al.* 2002, pp. 181–233; Daly and Magnacca 2003, pp. 9–10; Krushelnycky *et al.* 2005, p. 5).

The long-legged ant appeared in Hawaii in 1952, and now occurs on Hawaii, Kauai, Maui, and Oahu (Reimer *et al.* 1990, p. 42; *http://www.antweb.org,* 2011). It inhabits low-to-mid-elevation (less than 2,000 ft (600 m)), 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 the two known sites occupied by the picture-wing fly, we believe that the long-legged ant likely occurs within the lowland mesic ecosystem that supports the picture-wing fly due to the ant's aggressive nature and ability to spread and colonize new locations (Foote 2008, pers. comm.). Direct observations indicate Hawaiian arthropods are susceptible to predation by this species; Gillespie and Reimer (1993, p. 21) and Hardy (1979, pp. 37–38) documented the complete extirpation of several native insects within the Kipahulu area on Maui after this area was invaded by the long-legged ant. Lester and Tavite (2004, p. 391) found that long-legged ants in the Tokelau Atolls (New Zealand) can 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 upon invertebrates ranging from crabs to other ant species. On Christmas Island in the Indian Ocean, numerous studies have documented the range of impacts to native invertebrates, including the red land crab (*Gecarcoidea natalis*), as a result of predation by supercolonies of the long-legged ant (Abbott 2006, p. 102). Long-legged ants have the potential as predators to profoundly affect the endemic insect fauna in territories they occupy. Studies comparing insect populations at otherwise similar ant-infested and ant-free sites found extremely low numbers of large endemic noctuid moth larvae (*Agrotis* spp. and *Peridroma* spp.) in ant-infested areas. Nests of groundnesting colletid bees (*Nesoprosopis* spp.) were eliminated from ant-infested sites (Reimer *et al.* 1990, p. 42). Although only cursory observations exist in Hawaii (Reimer *et al.* 1990, p. 42), we believe long-legged ants are a threat to the picture-wing fly listed as endangered in this rule in the lowland mesic ecosystem.

Solenopsis papuana is the only abundant, aggressive ant that has invaded intact mesic to wet forest, as well as coastal and lowland dry habitats. This species occurs from sea level to over 2,000 ft (600 m) on all of the main Hawaiian Islands, and is still expanding its range (Reimer 1993, p. 14). Although surveys have not been conducted to ascertain this species' presence in either of the two known sites occupied by the picture-wing fly, because of the ant's expanding range and its widespread occurrence in coastal, lowland dry, and lowland mesic habitats, we believe *S. papuana* is a threat to the picture-wing fly in the lowland mesic and montane mesic ecosystems.

Like *Solenopsis papuana, S. geminata* is also considered a significant threat to native invertebrates (Gillespie and Reimer 1993, pp. 21–33) and occurs on all the main Hawaiian Islands (Reimer *et al.* 1990, p. 42; Loope and Krushelnycky 2007, p. 70). Found in drier areas of the Hawaiian Islands, it has displaced *Pheidole megacephala* as the dominant ant in some areas (Wong and Wong 1988, p. 175). Known to be a voracious, nonnative predator in many areas to where it has spread, the species was documented to significantly increase fruit fly mortality in field studies in Hawaii (Wong and Wong 1988, p. 175). 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 Whenua Landcare Research 2012—*Ant Distribution Database*). *Solenopsis geminata* was included among the eight species ranked as having the highest potential risk to New Zealand in a detailed pest risk assessment for the country (GISD 2012c), and is included as one of five ant species listed among the ''100 of the World's Worst Invaders'' (Manaaki Whenua Landcare Research 2012—*Ant Distribution Database*). Although surveys have not been conducted to ascertain this species' presence in either of the two sites occupied by the picture-wing fly, because of the ant's expanding range and its widespread occurrence in coastal, lowland dry, and lowland mesic habitats, it is a potential threat to the picture-wing fly in the lowland mesic ecosystem.

The Argentine ant (*Linepithema humile*) was discovered on the island of Oahu in 1940, and is now established on all the main Hawaiian Islands (Reimer *et al.* 1990, p. 42). Argentine ants do not disperse by flight, instead colonies are moved about with soil and construction material. The Argentine ant is found from coastal to subalpine ecosystems on the island of Maui, and on the slopes of Mauna Loa, in the lowland mesic and montane mesic ecosystems on Hawaii Island, the location of one of the two occurrences of the picture-wing fly (Hartley *et al.* 2010, pp. 83–94; Krushelnychy and Gillespie 2010, pp. 643–655). The Argentine ant has been documented to reduce populations of, or even eliminate, native arthropods in Haleakala National Park on Maui (Cole *et al.* 1992, pp. 1313–1322). On Maui, Argentine ants are significant predators on pest fruit flies (Wong *et al.* 1984, pp. 1454–1458), and Krushelychy and Gillespie (2010, pp. 643–655) found that Argentine ants on Hawaii Island are associated with the decline of an endemic phorid fly (*Megaselia* sp.). Krushelychy and Gillespie (2010, pp. 643–655) suggest that ants severely impact larval stages of many flies. While we are not aware of documented occurrences of predation by Argentine ants on picture-wing flies, including the species listed as endangered in this rule, these ants are considered to be a threat to native arthropods located at higher elevations (Cole *et al.* 1992, pp. 1313–1322) and thus potentially to the picture-wing fly that occurs from 2,000 ft to 4,500 ft (610 m to 1,372 m) in elevation, in the lowland mesic, montane mesic, and montane wet ecosystems on Hawaii Island (Science Panel 2005, pp. 1–23; Magnacca 2011b, pers. comm.).

The rarity or disappearance of native picture-wing fly species, including the species listed as endangered in this final rule, from historical observation sites over the past 100 years is due to a variety of factors. While there is no documentation that conclusively ties the decrease in picture-wing fly observations to the establishment of nonnative ants in lowland mesic, montane mesic, and montane wet ecosystems on Hawaii Island, the presence of nonnative ants in these habitats and the decline of picture-wing fly observations in some areas in these habitats suggest that nonnative ants may have played a role in the decline of some populations of the picture-wing fly listed as endangered in this rule. As nonnative predatory ants are found in three of the described ecosystems (lowland mesic, montane mesic, and montane wet) on Hawaii Island in which the picture-wing fly occurs, the data from the above studies, in addition to direct observations from field biologists, suggest that nonnative predatory ants contribute to the reduction in range and abundance of the picture-wing fly (Science Panel 2005, pp. 1–23).

Two-Spotted Leaf Hopper

Predation by the two-spotted leafhopper (*Sophonia rufofascia*) has been reported on plants in the genus *Pritchardia* throughout the main Hawaiian Islands and may be a threat to the plant *Pritchardia lanigera* in this final rule (Chapin *et al.* 2004, p. 279). This nonnative insect damages the leaves it feeds on, typically causing chlorosis (yellowing due to disrupted chlorophyll production) to browning and death of foliage (Jones *et al.* 2000, pp. 171–180). The damage to plants can result in the death of affected leaves or the whole plant, owing to the combined action of its feeding and oviposition behavior (Alyokhin *et al.* 2004, p. 1). In addition to the mechanical damage caused by the feeding process, the insect may introduce plant pathogens that lead to eventual plant death (Jones *et al.* 2006, p. 2). The two-spotted leafhopper is a highly polyphagous insect (it feeds on many different types of food). Sixty-eight percent of its recorded host plant species in Hawaii are fruit, vegetable, and ornamental crops, and 22 percent are endemic plants, over half of which are rare and endangered (Alyokhin *et al.* 2004, p. 6). Its range is limited to below 4,000 ft (1,219 m) in elevation, unless there is a favorable microclimate. While there has been a dramatic reduction in the number of two-spotted leafhopper populations between 2005 and 2007 (possibly due to egg parasitism), this nonnative insect has not been eradicated, and predation by this nonnative insect remains a threat (Fukada 2007, in litt.). Chapin *et al.* (2004, p. 279) believe that constant monitoring of both wild and cultivated *Pritchardia* populations will be necessary to abate this threat.

Nonnative Beetles

The Hawaiian Islands now support several species of nonnative beetles (family Scolytidae, genus *Coccotrypes*), a few of which bore into and feed on the nuts produced by certain native and nonnative palm trees, including those in the genus *Pritchardia* (Swezey 1927, in litt.; Science Panel 2005, pp. 1–23; Magnacca 2011b, pers. comm.). Species of *Coccotrypes* beetles prefer trees with large seeds, like those of *Pritchardia* spp. (Beaver 1987, p. 11). Trees of *Pritchardia* spp. drop their fruit before the fruit reaches maturity due to the boring action of the *Coccotrypes* spp. beetles, thereby reducing natural regeneration in the wild (Beaver 1987, p. 11; Magnacca 2005, in litt.; Science Panel 2005, pp. 1–23). The threat from *Coccotrypes* spp. beetles on *Pritchardia* spp. in Hawaii is expected to increase with time if the beetles are not controlled (Richardson 2011, pers. comm.). Although *Pritchardia* spp. are long-lived (up to 100 years), over time, *Coccotrypes* spp. beetles may severely impact Hawaiian species of *Pritchardia,* including *Pritchardia lanigera,* which is listed as endangered in this final rule.

