DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[Docket No. FWS–R1–ES–2011–0098; 4500030113]

RIN 1018–AX14

Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Final rule.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), determine endangered status under the Endangered Species Act of 1973 (Act), as amended, for 38 species on the Hawaiian Islands of Molokai, Lanai, and Maui, and reaffirm the listing of 2 endemic Hawaiian plants currently listed as endangered. In this final rule, we are also delisting the plant *Gahnia lanaiensis,* due to new information that this species is synonymous with *G. lacera,* a widespread species from New Zealand. The effect of this regulation is to conserve these 40 species under the Endangered Species Act.

DATES: This rule becomes effective on June 27, 2013.

ADDRESSES: This final rule is available on the Internet at *http://www.regulations.gov.* 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, Box 50088, Honolulu, HI 96850; telephone 808–792–9400; facsimile 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, Box 50088, 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 38 species (35 plants and 3 tree snails) as endangered under the Act from the island cluster of Maui Nui (Molokai, Lanai, Maui, and Kahoolawe) in the State of Hawaii. In addition, the rule reaffirms the listing of two endemic Hawaiian plants currently listed as endangered. Collectively, in this document we refer to these 40 species as the ''Maui Nui species.''

The basis for our action. Under the Endangered Species Act, we determine that a species is endangered or threatened 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 40 Maui Nui species are currently in danger of extinction throughout all their ranges, as the result of the following current and ongoing threats:

- All of these species face threats from the present destruction and modification of their habitat, primarily from introduced ungulates (such as feral pigs, goats, cattle, mouflon sheep, and axis deer) and the spread of nonnative plants.
- Thirteen plant species face threats from habitat destruction and modification from fire.
- All 37 plant species face threats from destruction and modification of their habitats from hurricanes, landslides, rockfalls, and flooding. In addition, hurricanes are a threat to all three tree snail species.
- Nine of these species face threats from habitat destruction and modification from drought.
- The projected effects of climate change will likely exacerbate the effects of the other threats to these species.
- There is a serious threat of widespread impacts of predation and herbivory on all 37 plant species by nonnative ungulates, rats, and invertebrates; and predation on the three tree snails by nonnative rats and invertebrates.
- Some of the plant species face the additional threat of trampling.
- The inadequacy of existing regulatory mechanisms (specifically inadequate protection of habitat and inadequate protection from the introduction of nonnative species) poses a current and ongoing threat to all 40 species.
- There are current and ongoing threats to 20 plant species and the 3 tree snail species due to factors associated with small numbers of populations and individuals.
- Five plant species face threats from hybridization and lack of or low levels of regeneration.
- 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.

We fully considered comments from the public, including comments received during a public hearing and comments received from peer reviewers, on the proposed rule.

Peer reviewers support our methods. We obtained opinions from four knowledgeable individuals with scientific expertise to review our technical assumptions, analysis, and whether or not we had used the best available information. These peer reviewers generally concurred with our methods and conclusions, and provided additional information, clarifications, and suggestions to improve this final rule.

This document consists of a final rule to list 35 plant species and 3 tree snail species as endangered and reaffirms the listing as endangered for 2 plants (40 species total). We additionally delist the plant *Gahnia lanaiensis* due to taxonomic error.

Previous Federal Actions

Federal actions for these species prior to June 11, 2012, are outlined in our proposed rule (77 FR 34464), which was published on that date. Publication of the proposed rule opened a 60-day comment period, which was extended on August 9, 2012 (77 FR 47587), for an additional 30 days and closed on September 10, 2012. We published a public notice of the proposed rule on June 20, 2012, in the local Honolulu Star Advertiser, Maui Times, and Molokai Dispatch newspapers. On January 31, 2013 (78 FR 6785), we reopened the comment period for an additional 30 days on the entire June 11, 2012, proposed rule (77 FR 34464), as well as the draft economic analysis on the proposed critical habitat designation, and announced a public information meeting and hearing that we held in Kihei, Maui, on February 21, 2013. This second comment period closed on March 4, 2013. In total, we accepted public comments on the June 11, 2012, proposed rule for 120 days.

Background

On June 11, 2012, we published in the **Federal Register** (77 FR 34464) a proposed rule to list 38 species on the Hawaiian Islands of Molokai, Lanai, and Maui as endangered under the Endangered Species Act of 1973, as amended (Act; 16 U.S.C. 1531 *et seq.*). We also proposed to reaffirm the listing of two endemic Hawaiian plants listed as endangered. We further proposed to designate critical habitat for 39 of these 40 plant and animal species, to designate critical habitat for 11 previously listed plant and animal species that do not have designated critical habitat, and to revise critical habitat for 85 plant species already listed as endangered or threatened.

The final critical habitat determination for the Maui Nui species is still under development and undergoing Service review. It will publish in the **Federal Register** in the near future under Docket No. FWS–R1–ES–2013–0003. That document will also provide our final determinations regarding the name changes and spelling corrections proposed in our June 1, 2012, proposed rule (77 FR 34464).

Maui Nui Species Addressed in this Final Rule

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

TABLE 1—THE MAUI NUI SPECIES ADDRESSED IN THIS FINAL RULE

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

Scientific name	Common name(s)	Listing Status
Species Listed as Endangered		
Plants:		
Bidens campylotheca ssp. *pentamera*	kookoolau	Endangered.
Bidens campylotheca ssp. *waihoiensis*	kookoolau	Endangered.
Bidens conjuncta	kookoolau	Endangered.
Calamagrostis hillebrandii	[NCN] [1]	Endangered.
Canavalia pubescens	awikiwiki	Endangered.
Cyanea asplenifolia	haha	Endangered.
Cyanea duvalliorum	haha	Endangered.
Cyanea horrida	haha nui	Endangered.
Cyanea kunthiana	haha	Endangered.
Cyanea magnicalyx	haha	Endangered.
Cyanea maritae	haha	Endangered.
Cyanea mauiensis	haha	Endangered.
Cyanea munroi	haha	Endangered.
Cyanea obtusa	haha	Endangered.
Cyanea profuga	haha	Endangered.
Cyanea solanacea	popolo	Endangered.
Cyrtandra ferripilosa	haiwale	Endangered.
Cyrtandra filipes	haiwale	Endangered.
Cyrtandra oxybapha	haiwale	Endangered.
Festuca molokaiensis	[NCN]	Endangered.
Geranium hanaense	nohoanu	Endangered.
Geranium hillebrandii	nohoanu	Endangered.
Mucuna sloanei var. *persericea*	sea bean	Endangered.
Myrsine vaccinioides	kolea	Endangered.
Peperomia subpetiolata	alaala wai nui	Endangered.
Phyllostegia bracteata	[NCN]	Endangered.
Phyllostegia haliakalae	[NCN]	Endangered.
Phyllostegia pilosa	[NCN]	Endangered.
Pittosporum halophilum	hoawa	Endangered.
Pleomele fernaldii	hala pepe	Endangered.
Schiedea jacobii	[NCN]	Endangered.
Schiedea laui	[NCN]	Endangered.
Schiedea salicaria	[NCN]	Endangered.
Stenogyne kauaulaensis	[NCN]	Endangered.
Wikstroemia villosa	akia	Endangered.
Animals:		
Newcombia cumingi	Newcomb's tree snail	Endangered.
Partulina semicarinata	Lanai tree snail	Endangered.
Partulina variabilis	Lanai tree snail	Endangered.
Species Reevaluated for Listing		
Cyanea grimesiana ssp. *grimesiana*	haha	Endangered.
Santalum haleakalae var. *lanaiense* (synonym = *Santalum freycinetianum* var. *lanaiense*)	iliahi	Endangered.

[1] NCN = no common name.