Conservation Efforts To Reduce Disease or Predation

There are no approved HCPs, CCAs, or SHAs that specifically address these 15 species and threats from predation. We acknowledge that in the State of Hawaii there are several voluntary conservation efforts (e.g., construction of fences) that may be helping to ameliorate the threats to the 15 species listed as endangered in this final rule due to predation by nonnative animal species, specifically predation by feral ungulates on the 13 plants species. However, these efforts are overwhelmed by the number of threats, the extent of these threats across the landscape, and the lack of sufficient resources (e.g., funding) to control or eradicate them from all areas where these 15 species occur now or occurred historically. See ‘‘Conservation Efforts to Reduce Habitat Destruction, Modification, or Curtailment of Range’’ under *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range,* above, for a summary of some voluntary conservation actions to address threats from feral ungulates. We are unaware of voluntary conservation measures to address the following threats: (1) Predation by rats on 11 of the 13 plants; (2) predation by nonnative slugs on 5 of the 13 plant species; (3) predation by nonnative insects (e.g., western yellow-jacket wasp, ants, parasitoid wasps) on the picture-wing fly; and (4) predation by nonnative insects on *Pritchardia lanigera.*

Summary of Disease or Predation

We are unaware of any information that indicates that disease is a threat to any of the 15 species in this final rule.

Although conservation measures are in place in some areas where each of the 15 species in this final rule occurs, information does not indicate that they are ameliorating the threat of predation described above. Therefore, we consider predation by nonnative animal species (pigs, goats, cattle, sheep, mouflon sheep, rats, slugs, wasps, ants, the two-spotted leaf hopper, and beetles) to pose an ongoing threat to all 13 plant species and the picture-wing fly in this final rule throughout their ranges for the following reasons:

(1) Observations and reports have documented that pigs, goats, cattle, sheep, and mouflon sheep browse and trample all 13 plant species and the host plants of the picture-wing fly in this rule (see Table 3), in addition to other studies demonstrating the negative impacts of ungulate browsing and trampling on native plant species of the islands (Spatz and Mueller-Dombois 1973, p. 874; Diong 1982, p. 160; Cuddihy and Stone 1990, p. 67).

(2) Nonnative rats and slugs cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds), and are considered a threat to 11 of the 13 plant species in this rule (see Table 3). All of the plants and the picture-wing fly in this final rule are impacted by either introduced ungulates, as noted in item (1) above, or nonnative rats and slugs, or both.

(3) Predation of adults and larvae of Hawaiian picture-wing flies by the western yellow-jacket wasp has been observed, and it has been suggested that wasp predation has played a significant role in the dramatic declines of some populations of picture-wing flies (Carson 1986, pp. 3–9; Foote and Carson 1995, p. 371; Kaneshiro and Kaneshiro 1995, pp. 40–45; Science Panel 2005, pp. 1–23). Because western yellow-jacket wasps are found in the three

ecosystems in which the picture-wing fly is found, and western yellow-jacket wasps are known to prey on picture-wing flies, we consider predation by the western yellow-jacket wasp to be a serious and ongoing threat to *Drosophila digressa.*

(4) Parasitic wasps purposefully introduced to Hawaii to control nonnative pest fruit flies will indiscriminately sting any fly larvae when attempting to lay their eggs. Predation by one or more of these nonnative parasitic wasps is a threat to *Drosophila digressa.*

(5) Picture-wing flies are vulnerable to predation by ants, and the range of *Drosophila digressa* overlaps that of particularly aggressive, nonnative, predatory ant species that currently occur from sea level to the montane mesic ecosystem (over 3,280 ft (1,000 m) elevation) on all of the main Hawaiian Islands. We therefore consider predation by these nonnative ants to be a threat to *Drosophila digressa.*

(6) The plant *Pritchardia lanigera* is vulnerable to predation by nonnative invertebrates. The two-spotted leafhopper has been observed on plants in the genus *Pritchardia* throughout the main Hawaiian Islands, and poses a threat to *Pritchardia lanigera* (Chapin *et al.* 2004, p. 279). Two-spotted leafhopper damage results in the death of affected leaves or the entire plant (Alyokhin *et al.* 2004, p. 1). In addition, several species of nonnative beetles (*Coccotrypes* spp.) bore into and feed upon the seeds of the native palm genus *Pritchardia* (Swezey 1927, in litt.; Science Panel 2005, pp. 1–23; Magnacca 2011b, pers. comm.), which results in reduced natural regeneration of the plants (Beaver 1987, p. 11; Magnacca 2005, in litt.; Science Panel 2005, pp. 1–23).

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 Hawaii Island from grazing and browsing by axis deer are likely should this nonnative ungulate increase in numbers and range on the island.

Factor D. The Inadequacy of Existing Regulatory Mechanisms

Feral Ungulates

Nonnative ungulates pose a major ongoing threat to all 13 plant species, and to the picture-wing fly, through destruction and degradation of terrestrial habitat, and through direct predation of the 13 plant species (see Table 3). In addition, nonnative ungulates (feral goats and cattle) pose an ongoing threat to the anchialine pool shrimp through destruction and degradation of its anchialine pool habitat at Lua o Palahemo (feral ungulates are not reported to pose a threat to the anchialine pool habitat at Manuka). Feral goats and cattle trample and forage on both native and nonnative plants around and near the pool opening at Lua o Palahemo, and increase erosion around the pool and sediment entering the pool. The State of Hawaii provides game mammal (feral pigs, goats, cattle, sheep, and mouflon sheep) hunting opportunities on 42 State-designated public hunting areas on the island of Hawaii (H.A.R. 13–123; Mello 2011, pers. comm.). 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 (H.A.R. 13–123). Ten of the 13 plant species (*Cyanea marksii, Cyanea tritomantha, Cyrtandra nanawaleensis, Cyrtandra wagneri, Phyllostegia floribunda, Pittosporum hawaiiense, Platydesma remyi, Pritchardia lanigera, Schiedea hawaiiensis,* and *Stenogyne cranwelliae*) and the picture-wing fly have occurrences in areas where terrestrial habitat may be manipulated for game enhancement and where game populations are maintained at prescribed levels using public hunting (Perlman *et al.* 2001, in litt.; Perlman *et al.* 2004, in litt.; Lorence and Perlman 2007, pp. 357–361; PEPP 2007, p. 61; Pratt 2007a, in litt.; Pratt 2007b, in litt.; Benitez *et al.* 2008, p. 58; Agorastos 2010, in litt.; HBMP 2010c; HBMP 2010e; HBMP 2010f; HBMP 2010g; HBMP 2010h; HBMP 2010i; HBMPk; PEPP 2010, p. 63; Bio 2011, pers. comm.; Evans 2011, in litt.; Perry 2011, in litt.; Magnacca 2011b, pers. comm.; H.A.R. 13–123). Public hunting areas are 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 degradation and destruction for all 15 species, or the direct predation of the 13 plant species on Hawaii Island (see Table 3). However, the State game animal regulations are not designed nor intended to provide habitat protection, and there are no other regulations designed to address habitat protection from ungulates.

The capacity of Federal and State agencies and their nongovernmental partners in Hawaii to mitigate the effects of introduced pests, such as ungulates and weeds, is limited due to the large number of taxa currently causing damage (Coordinating Group on Alien Pest Species (CGAPS) 2009). Many invasive weeds established on Hawaii Island have currently limited but expanding ranges and are of concern. Resources available to reduce the spread of these species and counter their negative ecological effects are limited. Control of established pests is 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 invasive pests and management to reduce disturbance regimes that favor certain invasive species remain limited in scope. If current levels of funding and regulatory support for invasive species control are maintained on Hawaii Island, the Service expects existing programs to continue to exclude or, on a very limited basis, control invasive species only in high-priority areas. Threats from established pests (e.g., nonnative ungulates, weeds, and invertebrates) are ongoing and expected to continue into the future.