Taxonomic Changes Since Listing for Two Maui Nui Plant Species

At the time we listed *Cyanea grimesiana* ssp. *grimesiana* as endangered (61 FR 53108; October 10, 1996), we followed the taxonomic treatment of Lammers in Wagner *et al.* (1990, pp. 451–452). The distribution of *C. grimesiana* ssp. *grimesiana* as recognized at that time included the islands of Oahu, Molokai, Lanai, and Maui. Subsequently, Lammers (1998, pp. 31–32) recognized morphological differences in the broadly circumscribed *Cyanea grimesiana* group and published new combinations for the plants reported from Maui (*C. mauiensis*) and

Lanai (*C. munroi*). Plants reported from Molokai were identified as either *C. munroi* or *C. grimesiana* ssp. *grimesiana.* In 2004, Lammers (pp. 85–87) recognized further differences in the plants reported from Maui and described a new species, *C. magnicalyx,* known only from west Maui. The range of *C. grimesiana* ssp. *grimesiana* now includes only Oahu and Molokai (Lammers 1998, pp. 31–32; Lammers 2004, pp. 84–85). Because the range of the listed entity has changed, we evaluated the effects of the five factors described in section 4(a)(1) of the Act on *C. grimesiana* ssp. *grimesiana* as currently recognized, and determine that this species warrants endangered status under the Act (see Summary of Factors Affecting the 40 Maui Nui Species, below).

We listed *Santalum freycinetianum* var. *lanaiense* as endangered (51 FR 3182; January 24, 1986) in 1986. At that time, the species was known only from the island of Lanai. Our recovery plan for this species, published in 1995, recognized that the range of the species additionally includes west Maui, as well as Lanai, based on new information (USFWS 1995a, pp. 35–36). In her revision of the Hawaiian species of *Santalum,* Harbaugh *et al.* (2010, pp. 834–835) moved the plants previously recognized as *S. freycinetianum* var. *lanaiense* to *S. haleakalae* var. *lanaiense.* The range of *S. haleakalae* var. *lanaiense* now includes Molokai, Lanai, and east and west Maui (HBMP 2010; Harbaugh *et al.* 2010, pp. 834–835). Because the range of the listed entity has changed, we evaluated the effects of the five factors described in section 4(a)(1) of the Act on *S. haleakalae* var. *lanaiense* as currently recognized and determine that this species as described herein warrants its status as endangered under the Act (see Summary of Factors Affecting the 40 Maui Nui Species, below).

Delisting of *Gahnia lanaiensis*

Gahnia lanaiensis was listed as endangered in 1991 (56 FR 47686; September 20, 1991). At that time, this species was known from 15 or 16 large ‘‘clumped’’ plants growing on the summit of Lanaihale, on the island of Lanai. The distribution of these plants was considered to be the entire known range of the species. *Gahnia lanaiensis* was listed as threatened due the small number of individuals remaining and resulting negative consequences of very small populations, which increased the potential for extinction of the species due to stochastic events; the potential for destruction of plants due their proximity to a popular hiking and jeep trail; and habitat degradation and destruction by feral ungulates and nonnative plants (56 FR 47686; September 20, 1991).

In a recently published paper, Koyama *et al.* (2010, pp. 29–30) found that based on spikelet and achene characters, *Gahnia lanaiensis* is a complete match for *G. lacera,* a species endemic to New Zealand. Koyama further states that *G. lacera* likely arrived on Lanai, either intentionally or unintentionally, through the restoration efforts of George Munro, the Resident Manager of Lanai Ranch from 1911 to 1930 (Koyama 2010, p. 30). Born and raised in New Zealand, Munro is known to have used seeds of New Zealand’s native plants for reforestation efforts on Lanai (Koyama 2010, p. 30).

Because *Gahnia lanaiensis* is not believed to be a uniquely valid species; is synonymous with *G. lacera,* a species endemic to New Zealand where it is known to be common (Piha New Zealand Plant Conservation Network 2010, in litt.); and is not in danger of extinction or likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range, we delist *G. lanaiensis* due to error in the original listing. We did not receive any public comments on our proposed delisting of *G. lanaiensis* due to taxonomic error.

An Ecosystem-based Approach

On the islands of Molokai, Lanai, and Maui, 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 negatively impact 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 to not only organize this 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 concordance with one of the primary stated purposes of the Act, as stated in 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 campylotheca* ssp. *pentamera, Bidens campylotheca* ssp. *waihoiensis, Bidens conjuncta, Calamagrostis hillebrandii, Cyanea asplenifolia, Cyanea duvalliorum, Cyanea horrida, Cyanea kunthiana, Cyanea magnicalyx, Cyanea maritae, Cyanea mauiensis, Cyanea munroi, Cyanea obtusa, Cyanea profuga, Cyanea solanacea, Cyrtandra ferripilosa, Cyrtandra filipes, Cyrtandra oxybapha, Festuca molokaiensis, Geranium hanaense, Geranium hillebrandii, Mucuna sloanei* var. *persericea, Myrsine vaccinioides, Peperomia subpetiolata, Phyllostegia bracteata, Phyllostegia haliakalae, Phyllostegia pilosa, Pittosporum halophilum, Pleomele fernaldii, Schiedea jacobii, Schiedea laui, Schiedea salicaria, Stenogyne kauaulaensis,* and *Wikstroemia villosa;* and the tree snails *Newcombia cumingi, Partulina semicarinata* and *Partulina variabilis,* from the islands of Molokai, Lanai, and Maui as endangered species. We are also listing the plant *Canavalia pubescens,* known from the islands of Niihau, Kauai, Lanai, and Maui as an endangered species. In addition, we reaffirm the listing of two plant species, *Santalum haleakalae* var. *lanaiense* (formerly *Santalum freycinetianum* var. *lanaiense*) from the islands of Molokai, Lanai, and Maui, and *Cyanea grimesiana* ssp. *grimesiana,* known from Oahu and Molokai, as endangered species. These 40 species (37 plants and 3 tree snails) are found in 10 ecosystem types: Coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane wet, montane mesic, subalpine, dry cliff, and wet cliff (Table 3).

TABLE 3—THE 40 MAUI NUI SPECIES [1] AND THE ECOSYSTEMS UPON WHICH THEY DEPEND

Ecosystem	Island		
	Molokai	Lanai	Maui
Coastal	*Pittosporum halophilum*	*Canavalia pubescens*	
Lowland Dry		*Pleomele fernaldii*	*Bidens campylotheca* ssp. *pentamera*.
			Canavalia pubescens.
			Cyanea obtusa.
			Santalum haleakalae var. *lanaiense*.
			Schiedea salicaria.
Lowland Mesic	*Cyanea profuga*	*Pleomele fernaldii*	*Bidens campylotheca* ssp. *pentamera*.
	Cyanea solanacea	*Santalum haleakalae* var. *lanaiense*	*Cyanea asplenifolia*.
	Cyrtandra filipes		*Cyanea mauiensis*.[2]
	Festuca molokaiensis		*Santalum haleakalae* var. *lanaiense*
	Phyllostegia haliakalae		
	Phyllostegia pilosa		
	Santalum haleakalae var. *lanaiense*		
Lowland Wet	*Cyanea grimesiana* ssp. *grimesiana*	*Pleomele fernaldii*	*Bidens campylotheca* ssp. *waihoiensis*.
	Cyanea solanacea	*Santalum haleakalae* var. *lanaiense*	*Bidens conjuncta*.
	Cyrtandra filipes	*Partulina semicarinata*	*Cyanea asplenifolia*.
		Partulina variabilis	*Cyanea duvalliorum*.
			Cyanea kunthiana.
			Cyanea magnicalyx.
			Cyanea maritae.
			Cyrtandra filipes.
			Mucuna sloanei var. *persericea*.
			Phyllostegia bracteata
			Santalum haleakalae var. *lanaiense*.
			Wikstroemia villosa.
			Newcombia cumingi.
Montane Dry			*Santalum haleakalae* var. *lanaiense*.
Montane Mesic	*Cyanea solanacea*		*Bidens campylotheca* ssp.*pentamera*.
	Santalum haleakalae var. *lanaiense*		*Cyanea horrida*.
			Cyanea kunthiana.
			Cyanea magnicalyx.
			Cyanea obtusa.
			Cyrtandra ferripilosa.
			Cyrtandra oxybapha
			Geranium hillebrandii.
			Phyllostegia bracteata.
			Phyllostegia haliakalae.
			Santalum haleakalae var. *lanaiense*.
			Stenogyne kauaulaensis.
			Wikstroemia villosa.
Montane Wet	*Cyanea profuga*	*Santalum haleakalae* var. *lanaiense*	*Bidens campylotheca* ssp. *pentamera*.
	Cyanea solanacea	*Partulina semicarinata*	*Bidens campylotheca* ssp. *waihoiensis*.
	Phyllostegia pilosa	*Partulina variabilis*	*Bidens conjuncta*.
	Schiedea laui		*Calamagrostis hillebrandii*.
			Cyanea duvalliorum.
			Cyanea horrida.
			Cyanea kunthiana.
			Cyanea maritae.
			Cyrtandra ferripilosa.
			Cyrtandra oxybapha.
			Geranium hanaense.
			Geranium hillebrandii.
			Myrsine vaccinioides.
			Peperomia subpetiolata.
			Phyllostegia bracteata.
			Phyllostegia pilosa.
			Schiedea jacobii.
			Wikstroemia villosa.
Subalpine			*Phyllostegia bracteata*.
Dry Cliff	*Phyllostegia haliakalae*	*Pleomele fernaldii*	*Bidens campylotheca* ssp. *pentamera*.
		Pleomele fernaldii	*Cyanea mauiensis*.[2]
Wet Cliff	*Cyanea grimesiana* ssp. *grimesiana*	*Cyanea munroi*	*Bidens campylotheca* ssp. *pentamera*.
	Cyanea munroi	*Phyllostegia haliakalae*	*Bidens campylotheca* ssp. *waihoiensis*.
		Pleomele fernaldii	*Bidens conjuncta*.
		Santalum haleakalae var. *lanaiense*	*Cyanea horrida*.
		Partulina semicarinata	*Cyanea magnicalyx*.
		Partulina variabilis	*Cyrtandra filipes*.
			Phyllostegia bracteata.
			Phyllostegia haliakalae.