Introduction of Nonnative Species

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 pests of concern to Hawaii, especially insects or plant diseases not yet known to be present in the State (HDOA 2009). The U.S. Department of Homeland Security's 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 (processed and unprocessed); 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); seeds and plants listed as noxious; soil; and pests of concern to the greater United States, such as pests of mainland U.S. forests and agriculture. The U.S. Department of Agriculture's Animal and Plant Health Inspection Service, Plant Protection and Quarantine (USDA–APHIS–PPQ) inspects propagative plant material, provides identification services for arriving plants and pests, conducts pest risk assessments, trains CBP personnel, conducts permitting and preclearance inspections for products originating in foreign countries, and maintains a pest database that, again, has a focus on pests of wide concern across the United States. The Service inspects arriving wildlife products, with the goal of enforcing the injurious wildlife provisions of the Lacey Act (18 U.S.C. 42; 16 U.S.C. 3371 *et seq.*), and identifying CITES violations.

The State of Hawaii's unique biosecurity needs are not recognized by Federal import regulations. Under the USDA–APHIS–PPQ's commodity risk assessments for plant pests, regulations are based on species considered threats to the mainland United States and do not address many species that could be pests in Hawaii (Hawaii Legislative Reference Bureau (HLRB) 2002, pp. 1–109; USDA–APHIS–PPQ 2010, pp. 1–88; CGAPS 2009, pp. 1–14). Interstate commerce provides the pathway for invasive species and commodities infested with non-Federal quarantine pests to enter Hawaii. Pests of quarantine concern for Hawaii may be intercepted at Hawaiian ports by Federal agents, but are not always acted on by them because these pests are not regulated under Federal mandates. Hence, Federal protection against pest species of concern to Hawaii has historically 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. Therefore, that avenue may only provide minimal protection against the large diversity of foreign pests that threaten Hawaii.

Adequate staffing, facilities, and equipment for Federal and State pest inspectors and identifiers in Hawaii devoted to invasive species interdiction are critical biosecurity gaps (HLRB 2002, pp. 1–14; USDA–APHIS–PPQ 2010, pp. 1–88; CGAPS 2009, pp. 1–14). 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) H.R.S. 150A–5.3). Legislation passed and enacted on July 8, 2011 (H.B. 1568), requires commercial harbors and airports in Hawaii to provide biosecurity and inspection facilities to facilitate the movement of cargo through the ports. This enactment is a significant step toward optimizing the biosecurity capacity in the State of Hawaii; however, only time will determine the true effectiveness of this legislation. From a Federal perspective, there is a need to ensure that all civilian and military port and airport operations and construction are in compliance with the Federal Endangered Species Act of 1973, as amended. The introduction of new pests to the State of Hawaii is a significant risk to federally listed species because the existing regulations are inadequate for the reasons discussed in the sections below.

Nonnative Animal Species

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, pp. 1–109; CGAPS 2010, pp. 1–14). 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); the list of vertebrates considered ''injurious wildlife'' is provided at 50 CFR 16. However, the law in its current form has limited effectiveness in preventing invasive vertebrate introductions into the State of Hawaii due to the following factors: (1) The list of vertebrates considered as ''injurious wildlife'' and provided at 50 CFR 16 includes a relatively limited list of vertebrate species that are federally enforceable under the Lacey Act; (2) the current list of vertebrates that are considered ''injurious wildlife'' may not include injurious wildlife that are identified under individual State laws or regulations; and (3) listing additional vertebrate species under 50 CFR 16 may entail a long process or timeframe. On June 21, 2012, a new State law, Act 144 (''Relating to Wildlife''), was signed into law. Act 144 prohibits the interisland possession, transfer, transport, or release after transport of wild or feral deer, and establishes mandatory fines. On June 21, 2012, Act 149 (''Relating to Emergency Rules for Threats to Natural Resources or the Health of the Environment'') was also signed into State law. Act 149 expands the ability of State agencies to adopt emergency rules to address situations that impose imminent threats to natural resources (Aila 2012a, in litt.; Martin 2012, in litt.). However, the effectiveness of these two recently enacted laws has not yet been demonstrated.

Recently (2010–2011), unauthorized introduction of axis deer (*Axis axis*) to the island of Hawaii as a game animal has occurred (Kessler 2011, in litt.; Aila 2012a, in litt.). They have been observed in the regions of Kohala, Kau, Kona, and Mauna Kea (HDLNR 2011, in litt.). The Hawaii Department of Land and Natural Resources-Department of Forestry and Wildlife (HDLNR–HDOFAW) has developed a response-and-removal plan, including a partnership now underway between HDLNR, Hawaii Department of Agriculture (HDOA), the Big Island Invasive Species Committee (BIISC), Federal natural resource management agencies, ranchers, farmers, private landowners, and concerned citizens (*http://www.bigisland-bigisland.com/,* June 6, 2011). The partnership is working with animal trackers and game cameras to survey locations where axis deer have been observed in an effort to eradicate them on the island (*http://www.bigisland-bigisland.com/,* June 6, 2011; Osher 2012, in litt.). There is a high level of concern by the partnership due to the negative impacts of axis deer on agriculture and native ecosystems on neighboring islands (e.g., Maui) (Aila 2011, in litt.; Schipper 2011, in litt.; Aila 2012b, in litt.). In response to the presence of axis deer on Hawaii Island, the Hawaii Invasive Species Council drafted a bill to allow State agencies to adopt emergency rules in instances of imminent peril to the public health, safety, or morals, or to livestock and poultry health (Aila 2012a, in litt.). This was intended to address a gap in the current emergency rules authority, expanding the ability of State agencies to adopt emergency rules to address situations that impose imminent threats to natural resources (Aila 2012a, in litt.; Martin 2012, in litt.). This bill was enacted into State law on June 21, 2012.

Invertebrate Species

Predation by nonnative invertebrate pests (slugs, wasps, ants, leafhoppers, and beetles) negatively impacts 6 of the 13 the plant species and the picture-wing fly (see Table 3 and *Factor C. Disease or Predation,* above). 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. Although Hawaii State government and Federal agencies have regulations and some controls in place (see above), and a few private organizations are voluntarily addressing this issue, the introduction and movement of nonnative invertebrate pest species between islands and from one watershed to the next continues. For example, an average of 20 new alien invertebrate species have been introduced to Hawaii per year since 1970, an increase of 25 percent over the previous totals between 1930 and 1970 (The Nature Conservancy of Hawaii

(TNCH) 1992, p. 8). Existing regulatory mechanisms therefore appear inadequate to ameliorate the threat of introductions of nonnative invertebrates, and we have no evidence to suggest that any changes to these regulatory mechanisms are anticipated in the future.

Nonnative Plant Species

Nonnative plants destroy and modify habitat throughout the ranges of 14 of the 15 species listed as endangered in this final rule (see Table 3, above). As such, they represent a serious and ongoing threat to each of these species. In addition, nonnative plants have been shown to outcompete native plants and convert native-dominated plant communities to nonnative plant communities (see ''Habitat Destruction and Modification by Nonnative Plants,'' under *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range,* above).

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 2010). Hawaii's plant import rules (H.A.R. 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, prior to or following entry into the State. The State noxious weed list (H.A.R. 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. USDA–APHIS–PPQ is in the process of finalizing rules to include a weed risk assessment for newly imported plants. Although the State has general guidelines for the importation of plants, and regulations are in place regarding the plant crops mentioned above, the intentional or inadvertent introduction of nonnative plants outside the regulatory process and movement of species between islands and from one watershed to the next continues, which represents a threat to native flora for the reasons described 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. The author states the only thing that wide-scale public outreach can do in this regard is to let the public know new invasive plants are still being sold, and they should ask for noninvasive or native plants instead (Martin 2007, in litt.).

In 1995, the Coordinating Group on Alien and Plant Species (CGAPS), a partnership comprised primarily of managers from every major Federal, State, County, and private agency and organization involved in invasive species work in Hawaii, 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 and control of invasive species by providing policy-level direction and planning for the State departments responsible for invasive species issues. In 2003, the Governor signed into law Act 85, which conveys statutory authority to the HISC to continue to coordinate approaches among the various State and Federal agencies, and international and local initiatives for the prevention and control of invasive species (HDLNR 2003, p. 3–15; HISC 2009; H.R.S. 194–2(a)). Some of the recent priorities for the HISC include interagency efforts to control nonnative species such as the plants *Miconia calvescens* (miconia) and *Cortaderia* spp. (pampas grass), coqui frogs (*Eleutherodactylus coqui*), and ants (HISC 2009). Since 2009, State funding for HISC has been cut by approximately 50 percent (total funding dropped from $4 million in fiscal year FY 2009 to $2 million in FY 2010, and to $1.8 million for FY 2011 to FY 2013 (Atwood 2012, in litt.; Atwood 2013, in litt.). Congressional earmarks made up some of the shortfall in State funding in 2010 and into 2011. These funds supported ground crew staff that would have been laid off due to the shortfall in State funding (Clark 2012, in litt.). Following a 50-percent reduction from FY 2009 funding, the HISC budget has remained relatively flat (i.e., State funding is equal to funding provided in 2009) from FY 2010 to FY 2013 (Atwood 2013, in litt.).