TABLE 3—THE 40 MAUI NUI SPECIES[1] AND THE ECOSYSTEMS UPON WHICH THEY DEPEND—Continued

Ecosystem	Island		
	Molokai	Lanai	Maui
			Santalum haleakalae var. *lanaiense.*

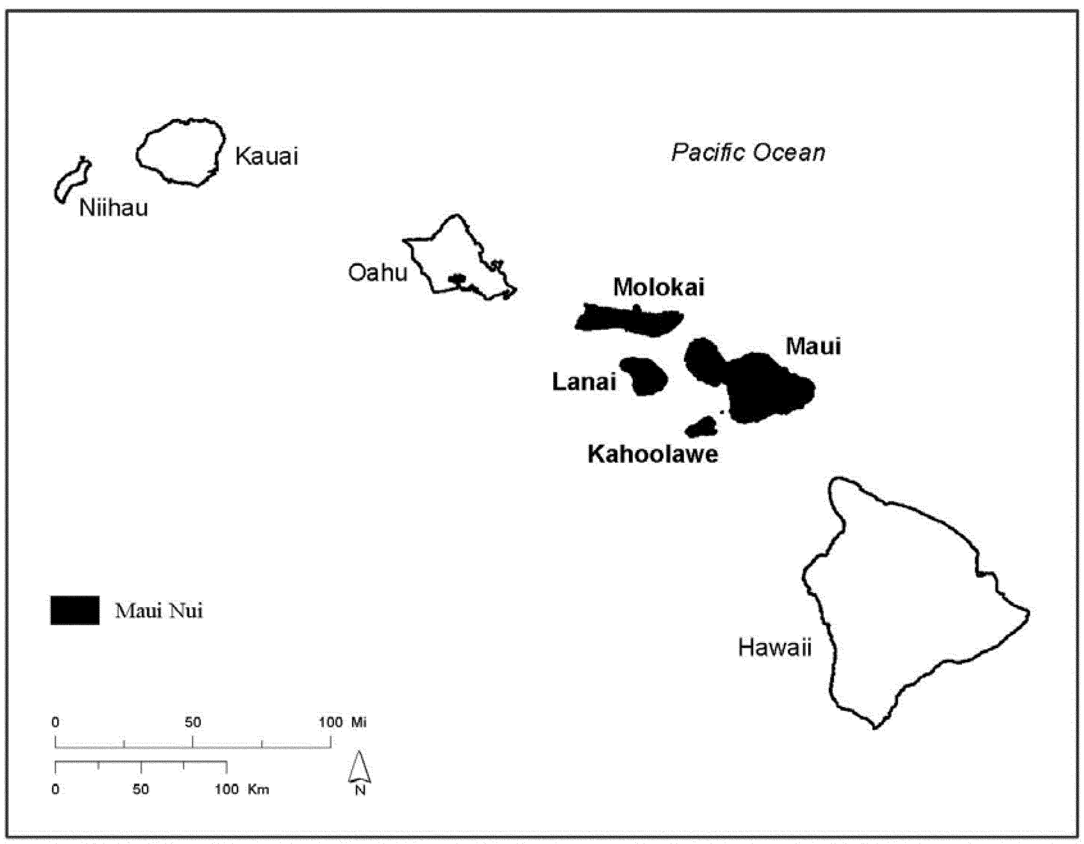
[1] 37 species are plants and 3 species (*Newcombia cumingi, Partulina semicarinata,* and *Partulina variabilis*) are tree snails.
[2] Not seen since the 1800s.

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 37 of the 40 species, and is likely a threat to many, if not most or even all, of the native species within a given ecosystem. We consider such a threat to be an ''ecosystem-level threat,'' as each individual species within that ecosystem faces an adverse impact that is essentially identical in terms of the nature of the its impact, its severity, its imminence, and its scope. Beyond ecosystem-level impacts, we further identified and evaluated factors that may represent unique adverse impacts to certain species, but do not apply to all species under consideration within the same ecosystem. For example, the threat of predation by nonnative snails is unique to the three tree snails in this rule, and is not applicable to any of the other 37 species. We have identified such threats, which apply only to certain species within the ecosystems addressed here, as ''species-specific threats.''

The Islands of Maui Nui

The islands of Maui Nui include Molokai, Lanai, Maui, and Kahoolawe (Figure 1). During the last Ice Age, about 21,000 years ago, when sea levels were approximately 459 feet (ft) (140 meters (m)) below their present level, these four islands were connected by a broad lowland plain and unified as a single island (Nullet *et al.* 1998, p. 64; Ziegler 2002, p. 22). This land bridge allowed the movement and interaction of each island's flora and fauna and contributed to the present close relationships of their biota (Nullet *et al.* 1998, p. 64).

Figure 1. Map of the Hawaiian Islands that collectively comprise Maui Nui.



The island of Molokai is the fifth largest of the eight main Hawaiian Islands. It was formed from three shield volcanoes and is about 260 square miles (sq mi) (673 square kilometers (sq km)) in area (Juvik and Juvik 1998, pp. 11, 13). The volcanoes that make up most of the land mass of Molokai include the west and east Molokai mountains, and a volcano that formed Kalaupapa peninsula. The taller and larger east Molokai mountain rises 4,970 ft (1,514 m) above sea level and comprises roughly 50 percent of the island's area (Juvik and Juvik 1998, p. 11). Topographically, the windward (north) side of east Molokai differs from the leeward (south) side. Precipitous cliffs line the windward coast and deep valleys dissect the coastal area. The annual rainfall on the windward side of Molokai is 75 to more than 150 inches (in) (200 to more than 375 centimeters (cm)) (Giambelluca and Schroeder 1998, p. 50).

The island of Lanai is the sixth largest of the eight main Hawaiian Islands, located southeast of Molokai and northwest of Hawaii Island. It is located in the lee or rain shadow of the taller west Maui mountains. Lanai was formed from a single shield volcano and built by eruptions at its summit and along three rift zones (Clague 1998, p. 42). The island is about 140 sq mi (364 sq km) in area and its highest point, Lanaihale, has an elevation of 3,366 ft (1,027 m) (Clague 1998, p. 42; Juvik and Juvik 1998, p. 13; Walker 1999, p. 21). Annual rainfall on the summit is 30 to 40 in (76 to 102 cm), but is considerably less, 10 to 20 in (25 to 50 cm), over much of the rest of the island (Giambelluca and Schroeder 1998, p. 56).