Dumping of Trash and Introduction of Nonnative Fish

The Lua o Palahemo anchialine pool is located in a remote, largely undeveloped area, but is well known and frequently visited by residents and visitors for recreational opportunities, as indicated by the numerous off-road vehicle tracks around the pool (USFWS 2012 in litt.; Richardson 2012, in litt., pp. 1–2). As of the 2010 survey, a sign posted near Lua o Palahemo indicates that individuals who disturb the site are subject to fines under Haw. Rev. Stat. 6E (Hawaii's State Historic Preservation Act (SHPA)). This statute makes it unlawful for any person to take, appropriate, excavate, injure, destroy, or alter any historic property or aviation artifact located upon lands owned or controlled by the State or any of its political subdivisions, except as permitted by the State. Violators are subject to fines of not less than $500 nor more than $10,000 for each separate offense. However, regardless of the above warning, sometime between the 2010 survey and the June 2012 visit by Service biologists, the sign had been removed by unknown persons (Richardson 2012, in litt., pp. 1–2).

Three of the four anchialine pools in Manuka that support *Vetericaris chaceorum* are located between 10 and 33 ft (3 and 10 m) from the jeep road, which provides access to popular coastal fishing and recreational locations frequented by the public, and one pool is approximately 60 ft (18 m) from the road (Sakihara 2013, in litt.). The intentional introduction of nonnative freshwater fish is possible at these pools because there is evidence that at least one pool in Manuka harbors nonnative freshwater poeciliids (see Factors Affecting the 15 Species, below) and marine fish, likely introduced by fishermen. Three of the four anchialine pools are located in Manuka NAR. Prohibited activities in the State natural area reserve include, but are not limited to, the removal, injury, or killing of any plant or animal life (except game mammals and birds), the introduction of any plant or animal life, and littering or deposition of refuse or any other substance (NAR System-Title 13, Subtitle 9 Natural Area Reserve System, Chap. 209 Sect. 13–209–4 Prohibited activities). The minimum fine for anyone convicted of violation of any laws or rules applicable to the natural area reserve system is $1,000. The maximum fine that may be collected is $10,000 for a third violation within 5 years. The State may also initiate legal action to recover administrative costs. However, there are no signs in place informing the public about the unique animals that inhabit the anchialine pools, the threats posed by dumping fish in the pools, or the prohibitions against the introduction of plants or animals into the pools. In addition, there are no law enforcement officers or NAR staff assigned to regularly patrol the area for prohibited activities such as fish dumping in the anchialine pools (Hadway 2013, pers. comm.). Although the introduction of animals, such nonnative freshwater fish and marine fish, into Manuka NAR is a prohibited activity, an introduction has been documented in at least one pool in Manuka. Therefore, the existing State NARs rules are not adequately preventing the introduction of nonnative freshwater fish into the anchialine pools within the NAR.

On the basis of the above information, existing State and Federal regulatory mechanisms are not adequately preventing the introduction of nonnative species to Hawaii via interstate and international mechanisms, or intrastate movement of nonnative species between islands, and watersheds in Hawaii, and thus do not adequately protect each of the 13 plant species and the picture-wing fly in this final rule from the threat of new introductions of nonnative species, or from the continued expansion of nonnative species populations on and between islands and watersheds. Nonnative species prey upon species, modify or destroy habitat, or directly compete with one or more of these 14 species for food, space, and other necessary resources. The impacts from these introduced threats are ongoing and are expected to continue into the future.

In addition, the existing regulatory mechanisms do not provide adequate protection for the anchialine pool shrimp, *Vetericaris chaceorum,* from the intentional dumping of trash and introduction of nonnative fish into the pools that support this pool shrimp (at Lua o Palahemo and Manuka NAR, see above) (see *Factor E. Other Natural or Manmade Factors Affecting Their Continued Existence,* below). Existing regulatory mechanisms are therefore inadequate to ameliorate the threat of introductions of trash and nonnative fish into the pools that support the anchialine pool shrimp listed as endangered in this final rule, and we have no evidence to suggest that any changes to these regulatory mechanisms are anticipated in the future.

Summary of Inadequacy of Existing Regulatory Mechanisms

The State's current management of nonnative game mammals is inadequate to prevent the degradation and destruction of habitat of the 13 plant species, the anchialine pool shrimp, and the picture-wing fly (*Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range*), and to prevent predation of all 13 plant species and the host plants of the picture-wing fly *Drosophila digressa* (*Factor C. Disease or Predation*).

Existing State and Federal regulatory mechanisms are not effectively preventing the introduction and spread of nonnative species from outside the State of Hawaii and between islands and watersheds within the State of Hawaii. Habitat-altering, nonnative plant species (*Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range*) and predation by nonnative animal species (*Factor C. Disease or Predation*) pose a major ongoing threat to the 13 plant species and the picture-wing fly listed in this final rule.

Existing State and Federal regulatory mechanisms do not provide adequate protection for the anchialine pool shrimp *Vetericaris chaceorum,* from the intentional dumping of trash and introduction of nonnative fish into Lua o Palahemo and the four pools at Manuka that support the anchialine pool shrimp (see *Factor E. Other Natural or Manmade Factors Affecting Their Continued Existence*).

As all 13 plant species and the picture-wing fly experience threats from habitat degradation and loss by nonnative plants (*Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range*), and all 15 species experience threats from nonnative animals (including nonnative fish) (*Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range* and *Factor C. Disease or Predation*), we conclude the existing regulatory mechanisms are inadequate to sufficiently reduce these threats to all 15 species.

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

Other factors that pose threats to some or all of the 15 species include dumping of trash and the introduction of nonnative fish, small numbers of populations and small population sizes, hybridization, lack of or declining regeneration, loss of host plants, and other activities. Each threat is discussed in detail below, along with identification of which species are affected by these threats.

Dumping of Trash and Introduction of Nonnative Fish

The depressional features of anchialine pools make them susceptible to dumping. Refuse found in degraded pools and pools that have been filled in with rubble has been dated to about 100 years old, and the practice continues today (Brock 2004, p. 15). Lua o Palahemo, one of the two known locations of *Vetericaris chaceorum,* the anchialine pool shrimp listed in this final rule, is located approximately 558 ft (170 m) from a sandy beach frequented by visitors who fish and swim. In addition, there are multiple dirt roads that surround the pool, making it highly accessible. Plastic bags, paper, fishing line, water bottles, soda cans, radios, barbed wire, and a bicycle have been documented within the pool (Kensley and Williams 1986, pp. 417–418; Bozanic 2004, p. 1; Wada 2010, in litt.). Physical trash can increase the accumulation of sediment in the pool portion of Lua o Palahemo by plugging up the cracks and trapping sediments, which subsequently negatively impacts adequate water flushing. Also, physical trash can block the currently narrow passage into the much larger water body in the lava tube below. The degree of impact that trash imposes on a given anchialine pool habitat depends on the ratio between the size of the pool and the amount and type of trash (i.e., in a smaller pool, the negative impacts of trash on flushing would be greater because of the reduced aquatic substrate area). Introduction of trash involving chemical contamination into anchialine pools, as has been observed elsewhere on Hawaii Island (Brock 2004, pp. 15–16), will more drastically affect water quality and result in local extirpation of hypogeal shrimp species. Biologists did not record an accumulation of trash in the pool during the December 2012 survey (Wada 2012, in litt.). According to Sakihara, the pools at Manuka are threatened by nonnative species, trash, human waste, and physical alteration (at least one pool has been physically altered by the public). Dumping of trash has not been observed at the four pools that support *V. chaceorum* at Manuka, although trash dumping has been documented in and around other anchialine pools at Manuka, including at Keawaiki, where this species has been documented (Sakihara 2009, pp. 1, 21, 23, 25, 30). In addition, physical alteration (e.g., filling with trash such as aluminum cans and paper by campers), has been reported in at least one anchialine pool at Keawaiki, although it has not been observed in the four pools that support *V. chaceorum* (Sakihara 2009, pp. 4, 23, 25).

In general, the accidental or intentional introduction and spread of nonnative fish (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. The release of mosquito fish (*Gambusia affinis*) and tilapia (*Oreochromis mossambica* (synonym: *Tilapia mossambica*) into the Waikoloa Anchialine Pond Preserve (WAAPA) at Waikoloa, North Kona, Hawaii, resulted in the infestation of all ponds within an approximately 3.2-ha (8-ac) area, which represented approximately two-thirds of the WAAPA. Within 6 months, all native hypogeal shrimp species disappeared (Brock 2004, pp. iii). Nonnative fish drive anchialine species out of the lighted, higher productivity portion of the pools, into the surrounding water table bedrock, subsequently leading to the decimation of the benthic community structure of the pool (Brock 2004, p. iii). In addition, nonnative fish prey on and exclude native hypogeal shrimp that are usually a dominant and essential (Brock 2004, p. 16) faunal component of anchialine pool ecosystems (Bailey-Brock and Brock 1993, pp. 338–355). The loss of the shrimp changes ecological succession by reducing herbivory of macroalgae, allowing an overgrowth and change of pool flora. This overgrowth changes the system from clear, well-flushed basins to a system characterized by heavy sedimentation and poor water exchange, which increases the rate of pool senescence (Brock 2004, p. 16). Nonnative fish, unlike native fish, are able to complete their life cycles within anchialine habitats, and remain a permanent, detrimental presence in all pools into which they are introduced (Brock 2004, p. 16). In Hawaii, the most frequently illegally introduced fish are in the Poeciliidae family (freshwater fish that bear live young) and include mosquito fish, various mollies (*Poecilia* spp.), and tilapia, which prey on and exclude native hypogeal shrimp such as the herbivorous species upon which *Vetericaris chaceorum* presumably feed.

Lua o Palahemo is highly accessible to off-road vehicle traffic and located near an area frequented by residents and visitors for fishing and other outdoor recreational activities. The pool is vulnerable to the intentional dumping of trash and introduction of nonnative fish (bait and aquarium fish) because the area is easily accessible to vehicles and human traffic, and yet due to its remote location, is far from regulatory oversight by the DHHL or the Hawaii State Deparment of Aquatic Resources (DAR). According to Brock (2012, pers. comm.), sometime in the 1980s, nonnative fish were introduced into Lua o Palahemo. It is our understanding that the fish were subsequently removed with a fish poison, and to our knowledge the pool currently remains free of nonnative fish. The most commonly used piscicide (fish pesticide) in the United States for management of fish in freshwater systems is a naturally occurring chemical, marketed as Rotenone. Rotenone use in marine systems (including anchialine pools) is illegal according to the Environmental Protection Agency (EPA 2007, pp. 22–23, 29, 32; Finlayson et al. 2010, p. 2).

Three of the four pools that support *Vetericaris chaceorum* at Manuka are located between 10 and 33 ft (3 and 10 m) from a jeep road that provides access to coastal fishing and recreational locations frequented by the public (Sakihara 2013, in litt.). The fourth pool is approximately 60 ft (18 m) from the jeep road (Sakihara 2013, in litt.). The pools are vulnerable to the intentional dumping of trash and introduction of nonnative fish because trash dumping has been documented in and around anchialine pools at Manuka, including at Keawaiki, where this species has been documented (Sakihara 2009, pp. 21, 25, 30), and nonnative freshwater poeciliids (fish in the Poeciliidae family and that bear live young) have been introduced and established in at least one pool in the Manuka pool complex (Sakihara 2012, in litt.). This pool is approximately 0.3 mi (0.5 km) from the four pools that support *V. chaceorum.* Marine fish have been detected in the same pool, and it is speculated that these fish were intentionally introduced into the pool by fishermen (Sakihara 2012, in litt.). Recreational users utilize anchialine pools as ''holding pools'' for bait fish (e.g., nonnative freshwater fish like tilapia, mosquito fish, and marine fish like aholehole (*Kuhlia* sp.) and kupipi (blackspot sergeant; *Abudefduf sordidus*)) used for fishing (Wada 2013, in litt.). The impacts of native marine fish on *V. chaceorum* are unknown. In addition, the pools that support *V. chaceorum* at Manuka are vulnerable to intentional physical alteration because at least one anchialine pool at Keawaiki (where this species has been documented) has been altered, although pool alteration has not been observed in the four pools that support *V. chaceorum* (Sakihara 2009, p. 23).

As the anchialine pool shrimp *Vetericaris chaceorum* is only known from two locations, the introduction of nonnative fish, which prey on and exclude native hypogeal shrimp like *V. chaceorum* or its associated prey shrimp species, would lead to the extirpation of this species at one or both of its known locations, directly or indirectly due to the lower abundance of co-occurring shrimp species that provide food resources to *V. chaceorum.* In addition, the loss of native shrimp species leads to changes in ecological succession in anchialine pools, leading to senescence of the pool habitat, thereby rendering the pool unsuitable habitat (Brock 2004, p. 16). Dumping of nonnative fish into one or more of the three anchialine pools at Manuka, which are believed to have a subterranean connection, would impact the integrity of all three pools should nonnative fish spread from the pool of introduction to the other two pools. Although not common, experts agree that the dumping of nonnative fish can happen (Sakihara 2013, in litt.; Wada 2013, pers. comm.). A fourth pool that supports *V. chaceorum* is not believed to have a subterranean connection to other pools at Manuka.

Recreational Use of Off-Road Vehicles

Off-road vehicles frequent the area surrounding the Lua o Palahemo anchialine pool that supports one of the two known occurrences of *Vetericaris chaceorum,* resulting in increased erosion and accumulation of sediment, which negative impacts the anchialine pool habitat. The negative impacts from sedimentation are discussed under *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range,* above (Richarson 2012, in litt.)

Small Number of Individuals and Populations

Species that are endemic to single islands are inherently more vulnerable to extinction than are widespread species, because of the increased risk of genetic bottlenecks; random demographic fluctuations; climate change effects; and localized catastrophes, such as hurricanes, drought, rockfalls, landslides, and disease outbreaks (Pimm *et al.* 1988, p. 757; Mangel and Tier 1994, p. 607). These problems are further magnified when populations are few and restricted to a very small geographic area, and when the number of individuals in each population is very small. Populations with these characteristics face an increased likelihood of stochastic extinction due to changes in demography, the environment, genetics, or other factors (Gilpin and Soulé 1986, pp. 24–34). Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (e.g., Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). Very small, isolated populations are also more susceptible to reduced reproductive vigor due to ineffective pollination (plants), inbreeding depression (plants and shrimp), and hybridization (plants and flies). The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as those discussed above (see *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range* and *Factor C. Disease or Predation,* above).

Plants

A limited number of individuals (fewer than 50 individuals) is a threat to the following six plant species listed as endangered in this final rule: *Bidens hillebrandiana* ssp. *hillebrandiana, Cyanea marksii, Cyrtandra wagneri, Platydesma remyi, Schiedea diffusa* ssp. *macraei,* and *S. hawaiiensis.* We consider these species highly vulnerable to extinction due to threats associated with small population size or small number of populations because:

- The only known occurrences of *Bidens hillebrandiana* ssp. *hillebrandiana, Cyanea marksii,* and *Cyrtandra wagneri* are threatened either by landslides, rockfalls, inundation by high surf, or erosion, or a combination of these, because of their locations in lowland wet, montane wet, coastal, and dry cliff ecosystems.
- *Platydesma remyi* is known from fewer than 40 scattered individuals (Stone *et al.* 1999, p. 1210; HBMP 2010i). Declining or lack of regeneration in the wild appears to threaten this species.
- *Schiedea diffusa* ssp. *macraei* is known from a single individual in the Kohala Mountains (Perlman *et al.* 2001, in litt.; Wagner *et al.* 2005d, p. 106; HBMP 2010j; Bio 2011, pers. comm.).
- Habitat destruction or direct predation by ungulates, nonnative plants, drought, and fire are threats to the 25 to 40 individuals of *Schiedea hawaiiensis* (Mitchell *et al.* 2005a; NDMC 2012—*Online Archives*).

Animals

Like most native island biota, the endemic anchialine pool shrimp and Hawaiian picture-wing fly are particularly sensitive to disturbances due to low number of individuals, low population numbers, and small geographic ranges. We consider the picture-wing fly vulnerable to extinction due to threats associated with low number of individuals and low number of populations because *Drosophila digressa* is known from only two of its five historically known locations. The following threats to this species have all been documented: Predation by nonnative wasps and ants; habitat degradation and destruction by nonnative ungulates, fire, and drought; loss of its host plants; and competition with nonnative flies for its host plants (Science Panel 2005, pp. 1–23; Magnacca 2011b, pers. comm.).