The island of Maui is the second largest of the eight main Hawaiian Islands, located southeast of Molokai and northwest of Hawaii Island (Juvik and Juvik 1998, p. 14). It was formed from two shield volcanoes and resulted in the west Maui mountains, which are about 1.3 million years old, and Haleakala on east Maui, which is about 750,000 years old (Juvik and Juvik 1998, p. 14). West and east Maui are connected by the central Maui isthmus, and the island's total land area is 729 sq mi (1,888 sq km) (Juvik and Juvik 1998, p. 14; Walker 1999, p. 21). The west Maui mountains have been eroded by streams that created deep valleys and ridges. The highest point on west Maui is Puu Kukui at 5,788 ft (1,764 m) in elevation, with with an average rainfall greater than 400 in (1,020 cm) per year (Juvik and Juvik 1998, p. 14; Wagner *et al.* 1999b, p. 41; Giambelluca *et al.* 2011–*Online Rainfall Atlas of Hawaii*). East Maui's Haleakala volcano remains volcanically active, with its last eruption occurring less than 500 years ago (Sherrod *et al.* 2007, p. 40). Haleakala rises 10,023 ft (3,055 m) in elevation, and despite being younger in age, possesses areas of diverse vegetation equal or greater than the older and more eroded west Maui mountains (Price 2004, p. 493). Rainfall on the slopes of Haleakala ranges from about 35 in (89 cm) to over 400 in (1,000 cm) per year, with its windward (northeastern) slope receiving the most precipitation (Giambelluca *et al.* 2011–*Online Rainfall Atlas of Hawaii*). However, Haleakala's crater is a dry cinder desert because it is above the level at which precipitation develops and is sheltered from moisture-laden winds usually associated with orographic (mountain) rainfall (Giambelluca and Schroeder 1998, p. 55).

The island of Kahoolawe is the smallest of the eight main Hawaiian Islands, located southeast of Molokai and northwest of Hawaii Island. The island is about 45 sq mi (116 sq km) in area, and was formed from a single shield volcano (Clague 1998, p. 42; Juvik and Juvik 1998, pp. 7, 16). The maximum elevation on Kahoolawe is 1,477 ft (450 m) at the summit of Puu Moaulanui (Juvik and Juvik 1998, pp. 15–16). Kahoolawe is in the rain shadow of Haleakala and is arid, receiving no more than 25 in (65 cm) of rainfall annually (Juvik and Juvik 1998, p. 16; Mitchell *et al.* 2005, pp. 6–66).

The vegetation of the islands of Maui Nui has undergone extreme alterations because of past and present land use and other activities. Land with rich soils was altered by the early Hawaiians and, more recently, converted to agricultural use in the production of sugar and pineapple (Gagne and Cuddihy 1999, p. 45) or pasture. For example, on Haleakala, on the island of Maui, the upland slopes have been converted to diversified agriculture and cattle ranches (Juvik and Juvik 1998, p. 16). Archaeological surveys suggest that the early Hawaiians did not live in the highest areas of Haleakala but instead inhabited the area temporarily for religious ceremonies, the creation of adzes (tools used for smoothing or carving wood), and bird hunting (Burney 1997, p. 448). Intentional and inadvertent introduction of alien plant and animal species has also contributed to the reduction in range of native vegetation on the islands of Maui Nui (throughout this rule, the terms ''alien,'' ''feral,'' ''nonnative,'' and ''introduced'' all refer to species that are not naturally native to the Hawaiian Islands). Currently, most of the native vegetation on the islands persists on upper elevation slopes, valleys and ridges; steep slopes; precipitous cliffs; valley headwalls; and other regions where unsuitable topography has prevented urbanization and agricultural development, or where inaccessibility has limited encroachment by nonnative plant and animal species.

Maui Nui Ecosystems

There are 11 different ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, subalpine, alpine, dry cliff, and wet cliff) recognized on the islands of Maui Nui. The 40 species in this rule occur in 10 of these ecosystems (all except the alpine). All 11 Maui Nui ecosystems are described in the following section.

Coastal

The coastal ecosystem is found on all of the main Hawaiian Islands, with the highest native species diversity in the least populated coastal areas of Kauai, Oahu, Molokai, Maui, Kahoolawe, Hawaii Island, and their associated islets. On Molokai, Lanai, Maui, and Kahoolawe, the coastal ecosystem includes mixed herblands, shrublands, and grasslands, from sea level to 980 ft (300 m) in elevation, generally within a narrow zone above the influence of waves to within 330 ft (100 m) inland, sometimes extending further inland if strong prevailing onshore winds drive sea spray and sand dunes into the lowland zone (The Nature Conservancy (TNC) 2006a). The coastal ecosystem is typically dry, with annual rainfall of less than 20 in (50 cm); however, windward rainfall may be high enough (up to 40 in (100 cm)) to support mesic-associated and sometimes wet-associated vegetation (Gagne and Cuddihy 1999, pp. 54–66). Biological diversity is low to moderate in this ecosystem, but may include some specialized plants and animals such as nesting seabirds and the endangered plant *Sesbania tomentosa* (ohai) (TNC 2006a). The plants *Canavalia pubescens* and *Pittosporum halophilum,* which are listed as endangered in this final rule, are reported in this ecosystem on Molokai or Lanai (Hawaii Biodiversity and Mapping Program (HBMP) 2008; TNC 2007).

Lowland Dry

The lowland dry ecosystem includes shrublands and forests generally below 3,300 ft (1,000 m) elevation that receive less than 50 in (130 cm) annual rainfall, or are in otherwise prevailingly dry substrate conditions that range from weathered reddish silty loams to stony clay soils, rocky ledges with very shallow soil, or relatively recent little-weathered lava (Gagne and Cuddihy 1999, p. 67). Areas consisting of predominantly native species in the lowland dry ecosystem are now rare; this ecosystem is found on the islands of Kauai, Oahu, Molokai, Lanai, Maui, Kahoolawe and Hawaii, and is best represented on the leeward sides of the islands (Gagne and Cuddihy 1999, p. 67). On the islands of Maui Nui, this ecosystem is typically found on the leeward side of the mountains (Gagne and Cuddihy 1999, p. 67; TNC 2006b). Native biological diversity is low to moderate in this ecosystem, and includes specialized animals and plants such as the Hawaiian owl or pueo (*Asio flammeus sandwichensis*) and *Santalum ellipticum* (iliahialoe or coast sandalwood) (Wagner *et al.* 1999c, pp. 1,220–1,221; TNC 2006b). The plants *Bidens campylotheca* ssp. *pentamera, Canavalia pubescens, Cyanea obtusa, Pleomele fernaldii, Santalum haleakalae* var. *lanaiense,* and *Schiedea salicaria,* which are listed as endangered in this final rule, are reported from this ecosystem on Lanai or Maui (HBMP 2008; TNC 2007).

Lowland Mesic

The lowland mesic ecosystem includes a variety of grasslands, shrublands, and forests, generally below 3,300 ft (1,000 m) elevation, that receive between 50 and 75 in (130 and 190 cm) annual rainfall (TNC 2006c). In the Hawaiian Islands, this ecosystem is found on Kauai, Molokai, Lanai, Maui, and Hawaii, on both windward and leeward sides of the islands. On the islands of Maui Nui, this ecosystem is typically found on the leeward slopes of Molokai, Lanai, and Maui (Gagne and Cuddihy 1999, p. 75; TNC 2006c). Native biological diversity is high in this system (TNC 2006c). The plants *Bidens campylotheca* ssp. *pentamera, Cyanea asplenifolia, C. profuga, C. solanacea, Cyrtandra filipes, Festuca molokaiensis, Phyllostegia haliakalae, P. pilosa, Pleomele fernaldii,* and *Santalum haleakalae* var. *lanaiense,* which are listed as endangered in this final rule, are reported in this ecosystem on this islands of Molokai, Lanai, or Maui (HBMP 2008; TNC 2007). In addition, *Cyanea mauiensis,* also listed as endangered in this final rule, may have occurred in this ecosystem on Maui, but this species has not been observed for over 100 years. The species-specific habitat needs of *Cyanea mauiensis* are not known.

Lowland Wet

The lowland wet ecosystem is generally found below 3,300 ft (1,000 m) elevation on the windward sides of the main Hawaiian Islands, except Niihau and Kahoolawe (Gagne and Cuddihy 1999, p. 85; TNC 2006d). These areas include a variety of wet grasslands, shrublands, and forests that receive greater than 75 in (190 cm) annual precipitation, or are in otherwise wet substrate conditions (TNC 2006d). On the islands of Maui Nui, this system is best developed in wet valleys and slopes on Molokai, Lanai, and Maui (TNC 2006d). Native biological diversity is high in this system (TNC 2006d). The plants *Bidens campylotheca* ssp. *waihoiensis, B. conjuncta, Cyanea asplenifolia, C. duvalliorum, C. grimesiana* ssp. *grimesiana, C. kunthiana, C. magnicalyx, C. maritae, C. solanacea, Cyrtandra filipes, Mucuna sloanei* var. *persericea, Phyllostegia bracteata, Pleomele fernaldii, Santalum haleakalae* var. *lanaiense,* and *Wikstroemia villosa;* and the tree snails *Newcombia cumingi, Partulina semicarinata,* and *P. variabilis,* which are listed as endangered in this final rule, are reported in this ecosystem on Molokai, Lanai, or Maui (HBMP 2008; TNC 2007).

Montane Wet

The montane wet ecosystem is composed of natural communities (grasslands, shrublands, forests, and bogs) found at elevations between 3,300 and 6,500 ft (1,000 and 2,000 m), in areas where annual precipitation is greater than 75 in (190 cm) (TNC 2006e). This system is found on all of the main Hawaiian Islands except Niihau and Kahoolawe, and only the islands of Molokai, Maui, and Hawaii have areas above 4,020 ft (1,225 m) (TNC 2006e). On the islands of Maui Nui this ecosystem is found on Molokai, Lanai, and Maui (TNC 2007). Native biological diversity is moderate to high (TNC 2006e). The plants *Bidens campylotheca* ssp. *pentamera, B. campylotheca* ssp. *waihoiensis, B. conjuncta, Calamagrostis hillebrandii, Cyanea duvalliorum, C. horrida, C. kunthiana, C. maritae, C. profuga, C. solanacea, Cyrtandra ferripilosa, C. oxybapha, Geranium hanaense, G. hillebrandii, Myrsine vaccinioides, Peperomia subpetiolata, Phyllostegia bracteata, P. pilosa, Santalum haleakalae* var. *lanaiense, Schiedea jacobii, S. laui, and Wikstroemia villosa;* and the tree snails *Partulina semicarinata* and *P. variabilis,* which are listed as endangered in this final rule, are reported in this ecosystem on the islands of Molokai, Lanai, or Maui (HBMP 2008; TNC 2007).

Montane Mesic

The montane mesic ecosystem is composed of natural communities (forests and shrublands) found at elevations between 3,300 and 6,500 ft (1,000 and 2,000 m), in areas where annual precipitation is between 50 and 75 in (130 and 190 cm), or are in otherwise mesic substrate conditions (TNC 2006f). This system is found on Kauai, Molokai, Maui, and Hawaii Island (Gagne and Cuddihy 1999, pp. 97–99; TNC 2007). Native biological diversity is moderate, and this habitat is important for Hawaiian forest birds (Gagne and Cuddihy 1999, pp. 98–99; TNC 2006f). The plants *Bidens campylotheca* ssp. *pentamera, Cyanea horrida, C. kunthiana, C. magnicalyx, C. obtusa, C. solanacea, Cyrtandra ferripilosa, C. oxybapha, Geranium hillebrandii, Phyllostegia bracteata, Phyllostegia haliakalae, Santalum haleakalae* var. *lanaiense, Stenogyne kauaulaensis,* and *Wikstroemia villosa,* which are listed as endangered in this final rule, are reported in this ecosystem on Molokai or Maui (TNC 2007; HBMP 2008; HNP 2012, in litt.).

Montane Dry

The montane dry ecosystem is composed of natural communities (shrublands, grasslands, forests) found at elevations between 3,300 and 6,500 ft (1,000 and 2,000 m), in areas where annual precipitation is less than 50 in (130 cm), or are in otherwise dry substrate conditions (TNC 2006g). This system is found on the islands of Maui and Hawaii (Gagne and Cuddihy 1999, pp. 93–97). The only plant species listed as endangered in this final rule that is found in this ecosystem is *Santalum haleakalae* var. *lanaiense* (TNC 2007; HBMP 2008).

Subalpine

The subalpine ecosystem is composed of natural communities (shrublands, grasslands, forests) found at elevations between 6,500 ft and 9,800 ft (2,000 and 3,000 m), in areas where annual precipitation is seasonal, between 15 and 40 in (38 and 100 cm), or are in otherwise dry substrate conditions (TNC 2006h). Fog drip is an important moisture supplement (Gagne and Cuddihy 1999, pp. 107–110). This system is found on the islands of Maui and Hawaii (Gagne and Cuddihy 1999, pp. 107–110). Native biological diversity is not high, but specialized invertebrates and plants (*Sophora chrysophylla* (mamane), *Myoporum sandwicense* (naio), and *Deschampsia nubigena* (hairgrass)) are reported in this ecosystem (TNC 2006h). The plant *Phyllostegia bracteata,* which is listed as endangered in this final rule, is reported in this ecosystem (TNC 2007; HBMP 2008).

Alpine

The alpine ecosystem is composed of natural communities (shrublands, alpine lake, aeolian (wind-shaped) desert) found at elevations above 9,800 ft (3000 m), in areas where annual precipitation is infrequent, with frost and snow, and intense solar radiation (TNC 2006i). Fog drip is an important moisture supplement (Gagne and Cuddihy 1999, pp. 107–110). This system is found on the islands of Maui and Hawaii (Gagne and Cuddihy 1999, pp. 107–110). Native biological diversity is not high, but highly specialized plants, such as the threatened *Argyroxiphium sandwicense* ssp. *macrocephalum* (ahinahina), occur in this ecosystem on Maui (TNC 2006i). None of the species being listed as endangered in this final rule are reported from this ecosystem (TNC 2007; HBMP 2008).

Dry Cliff

The dry cliff ecosystem is composed of vegetation communities occupying steep slopes (greater than 65 degrees) in areas that receive less than 75 in (190 cm) of rainfall annually, or are in otherwise dry substrate conditions (TNC 2006j). This ecosystem is found on all of the main Hawaiian Islands except Niihau, and is best represented along the leeward slopes of Lanai and Maui (TNC 2006j). A variety of shrublands occur within this ecosystem (TNC 2006j). Native biological diversity is low to moderate (TNC 2006j). The plants *Bidens campylotheca* ssp. *pentamera, Phyllostegia haliakalae,* and *Pleomele fernaldii,* which are listed as endangered in this final rule, are reported in this ecosystem on Lanai or Maui (HBMP 2008; TNC 2007). In addition, *Cyanea mauiensis,* also listed as endangered in this final rule, may have occurred in this ecosystem on Maui, but this species has not been observed for over 100 years. The species-specific habitat needs of *Cyanea mauiensis* are not known.

Wet Cliff

The wet cliff ecosystem is generally composed of shrublands on near-vertical slopes (greater than 65 degrees) in areas that receive more than 75 in (190 cm) of annual precipitation, or in otherwise wet substrate conditions (TNC 2006k). This system is found on the islands of Kauai, Oahu, Molokai, Lanai, Maui, and Hawaii. On the islands of Maui Nui, this system is typically found along the windward sides of Molokai, Lanai, and Maui (TNC 2006k). Native biological diversity is low to moderate (TNC 2006k). The plants *Bidens campylotheca* ssp. *pentamera, B. campylotheca* ssp. *waihoiensis, B. conjuncta, Cyanea grimesiana* ssp. *grimesiana, C.horrida, C. magnicalyx, C. munroi, Cyrtandra filipes, Phyllostegia bracteata, P. haliakalae, Pleomele fernaldii,* and *Santalum haleakalae* var. *lanaiense,* and the tree snails *Partulina semicarinata* and *P. variabilis,* which are listed as endangered in this final rule, are reported in this ecosystem on the islands of Molokai, Lanai, or Maui (HBMP 2008; TNC 2007).