Hybridization

Natural hybridization is a frequent phenomenon in plants and can lead to the formation of new species (Orians 2000, p. 1,949), or sometimes to the decline of species through genetic assimilation or ''introgression'' (Ellstrand 1992, pp. 77, 81; Levine *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 three species, and potentially a threat to one more additional species in this final rule because hybridization may lead to extinction of the original genotypically distinct species. Hybrid swarms (hybrids between parent species, and subsequently formed progeny from crosses among hybrids and crosses of hybrids to parental species) have been reported between the plant *Bidens micrantha* ssp. *ctenophylla* and *B. menziesii* ssp. *filiformis* near Puuwaawaa in north Kona (Ganders and Nagata 1983, p. 12; Ganders and Nagata 1999, p. 278); the plant *Cyrtandra nanawaleensis* is known to hybridize with *C. lysiosepala* in and around the Nanawale FR (Price 2011, in litt.); and *Cyrtandra wagneri* is reported to hybridize with *C. tintinnabula.* Only eight individuals express the true phenotype of *C. wagneri,* and only three of these individuals are reproducing successfully (PEPP 2010, p. 102; Bio 2011, pers. comm.). Native species can also hybridize with related nonnative species. For example, native species of *Pittosporum,* including the plant *Pittosporum hawaiiense,* are known to exhibit high levels of gene flow, and hybridization between native *Pittosporum* and nonnative species of *Pittosporum* may occur when they occupy similar habitat and elevation (Daehler and Carino 2001, pp. 91–96; Bacon *et al.* 2011, p. 733).

Regeneration

Lack of, or low levels of, regeneration (reproduction and recruitment) in the wild has been observed, and is a threat to, *Pittosporum hawaiiense, Platydesma remyi,* and *Pritchardia lanigera* (Bio 2011, pers. comm.; Magnacca 2011b, pers. comm.). The reasons for this are not well understood: however, seed predation by rats, ungulates, and beetles is thought to play a role (Bio 2011, pers. comm.; Magnacca 2011b, pers. comm.; Crysdale 2013, pers. comm.). In addition, *Cyanea tritomantha* is reported to produce few seeds with low viability. The reasons for this are unknown (Bio 2008, in litt.).

Competition

Competition with nonnative tipulid flies (large crane flies, family Tipulidae) for larvae host plants adversely impacts the picture-wing fly listed in this final rule. The Hawaiian Islands now support several species of nonnative tipulid flies, and the larvae of some species within this group feed within the decomposing bark of some of the host plants utilized by picture-wing flies, including *Cheirodendron, Clermontia, Pleomele,* and *Charpentiera,* one of the two host plants for *Drosophila digressa* (Science Panel 2005, pp. 1–23; Magnacca 2005, in litt.). The effect of this competition is a reduction of available host plant material for the larvae of the picture-wing fly. In laboratory studies, Grimaldi and Jaenike (1984, pp. 1,113–1,120) demonstrated that competition between *Drosophila* larvae and other fly larvae can exhaust food resources, which affects both the probability of larval survival and the body size of adults, resulting in reduced adult fitness, fecundity, and lifespan. Both soldier and neriid flies have been suggested to impose a similar threat to Hawaiian picture-wing flies (Montgomery 2005, in litt.; Science Panel 2005, pp. 1–23).

Loss of Host Plants

Drosophila digressa is dependent on decaying stem bark from plants in the genera *Charpentiera* and *Pisonia* for oviposition and larval development (Montgomery 1975, p. 95; Magnacca 2013, in litt.). *Charpentiera* and *Pisonia* are considered highly susceptible to damage from alien ungulates, such as pigs, cattle, mouflon, and goats, as well as competition with nonnative plants (e.g., *Omalanthus populifolius, Schinus terebinthifolius,* and *Psidium cattleianum*) (Foote and Carson 1995, pp. 370–37; Science Panel 2005, pp.

1–23; Magnacca 2011b, pers. comm.; Magnacca 2013, in litt.). Bark-breeding *Drosophila* species are sensitive to bottlenecks in host plant populations due to their dependence on older, senescent, or dying plants (Magnacca *et al.* 2008, p. 32). Altered decay cycles in host plants caused by genetic bottlenecks, or decreasing availability of host plants due to browsing and trampling by nonnative ungulates (pigs, goats, cattle, and mouflon), competition with nonnative plants, drought, or other phenomena can subsequently alter the life cycle of the picture-wing fly by disrupting the early stages of development. The habitat of *Drosophila digressa* at Manuka has experienced extreme to severe drought for several years, which has resulted in overall habitat degradation and appears to alter decay processes in the picture-wing fly host plants (both *Charpentiera* spp. and *Pisonia* spp.). Magnacca (2013, in litt.) anticipates an alteration in host plant decay will lead to a long-term decline in availability of host plants that can support the life-history requirements of *D. digressa* (see ''Habitat Destruction and Modification Due to Rockfalls, Treefalls, Landslides, Heavy Rain, Inundation by High Surf, Erosion, and Drought,'' above). In addition, predation by nonnative beetles (the branch and twig borer (*Amphicerus cornutus*), the black twig borer (*Xylosandrus compactus*), and weevils (*Oxydema fusiforme*) has been documented as a threat to *Charpentiera* spp. (Medeiros *et al.* 1986, p. 29; Giffin 2009, p. 81).

Conservation Efforts To Reduce Other Natural or Manmade Factors Affecting Their Continued Existence

There are no approved HCPs, CCAs, SHAs, MOUs, or other voluntary actions that specifically address these 15 species and the threats from other natural or manmade factors. We are unaware of any voluntary conservation actions to address the threat of dumping of trash and introduction of nonnative fish into anchialine pools that support the anchialine pool shrimp, *Vetericaris chaceorum,* which is listed as endangered in this final rule. The State's PEP Program identified 8 of the 13 plant species (*Cyanea marksii, Cyrtandra wagneri, Phyllostegia floribunda, Pittosporum hawaiiense, Platydesma remyi, Schiedea diffusa* ssp. *macraei, S. hawaiiensis,* and *Stenogyne cranwelliae*) in this final rule as priority species for collection, propagation, and outplanting; however, due to other workload priorities and limited funding, they have not been able to carry out all of these actions (PEPP 2012, pp. 1–169). While the actions they have been able to implement are a step toward increasing the overall numbers and populations of PEPP species in the wild, these actions are insufficient to eliminate the threat of limited numbers at this time. In addition, successful reproduction and replacement of outplanted individuals by seedlings, juveniles, and adults has not yet been observed in the wild. We are unaware of any voluntary conservation actions to address the threat to the picture-wing fly from low number of individuals. We are unaware of any voluntary conservation actions to address the threat to three plant species from hybridization, the threat of lack of regeneration to four plant species, or the threats from competition with nonnative tipulid flies and the loss of host plants for the picture-wing fly.

Summary of Other Natural or Manmade Factors Affecting Their Continued Existence

The conservation measures described above are insufficient to eliminate the threat from other natural or manmade factors to each of the 15 species listed as endangered in this final rule. We consider the threats from dumping of trash and introduction of nonnative fish into the pools that support the anchialine pool shrimp in this final rule to be serious threats that can occur at any time, although their occurrence is not predictable. The use of anchialine pools for dumping of trash and introduction of nonnative fish are widespread practices in Hawaii and can occur at any time at the Lua o Palahemo and Manuka pools. Nonnative fish prey on or outcompete native, herbivorous anchialine pool shrimp that serve as the prey base for predatory species of shrimp, including the anchialine pool shrimp listed as endangered in this rule. In addition, recreational use of off-road vehicles that frequent Lua o Palahemo are a threat to the shrimp, due to the resulting erosion and sedimentation that builds up in the pool (for impacts associated with sedimentation, see *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range,* above; and for impacts associated with off-road vehicles, see *Factor E. Other Natural or Manmade Factors Affecting Their Continued Existence,* above). The occurrence of off-road vehicle traffic is not predictable; however, it happens frequently and is expected to continue.

We consider the threat from limited number of populations and few (less than 50) individuals to be a serious and ongoing threat to 6 plant species in this final rule (*Bidens hillebrandiana* ssp. *hillebrandiana, Cyanea marksii, Cyrtandra wagneri, Platydesma remyi, Schiedea diffusa* ssp. *macraei,* and *S. hawaiiensis*) because: (1) These species may experience reduced reproductive vigor due to ineffective pollination or inbreeding depression; (2) they may experience reduced levels of genetic variability, leading to diminished capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence; and (3) a single catastrophic event may result in extirpation of remaining populations and extinction of the species. This threat applies to the entire range of each species.

The threat to the picture-wing fly from limited numbers of individuals and populations is ongoing and is expected to continue into the future because: (1) This species may experience reduced reproductive vigor due to inbreeding depression; (2) it may experience reduced levels of genetic variability leading to diminished capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence; (3) a single catastrophic event (e.g., hurricane, drought) may result in extirpation of remaining populations and extinction of this species; and (4) species with few known locations, such as *Drosophila digressa,* are less resilient to threats that might otherwise have a relatively minor impact on widely distributed species. For example, the reduced availability of host trees or an increase in predation of the picture-wing fly adults that might be absorbed in a widely distributed species could result in a significant decrease in survivorship or reproduction of a species with limited distribution. The limited distribution of this species thus magnifies the severity of the impact of the other threats discussed in this final rule.