Description of the 40 Maui Nui Species

Below is a brief description of each of the 40 Maui Nui 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 campylotheca ssp. *pentamera* (kookoolau), a perennial herb in the sunflower family (Asteraceae), occurs only on the island of Maui (Ganders and Nagata 1999, pp. 271, 273). Historically, *B. campylotheca* spp. *pentamera* was found on Maui's eastern volcano (Haleakala). Currently, this subspecies is found on east Maui in the montane mesic, montane wet, dry cliff, and wet cliff ecosystems of Waikamoi Preserve and Kipahulu Valley (in Haleakala National Park) (TNC 2007; HBMP 2008; Welton 2008, in litt.; National Tropical Botanical Garden (NTBGa) 2009, pp. 1–2; Fay 2010, in litt.). It is uncertain if plants observed in the Hana Forest Reserve at Waihoi Valley are *B. campylotheca* ssp. *pentamera* (Osterneck 2010, in litt.; Haleakala National Park (HNP) 2012, in litt.). On west Maui, *B. campylotheca* ssp. *pentamera* is found on and near cliff walls in the lowland dry and lowland mesic ecosystems of Papalaua Gulch (West Maui Forest Reserve) and Kauaula Valley (NTBG 2009a, pp. 1–2; Perlman 2009a, in litt.). The 6 occurrences on east and west Maui total approximately 200 individuals.

Bidens campylotheca ssp. *waihoiensis* (kookoolau), a perennial herb in the sunflower family (Asteraceae), occurs only on the island of Maui (Ganders and Nagata 1999, pp. 271, 273). Historically, *B. campylotheca* ssp. *waihoiensis* was found on Maui's eastern volcano in Waihoi Valley and Kaumakani ridge (HBMP 2008). Currently, this subspecies is found in the lowland wet, montane wet, and wet cliff ecosystems in Kipahulu Valley (Haleakala National Park) and possibly in Waihoi Valley (Hana Forest Reserve) on east Maui (TNC 2007; HBMP 2008; Welton 2008, in litt.). Approximately 200 plants are scattered over an area of about 2.5 miles (4 km) in Kipahulu Valley (Welton 2010a, in litt.). In 1974, hundreds of individuals were observed in Waihoi Valley along Waiohonu stream (NTBG 2009b, p. 4).

Bidens conjuncta (kookoolau), a perennial herb in the sunflower family (Asteraceae), occurs only on the island of Maui (Ganders and Nagata 1999, pp. 273–274). Historically, this species was known only from the mountains of west Maui in the Honokohau drainage basin (Sherff 1923, p. 162). Currently, *B. conjuncta* is found scattered throughout the upper elevation drainages of the west Maui mountains in the lowland wet, montane wet, and wet cliff ecosystems, in 9 occurrences totaling an estimated 7,000 individuals (TNC 2007; HBMP 2008; Oppenheimer 2008a, in litt.; Perlman 2010, in litt.).

Calamagrostis hillebrandii (NCN), a perennial in the grass family (Poaceae), occurs only on the island of Maui (O'Connor 1999, p. 1,509). Historically, this species was known from Puu Kukui in the west Maui mountains (Wagner *et al.* 2005a–*Flora of the Hawaiian Islands database*). Currently, this species is found in bogs in the montane wet ecosystem in the west Maui mountains, from Honokohau to Kahoolewa ridge, including East Bog and Eke Crater, in three occurrences totaling a few hundred individuals (TNC 2007; HBMP 2008; Oppenheimer 2010a, in litt.).

Canavalia pubescens (awikiwiki), a perennial climber in the pea family (Fabaceae), is currently found only on the island of Maui, although it was also historically known from Niihau, Kauai, and Lanai (Wagner and Herbst 1999, p. 654). On Niihau, this species was known from one population in Haao Valley that was last observed in 1949 (HBMP 2008). On Kauai, this species was known from six populations ranging from Awaawapuhi to Wainiha, where it was last observed in 1977 (HBMP 2008). On Lanai, this species was known from Kaena Point to Huawai Bay. Eight individuals were reported in the coastal ecosystem west of Hulupoe, but they have not been seen since 1998 (Oppenheimer 2007a, in litt.; HBMP 2008). At present, the only known occurrence is on east Maui, from Puu o Kali south to Pohakea, in the lowland dry ecosystem (Starr 2006, in litt.; Altenburg 2007, pp. 12–13; Oppenheimer 2006a, in litt.; 2007a, in litt.; Greenlee 2013, in litt.). All plants of this species that formerly were found in the Ahihi-Kinau Natural Area Reserve on Maui were destroyed by feral goats (*Capra hircus*) by the end of 2010

(Fell-McDonald 2010, in litt.). In addition, although approximately 20 individuals of *Canavalia pubescens* were reported from the Palauea-Keahou area as recently as 2010 (Altenberg 2010, in litt.), no individuals have been found in site visits to this area over the last 2 years (Greenlee 2013, in litt.). Greenlee (2013, in litt.) reports that these plants may have succumbed to prolonged drought. In April of 2010, *C. pubescens* totaled as many as 500 individuals; however, with the loss of the plants at Ahihi-Kinau Natural Area Reserve and the loss of plants at Palauea-Keahou, *C. pubescens* may currently total fewer than 200 individuals at a single location.

Cyanea asplenifolia (haha), a shrub in the bellflower family (Campanulaceae), is found only on the island of Maui. This species was known historically from Waihee Valley and Kaanapali on west Maui, and Halehaku ridge on east Maui (Lammers 1999, p. 445; HBMP 2008). On west Maui, in the lowland wet ecosystem, there are 3 occurrences totaling 14 individuals in the Puu Kukui Preserve and two occurrences totaling 5 individuals in the West Maui Natural Area Reserve. On east Maui, *C. asplenifolia* is found in 1 occurrence each in the lowland mesic ecosystem in Haleakala National Park (53 individuals) and Kipahulu Forest Reserve (FR) (140 individuals), and 1 occurrence in the lowland wet ecosystem in the Makawao FR (5 individuals) (TNC 2007; HBMP 2008; Oppenheimer 2008b, in litt, 2010b, in litt.; PEPP 2008, p. 48; Welton and Haus 2008, p. 12; NTBG 2009c, pp. 3–5; Welton 2010a, in litt.). Currently, *C. asplenifolia* is known from 8 occurrences totaling fewer than 200 individuals. The occurrence at Haleakala National Park is protected by a temporary exclosure (HNP 2012, in litt.).

Cyanea duvalliorum (haha), a tree in the bellflower family (Campanulaceae), is found only in the east Maui mountains (Lammers 2004, p. 89). This species was described in 2004, after the discovery of individuals of a previously unknown species of *Cyanea* at Waiohiwi Gulch (Lammers 2004, p. 91). Studies of earlier collections of sterile material extend the historical range of this species on the windward slopes of Haleakala in the lowland wet and montane wet ecosystems, east of Waiohiwi Stream, from Honomanu Stream to Wailua Iki Streams, and to Kipahulu Valley (Lammers 2004, p. 89). In 2007, one individual was observed in the lowland wet ecosystem of the Makawao FR (NTBG 2009d, p. 2). In 2008, 71 individuals were found in 2 new locations in the Makawao FR, along with many juveniles and seedlings (NTBG 2009d, p. 2). Currently there are 2 occurrences with an approximate total of 71 individuals in the montane wet ecosystem near Makawao FR, with an additional 135 individuals outplanted in Waikamoi Preserve (TNC 2007; NTBG 2009d, p. 2; Oppenheimer 2010a, in litt.).

Cyanea grimesiana ssp. *grimesiana* (haha), a shrub in the bellflower family (Campanulaceae), is known only from Oahu and Molokai (Lammers 2004 p. 84; Lammers 1999, pp. 449, 451; 68 FR 35950, June 17, 2003). On Molokai, this species was last observed in 1991 in the wet cliff ecosystem at Wailau Valley (PEPP 2010, p. 45). Currently, on Oahu there are five to six individuals in four occurrences in the Waianae and Koolau Mountains (U.S. Army 2006; HBMP 2008).

Cyanea horrida (haha nui), a member of the bellflower family (Campanulaceae), is a palm-like tree found only on the island of Maui. This species was known historically from the slopes of Haleakala (Lammers 1999, p. 453; HBMP 2008). Currently, *C. horrida* is known from 12 occurrences totaling 44 individuals in the montane mesic, montane wet, and wet cliff ecosystems in Waikamoi Preserve, Hanawai Natural Area Reserve, and Haleakala National Park on east Maui (TNC 2007; HBMP 2008; PEPP 2009, p. 52; PEPP 2010, pp. 46–47; Oppenheimer 2010c, in litt.; TNCH 2010a, p. 1).

Cyanea kunthiana (haha), a shrub in the bellflower family (Campanulaceae), is found only on Maui, and was historically known from both the east and west Maui mountains (Lammers 1999, p. 453; HBMP 2008). *Cyanea kunthiana* was known to occur in the montane mesic ecosystem in the east Maui mountains in upper Kipahulu Valley, in Haleakala National Park and Kipahulu FR (HBMP 2008). Currently, in the east Maui mountains, *C. kunthiana* occurs in the lowland wet and montane wet ecosystems in Waikamoi Preserve, Hanawi Natural Area Reserve, East Bog, Kaapahu, and Kipahulu Valley. In the west Maui mountains, *C. kunthiana* occurs in the lowland wet and montane wet ecosystems at Eke Crater, Kahoolewa ridge, and at the junction of the Honokowai, Hahakea, and Honokohau gulches (TNC 2007; HBMP 2008; NTBG 2009e, pp. 1–3; Perlman 2010, in litt.; Oppenheimer 2010a, in litt.). The 15 occurrences total 165 individuals, although botanists speculate that this species may total as many as 400 individuals with further surveys of potential habitat on east and west Maui (TNC 2007; HBMP 2008; Fay 2010, in litt.; Oppenheimer 2010a, in litt.; Osternak 2010, in litt.).

Cyanea magnicalyx (haha), a perennial shrub in the bellflower family (Campanulaceae), is known from west Maui (Lammers 1999, pp. 449, 451; Lammers 2004, p. 84). Currently, there are seven individuals in three occurrences on west Maui: two individuals in Kaluanui, a subgulch of Honokohau Valley, in the lowland wet ecosystem; four individuals in Iao Valley in the wet cliff ecosystem; and one individual in a small drainage south of the Kauaula rim, in the montane mesic ecosystem (Lammers 2004, p. 87; Perlman 2009b in litt.; Wood 2009, in litt.).

Cyanea maritae (haha), a shrub in the bellflower family (Campanulaceae), is found only on Maui (Lammers 2004, p. 92). Sterile specimens were collected from the northwestern slopes of Haleakala in the Waiohiwi watershed and east to Kipahulu in the early 1900s. Between 2000 and 2002, fewer than 20 individuals were found in the Waiohiwi area (Lammers 2004, pp. 92, 93). Currently, there are 4 occurrences, totaling between 23 to 50 individuals in Kipahulu, Kaapahu, west Kahakapao, and in the Koolau FR in the lowland wet and montane wet ecosystems on east Maui (TNC 2007; Oppenheimer 2010b, in litt.; Welton 2010b, in litt.).

Cyanea mauiensis (haha), a perennial shrub in the bellflower family (Campanulaceae), was last observed on Maui about 100 years ago (Lammers 2004, pp. 84–85; TNC 2007). Although there are no documented occurrences of this species known today, botanists believe this species may still be extant as all potentially suitable lowland mesic and dry cliff habitat has not been surveyed.

Cyanea munroi (haha), a short-lived shrub in the bellflower family (Campanulaceae), is known from Molokai and Lanai (Lammers 1999, pp. 449, 451; Lammers 2004, pp. 84–87). Currently, there are no known individuals on Molokai (last observed in 2001), and only two individuals on Lanai at a single location, in the wet cliff ecosystem (TNC 2007; HBMP 2008; Perlman 2008a, in litt.; Wood 2009a, in litt.; Oppenheimer 2010d, in litt.).

Cyanea obtusa (haha), a shrub in the bellflower family (Campanulaceae), is found only on Maui (Lammers 1999, p. 458). Historically, this species was found in both the east and west Maui mountains (Hillebrand 1888, p. 254; HBMP 2008). Not reported since 1919 (Lammers 1999, p. 458), *C. obtusa* was rediscovered in the early 1980s at one site each on east and west Maui. However, by 1989, plants in both locations had disappeared (Hobdy *et al.* 1991, p. 3; Medeiros 1996, in litt.). In 1997, 4 individuals were observed in Manawainui Gulch in Kahikinui, and another occurrence of 5 to 10 individuals was found in Kahakapao Gulch, both in the montane mesic ecosystem on east Maui (Wood and Perlman 1997, p. 11; Lau 2001, in litt.). However, the individuals found at Kahakapao Gulch are now considered to be *Cyanea elliptica* or hybrids between *C. obtusa* and *C. elliptica* (PEPP 2007, p. 40). In 2001, several individuals were seen in Hanaula and Pohakea gulches on west Maui; however, only hybrids are currently known in this area (NTBG 2009f, p. 3). It is unknown if individuals of *C. obtusa* remain at Kahikinui, as access to the area to ascertain the status of these plants is difficult and has not been attempted since 2001 (PEPP 2008, p. 55; PEPP 2009, p. 58). Two individuals were observed on a cliff along Wailaulau Stream in the montane mesic ecosystem on east Maui in 2009 (Duvall 2010, in litt.). Currently, this species is known from one occurrence of only a few individuals in the montane mesic ecosystem on east Maui. Historically, this species also occurred in the lowland dry ecosystem at Manawainui on west Maui and at Ulupalakua on east Maui (HBMP 2008).

Cyanea profuga (haha), a shrub in the bellflower family (Campanulaceae), occurs only on Molokai (Lammers 1999, pp. 461–462; Wood and Perlman 2002, p. 4). Historically, this species was found in Mapulehu Valley and along Pelekunu Trail, and has not been seen in those locations since the early 1900s (Wood and Perlman 2002, p. 4). In 2002, six individuals were discovered along a stream in Wawaia Gulch (Wood and Perlman 2002, p. 4). In 2007, seven individuals were known from Wawaia Gulch, and an additional six individuals were found in Kumueli (Wood 2005, p. 17; USFWS 2007a; PEPP 2010, p. 55). In 2009, only four individuals remained at Wawaia Gulch; however, nine were found in Kumueli Gulch (Bakutis 2010, in litt.; Oppenheimer 2010e, in litt.; Perlman 2010, in litt.; PEPP 2010, p. 55). Currently, there are 4 occurrences totaling up to 34 individuals in the lowland mesic and montane wet ecosystems on Molokai (TNC 2007; Bakutis 2010, in litt.; Perlman 2010, in litt.).

Cyanea solanacea (popolo, haha nui), a shrub in the bellflower family (Campanulaceae), is found only on Molokai. According to Lammers (1999, p. 464) and Wagner (*et al.* 2005a–*Flora of the Hawaiian Islands database*) the range of *C. solanacea* includes Molokai and may also include west Maui. In his treatment of the species of the Hawaiian endemic genus *Cyanea,* Lammers (1999, p. 464) included a few sterile specimens of *Cyanea* from Puu Kukui, west Maui and the type specimen (now destroyed) for *C. scabra* var. *sinuata* from west Maui in *C. solanacea.* However, Oppenheimer recently reported (Oppenheimer 2010a, in litt.) that the plants on west Maui were misidentified as *C. solanacea* and are actually *C. macrostegia.* Based on Oppenheimer's recent field observations, the range of *C. solanacea* is limited to Molokai. Historically, *Cyanea solanacea* ranged from central Molokai at Kalae, eastward to Pukoo in the lowland mesic, lowland wet, and montane mesic ecosystems (HBMP 2008). Currently, there are four small occurrences at Hanalilolilo, near Pepeopae Bog, Kaunakakai Gulch, and Kawela Gulch, in the montane wet ecosystem. These occurrences total 26 individuals (Bakutis 2010, in litt.; Oppenheimer 2010a, in litt.; TNCH 2011, pp. 21, 57).