The threat from hybridization is unpredictable but an ongoing and ever-present threat to *Bidens micrantha* ssp. *ctenophylla, Cyrtandra nanawaleensis,* and *Cyrtandra wagneri,* and a potential threat to *Pittosporum hawaiiense.* We consider the threat to *Cyanea tritomantha, Pittosporum hawaiiense, Platydesma remyi,* and *Pritchardia lanigera* from lack of regeneration to be ongoing and to continue into the future because the reasons for the lack of recruitment in the wild are unknown and uncontrolled, and any competition from nonnative plants or habitat modification by ungulates or fire could lead to the extirpation of these species.

Competition for host plants with nonnative tipulid flies is a threat to *Drosophila digressa* and is expected to continue into the future because field biologists report that these nonnative flies are widespread and there is no mechanism in place to control their population growth. Loss of host plants (*Charpentiera* spp. and *Pisonia* spp.) is a threat to the picture-wing fly, and we consider this threat to continue into the future because field biologists have reported that species of *Charpentiera* and *Pisonia* are declining overall in the wild (see *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range* and *Factor C. Disease or Predation,* above).

Summary of Factors

The primary factors that pose serious and ongoing threats to one or more of the 15 species throughout their ranges in this final rule include: Habitat degradation and destruction by agriculture and urbanization, nonnative ungulates and plants, fire, natural disasters, sedimentation, and potentially climate change, and the interaction of these threats (Factor A); overutilization due to collection of seeds and seedlings of the plant *Pritchardia lanigera* for trade or market (Factor B); predation by nonnative animal species (pigs, goats, sheep, mouflon sheep, cattle, rats, nonnative fish, slugs, wasps, ants, two-spotted leaf hopper, and beetles) (Factor C); inadequate regulatory mechanisms to address nonnative species, and human dumping of nonnative fish and trash into anchialine pools (Factor D); and dumping of trash, introduction of nonnative fish, recreational use, limited numbers of populations and individuals, hybridization, lack of regeneration, competition, and loss of host plants (Factor E). While we acknowledge the voluntary conservation measures described above may help to ameliorate one or more of the threats to the 15 species listed as endangered in this final rule, these conservation measures are insufficient to control or eradicate these threats from all areas where these species occur now or occurred historically.

Determination

We have carefully assessed the best scientific and commercial information available regarding threats to each of the 15 species. We find that each of the 13 plant species and the picture-wing fly face threats that are ongoing and expected to continue into the future throughout their ranges from the present destruction and modification of their habitats from nonnative feral ungulates and nonnative plants (Factor A). Destruction and modification of habitat by development and urbanization is a threat to one plant species (*Bidens micrantha* ssp. *ctenophylla*). Habitat destruction and modification from fire is a threat to three of the plant species (*Bidens micrantha* ssp. *ctenophylla, Phyllostegia floribunda,* and *Schiedea hawaiiensis*) and the picture-wing fly *Drosophila digressa.* Destruction and modification of habitat from rockfalls, landslides, treefalls, heavy rain, inundation by high surf, and subsequent erosion are a threat to four plant species (*Bidens hillebrandiana* ssp. *hillebrandiana, Cyanea marksii, Cyanea tritomantha,* and *Cyrtandra wagneri*). Habitat loss or degradation due to drought is a threat to two plants, *Bidens micrantha* ssp. *ctenophylla* and *Schiedea hawaiiensis,* as well as to the picture-wing fly. We are concerned about the effects of projected climate change on all 15 species, particularly rising temperatures, but recognize there is limited information on the exact nature of impacts that these species may experience.

We find that the anchialine pool shrimp faces threats that are ongoing and expected to continue into the future from the present destruction and modification of its anchialine pool habitat at Lua o Palahemo, one of only two known locations for this species, due to sedimentation resulting from degradation of the immediate area surrounding this anchialine pool from nonnative feral ungulates (cattle and goats). Sedimentation reduces both food productivity and the ability of Lua o Palahemo to support the anchialine pool shrimp (Factor A).

Overcollection for commercial and recreational purposes poses a threat to *Pritchardia lanigera* (Factor B).

Predation and herbivory on all 13 plant species by feral pigs, goats, cattle, sheep, mouflon, rats, slugs, two-spotted leaf hoppers, or beetles poses a serious and ongoing threat, as does predation of the picture-wing fly by nonnative wasps and ants (Factor C).

Existing regulatory mechanisms are inadequate to reduce current and ongoing threats posed by nonnative plants and animals to all 15 species, and human dumping of nonnative fish and trash into the anchialine pools that support the anchialine pool shrimp *Vetericaris chaceorum* (Factor D).

There are serious and ongoing threats to six plant species (*Bidens hillebrandiana* ssp. *hillebrandiana, Cyanea marksii, Cyrtandra wagneri, Platydesma remyi, Schiedea diffusa* ssp. *macraei,* and *S. hawaiiensis*) and the picture-wing fly due to factors associated with small numbers of populations and individuals; to *Bidens micrantha* ssp. *ctenophylla, Cyrtandra nanawaleensis, Cyrtandra wagneri,* and potentially to *Pittosporum hawaiiense* from hybridization; to *Cyanea tritomantha, Pittosporum hawaiiense, Platydesma remyi,* and *Pritchardia lanigera* from the lack of regeneration in the wild; and to the picture-wing fly from competition for host plants with nonnative flies and declining numbers of host plants (Factor E) (see Table 3).

The anchialine pool shrimp faces threats from the intentional dumping of trash and introduction of nonnative fish into its pool habitat in the two known locations. In addition, the pools that support *Vetericaris chaceorum* at Lua o Palahemo are potentially vulnerable to intentional physical alteration (i.e., sedimentation) (Bailey-Brock and Brock 1993, pp. 338–355; Brock 2004, pp. iii and 16) (Factor E) (see Table 3).

These threats are exacerbated by these species' inherent vulnerability to extinction from stochastic events at any time because of their endemism, small numbers of individuals and populations, and restricted habitats.

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 these 15 endemic species is presently in danger of extinction throughout its entire range, based on the severity and scope of the ongoing and projected threats described above. These threats are exacerbated by small population sizes, the loss of redundancy and resiliency of these species, and the continued inadequacy of existing protective regulations. Based on our analysis, we have no reason to believe that population trends for any of the species that are the subjects of this final rule will improve, nor will the negative impacts of current threats acting on the species be effectively ameliorated in the future. Therefore, on the basis of the best available scientific and commercial information, we are listing the following 15 species as endangered species in accordance with section 3(6) of the Act: The plants *Bidens hillebrandiana* ssp. *hillebrandiana, Bidens micrantha* ssp. *ctenophylla, Cyanea marksii, Cyanea tritomantha, Cyrtandra nanawaleensis, Cyrtandra wagneri, Phyllostegia floribunda, Pittosporum hawaiiense, Platydesma remyi, Pritchardia lanigera, Schiedea diffusa* ssp. *macraei, Schiedea hawaiiensis,* and *Stenogyne cranwelliae;* the anchialine pool shrimp, *Vetericaris chaceorum;* and the picture-wing fly, *Drosophila digressa.*

Under the Act and our implementing regulations, a species may warrant listing if it is endangered or threatened throughout all or a significant portion of its range. Each of the 15 Hawaii Island species listed as endangered in this final rule is highly restricted in its range, and the threats occur throughout its range. Therefore, we assessed the status of each species throughout its entire range. In each case, the threats to the survival of these species occur throughout the species' ranges and are not restricted to any particular portion of those ranges. Accordingly, our assessment and determination applies to each species throughout its entire range.

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 requires that recovery actions be carried out for all listed species. The protection measures required of 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 requires 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, preparation of a draft and final recovery plan, and revisions to the plan as significant new information becomes available. The recovery outline guides the immediate implementation of urgent recovery actions and describes the process to be used to develop a recovery plan. The recovery plan identifies site-specific management actions that will achieve recovery of the species, measurable criteria that help to determine when a species may be downlisted or delisted, and methods for monitoring recovery progress. Recovery plans also establish a framework for agencies to coordinate their recovery efforts and provide estimates of the cost of implementing recovery tasks. Recovery teams (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 from 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.

Funding for recovery actions may 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, under section 6 of the Act, the State of Hawaii will be eligible for Federal funds to implement management actions that promote the protection and recovery of the 15 species. Information on our grant programs that are available to aid species recovery can be found at: *http://www.fws.gov/grants.*

Please let us know if you are interested in participating in recovery efforts for 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)(1) of the Act mandates that all Federal agencies shall utilize their authorities in furtherance of the purposes of the Act by carrying out programs for the conservation of endangered and threatened species listed pursuant to section 4 of the Act. Section 7(a)(2) of the Act requires Federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species or result in destruction or adverse modification of critical habitat. If a Federal action may affect the continued existence of a listed species or its critical habitat, the responsible Federal agency must enter into consultation with the Service.

For the 15 plants and animals listed as endangered species in this final 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, 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 all endangered wildlife and plants. The prohibitions, codified at 50 CFR 17.21 for wildlife and 17.61 for plants, apply. These prohibitions, in part, make it illegal for any person subject to the jurisdiction of the United States to take (includes harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or to attempt any of these), import, export, ship in interstate commerce in the course of commercial activity, or sell or offer for sale in interstate or foreign commerce any listed wildlife species. It is also illegal to possess, sell, deliver, carry, transport, or ship any such wildlife that has been taken illegally. In addition, for plants listed as endangered, the Act prohibits the malicious damage or destruction on areas under Federal jurisdiction and the removal, cutting, digging up, or damaging or destroying of such plants in knowing violation of any State law or regulation, including State criminal trespass law. Certain exceptions to the prohibitions apply to agents of the Service and State conservation agencies.

We may issue permits to carry out otherwise prohibited activities involving endangered or threatened wildlife or plant species under certain circumstances. Regulations governing permits are codified at 50 CFR 17.22 and 17.62 for endangered wildlife and plants, respectively. With regard to endangered wildlife, a permit must be issued for the following purposes: For scientific purposes, to enhance the propagation and survival of the species, and for incidental take in connection with otherwise lawful activities. For endangered plants, a permit must be issued for scientific purposes or for the enhancement of propagation or survival. Requests for copies of the regulations regarding listed species and inquiries about prohibitions and permits may be addressed to U.S. Fish and Wildlife Service, Pacific Region, Ecological Services, Eastside Federal Complex, 911 NE. 11th Avenue, Portland, OR 97232–4181 (telephone 503–231–6131; facsimile 503–231–6243).

It is our policy, as published in the **Federal Register** on July 1, 1994 (59 FR 34272), to identify to the maximum extent practicable at the time a species is listed, those activities that would or would not constitute a violation of section 9 of the Act. The intent of this policy is to increase public awareness of the effect of a listing on proposed and ongoing activities within the range of listed species. The following activities could potentially result in a violation of section 9 of the Act; however, 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 picture-wing fly or anchialine pool shrimp by causing significant habitat modification or degradation such that it causes actual injury by significantly impairing its essential behavior patterns. This may include introduction of nonnative species that compete with or prey upon the picture-wing fly or anchialine pool shrimp, or the unauthorized release of biological control agents that attack any life stage of these two species; and

(3) Damaging or destroying any of the 13 listed plants in violation of the Hawaii State law prohibiting take of listed species.

Questions regarding whether specific activities would constitute a violation of section 9 of the Act should be directed to the Pacific Islands Fish and Wildlife Office (see **FOR FURTHER INFORMATION CONTACT**). Requests for copies of the regulations concerning listed animals and general inquiries regarding prohibitions and permits may be addressed to the U.S. Fish and Wildlife Service, Pacific Region, Ecological Services, Endangered Species Permits, Eastside Federal Complex, 911 NE. 11th Avenue, Portland, OR 97232–4181 (telephone 503–231–6131; facsimile 503–231–6243).

Federal listing of the 15 species included in this rule automatically invokes State listing under Hawaii's Endangered Species law (H.R.S. 195D 1–32) and supplements the protection available under other State laws. These protections prohibit take of these species and encourage conservation by State government agencies. Further, the State may enter into agreements with Federal agencies to administer and manage any area required for the conservation, management, enhancement, or protection of endangered species (H.R.S. 195D–5). Funds for these activities could be made available under section 6 of the Act (Cooperation with the States). Thus, the Federal protection afforded to these species by listing them as endangered species is reinforced and supplemented by protection under State law.

Required Determinations

National Environmental Policy Act (NEPA)

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 rule is available on the Internet at *http://www.regulations.gov* under Docket No. FWS–R1–ES–2012–0070 and upon request from the Pacific Islands Fish and Wildlife Office (see **ADDRESSES,** above).

Authors

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

List of Subjects in 50 CFR Part 17

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

Regulation Promulgation

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

PART 17—AMENDED

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

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

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

■ a. By adding an entry for ''Fly, Hawaiian picture-wing'' in alphabetical order under INSECTS; and

■ b. By adding an entry for the ''Shrimp, anchialine pool'' in alphabetical order under CRUSTACEANS, to read as set forth below.

§ 17.11 Endangered and threatened wildlife.

* * * * *

(h) * * *

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
*	*	*	*	*	*		*
INSECTS							
*	*	*	*	*	*		*
Fly, Hawaiian picture-wing.	*Drosophila digressa*	U.S.A. (HI)	Entire	E	818	NA	NA
*	*	*	*	*	*		*
CRUSTACEANS							
*	*	*	*	*	*		*
Shrimp, anchialine pool.	*Vetericaris chaceorum*.	U.S.A. (HI)	Entire	E	818	NA	NA
*	*	*	*	*	*		*

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

■ a. By removing the entry for *Caesalpinia kavaiense* under FLOWERING PLANTS; and

■ b. By adding entries for *Bidens hillebrandiana* ssp. *hillebrandiana, Bidens micrantha* ssp. *ctenophylla, Cyanea marksii, Cyanea tritomantha, Cyrtandra nanawaleensis, Cyrtandra wagneri, Mezoneuron kavaiense, Phyllostegia floribunda, Pittosporum hawaiiense, Platydesma remyi, Pritchardia lanigera, Schiedea diffusa* ssp. *macraei, Schiedea hawaiiensis,* and *Stenogyne cranwelliae,* in alphabetical order under FLOWERING PLANTS, to read as set forth below.

§ 17.12 Endangered and threatened plants.

* * * * *

(h) * * *

Species: Scientific name	Species: Common name	Historic range	Family	Status	When listed	Critical habitat	Special rules
FLOWERING PLANTS.							
*	*	*	*	*	*		*
Bidens hillebrandiana ssp. *hillebrandiana*.	Kookoolau	U.S.A. (HI)	Asteraceae	E	818	NA	NA
Bidens micrantha ssp. *ctenophylla*.	Kookoolau	U.S.A. (HI)	Asteraceae	E	818	NA	NA
*	*	*	*	*	*		*
Cyanea marksii	Haha	U.S.A. (HI)	Campanulaceae	E	818	NA	NA
*	*	*	*	*	*		*
Cyanea tritomantha	Aku	U.S.A. (HI)	Campanulaceae	E	818	NA	NA
*	*	*	*	*	*		*
Cyrtandra nanawaleensis.	Haiwale	U.S.A. (HI)	Gesneriaceae	E	818	NA	NA
*	*	*	*	*	*		*
Cyrtandra wagneri	Haiwale	U.S.A. (HI)	Gesneriaceae	E	818	NA	NA
*	*	*	*	*	*		*
Mezoneuron kavaiense.	Uhi uhi	U.S.A. (HI)	Fabaceae	E	238	NA	NA
*	*	*	*	*	*		*
Phyllostegia floribunda.	None	U.S.A. (HI)	Lamiaceae	E	818	NA	NA
*	*	*	*	*	*		*
Pittosporum hawaiiense.	Hoawa, haawa	U.S.A. (HI)	Pittosporaceae	E	818	NA	NA
*	*	*	*	*	*		*
Platydesma remyi	None	U.S.A. (HI)	Rutaceae	E	818	NA	NA
*	*	*	*	*	*		*
Pritchardia lanigera	Loulu	U.S.A. (HI)	Arecaceae	E	818	NA	NA

Species		Historic range	Family	Status	When listed	Critical habitat	Special rules
Scientific name	Common name						
*	*	*	*	*	*	*	
Schiedea diffusa ssp. *macraei*.	None	U.S.A. (HI)	Caryophyllaceae	E	818	NA	NA
*	*	*	*	*	*	*	
Schiedea hawaiiensis.	None	U.S.A. (HI)	Caryophyllaceae	E	818	NA	NA
*	*	*	*	*	*	*	
Stenogyne cranwelliae.	None	U.S.A. (HI)	Lamiaceae	E	818	NA	NA
*	*	*	*	*	*	*	

* * * * *

Dated: September 3, 2013.

Rowan W. Gould,

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

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