Cyrtandra ferripilosa (haiwale), a shrub in the African violet family (Gesneriaceae), occurs only on Maui (St. John 1987, pp. 497–498; Wagner and Herbst 2003, p. 29). This species was discovered in 1980 in the east Maui mountains at Kuiki in Kipahulu Valley (St. John 1987, pp. 497–498; Wagner *et al.* 2005a–*Flora of the Hawaiian Islands database*). Currently, there are a few individuals each in two occurrences at Kuiki and on the Manawainui plane in the montane mesic and montane wet ecosystems (Oppenheimer 2010f, in litt.; Welton 2010a, in litt.).

Cyrtandra filipes (haiwale), a shrub in the African violet family (Gesneriaceae), is found on Maui (Wagner *et al.* 1999d, pp. 753–754; Oppenheimer 2006b, in litt.). According to Wagner *et al.* (1999d, p. 754), the range of *C. filipes* includes Maui and Molokai. Historical collections from Kapunakea (1800) and Olowalu (1971) on Maui indicate it once had a wider range on this island. In 2004, it was believed there were over 2,000 plants at Honokohau and Waihee in the west Maui mountains; however, recent studies have shown that these plants do not match the description for *C. filipes* (Oppenheimer 2006b, in litt.). Currently, there are between 134 and 155 individuals in 4 occurrences in the lowland wet and wet cliff ecosystems at Kapalaoa, Honokowai, Honolua, and Waihee Valley on west Maui, and approximately 7 individuals at Mapulehu in the lowland mesic ecosystem on Molokai, with an historical occurrence in the lowland wet ecosystem (Oppenheimer 2010c, in litt.).

Cyrtandra oxybapha (haiwale), a shrub in the African violet family (Gesneriaceae), is found on Maui (Wagner *et al.* 1999d, p. 771). This species was discovered in the upper Pohakea Gulch in Hanaula in the west Maui mountains in 1986 (Wagner *et al.* 1989, p. 100; TNC 2007). Currently, there are 2 known occurrences with a total of 137 to 250 individuals. *Cyrtandra oxybapha* occurs in the montane wet ecosystem on west Maui, from Hanaula to Pohakea Gulch. This occurrence totals between 87 and 97 known individuals, with perhaps as many as 150 or more (Oppenheimer 2008c, in litt.). The current status of the 50 to 100 individuals in the montane mesic ecosystem in Manawainui Gulch on east Maui is unknown, as these plants have not been surveyed since 1997 (Oppenheimer 2010a, in litt.).

Festuca molokaiensis (NCN), a member of the grass family (Poaceae), is found on Molokai (Catalan *et al.* 2009, p. 54). This species is only known from the type locality at Kupaia Gulch, in the lowland mesic ecosystem (Catalan *et al.* 2009, p. 55). Last seen in 2009, the current number of individuals is unknown; however, field surveys for *F. molokaiensis* at Kupaia Gulch are planned for 2011 (Oppenheimer 2010g, in litt.). Oppenheimer (2011, pers. comm.) suggests that the drought over the past couple of years on Molokai may have suppressed the growth of *F. molokaiensis* and prevented its observation by botanists in the field. He also suggested that this species may be an annual whose growth will be stimulated by normal rainfall patterns.

Geranium hanaense (nohoanu), a shrub in the geranium family (Geraniaceae), is found on Maui (Wagner *et al.* 1999e, pp. 730–732). This species was first collected in 1973, from two adjacent montane bogs on the northeast rift of Haleakala, east Maui (Medeiros and St. John 1988, pp. 214–220). At that time, there were an estimated 500 to 700 individuals (Medeiros and St. John 1988, pp. 214–220). Currently, *G. hanaense* occurs in ''Big Bog'' and ''Mid Camp Bog'' in the montane wet ecosystem on the northeast rift of Haleakala, with the same number of estimated individuals (Welton 2008, in litt.; Welton 2010a, in litt.; Welton 2010b, in litt.).

Geranium hillebrandii (nohoanu), a shrub in the geranium family (Geraniaceae), is found on Maui (Aedo and Munoz Garmendia 1997; p. 725; Wagner *et al.* 1999e, pp. 732–733; Wagner and Herbst 2003, p. 28). Little is known of the historical locations of *G. hillebrandii,* other than the type collection made in the 1800s at Eke Crater, in the west Maui mountains (Hillebrand 1888, p. 56). Currently, 4 occurrences total over 10,000 individuals, with the largest 2 occurrences in the west Maui bogs, from Puu Kukui to East Bog and Kahoolewa ridge. A third occurrence is at Eke Crater and the surrounding area, and the fourth occurrence is at Lihau (HBMP 2008; Oppenheimer 2010h, in litt.). These occurrences are found in the montane wet and montane mesic ecosystems on west Maui (TNC 2007).

Mucuna sloanei var. *persericea* (sea bean), a vine in the pea family (Fabaceae), is found on Maui (Wilmot-Dear 1990, pp. 27–29; Wagner *et al.* 2005a–*Flora of the Hawaiian Islands database*). In her revision of *Mucuna* in the Pacific Islands, Wilmot-Dear recognized this variety from Maui based on leaf indumentum (covering of fine hairs or bristles) (Wilmot-Dear 1990, p. 29). At the time of Wilmot-Dear's publication, *M. sloanei* var. *persericea* ranged from Makawao to Wailua Iki, on the windward slopes of the east Maui mountains (Wagner *et al.* 2005a–*Flora of the Hawaiian Islands database*). Currently, there are possibly a few hundred individuals in five occurrences: Ulalena Hill, north of Kawaipapa Gulch, lower Nahiku, Koki Beach, and Piinau Road, all in the lowland wet ecosystem on east Maui (Duvall 2010, in litt.; Hobdy 2010, in litt.).

Myrsine vaccinioides (kolea), a shrub in the myrsine family (Myrsinaceae), is found on Maui (Wagner *et al.* 1999f, p. 946; HBMP 2008). This species was historically known from shrubby bogs near Violet Lake on west Maui (Wagner *et al.* 1999f, p. 946). In 2005, three occurrences of a few hundred individuals were reported at Eke, Puu Kukui and near Violet Lake (Oppenheimer 2006c, in litt.). Currently, there are estimated to be several hundred, but fewer than 1,000, individuals scattered in the summit area of the west Maui mountains at Eke Crater, Puu Kukui, Honokowai-Honolua, and Kahoolewa, in the montane wet ecosystem (Oppenheimer 2010i, in litt.).

Peperomia subpetiolata (alaala wai nui), a perennial herb in the pepper family (Piperaceae), is found on Maui (Wagner *et al.* 1999g, p. 1035; HBMP 2008). Historically, *P. subpetiolata* was known only from the lower Waikamoi (Kula pipeline) area on the windward side of Haleakala on east Maui (Wagner *et al.* 1999g, p. 1,035; HBMP 2008). In 2001, it was estimated that 40 individuals occurred just west of the Makawao-Koolau FR boundary, in the montane wet ecosystem. *Peperomia cookiana* and *P. hirtipetiola* also occur in this area, and are known to hybridize with *P. subpetiolata* (NTBG 2009g, p. 2; Oppenheimer 2010j, in litt.). In 2007, 20 to 30 hybrid plants were observed at Maile Trail, and at three areas near the Waikamoi Flume road (NTBG 2009g, p. 2). Based on the 2007 and 2010 surveys, all known plants are now considered to be hybrids mostly between *P. subpetiolata* and *P. cookiana,* with a smaller number of hybrids between *P. subpetiolata* and *P. hirtipetiola* (NTBG 2009g, p. 2; Lau 2011, in litt.). *Peperomia subpetiolata* is recognized as a valid species, and botanists continue to search for plants in its previously known locations as well as in new locations with potentially suitable habitat (NTBG 2009g, p. 2; PEPP 2010, p. 96; Lau 2011, pers. comm.).

Phyllostegia bracteata (NCN), a perennial herb in the mint family (Lamiaceae), is found on Maui (Wagner *et al.* 1999h, pp. 814–815). Historically, this species was known from the east Maui mountains at Ukulele, Puu Nianiau, Waikamoi Gulch, Koolau Gap, Kipahulu, Nahiku-Kuhiwa trail, Waihoi Valley, and Manawainui; and from the west Maui mountains at Puu Kukui and Hanakaoo (HBMP 2008). This species appears to be short-lived, ephemeral, and disturbance-dependent, in the lowland wet, montane mesic, montane wet, subalpine, and wet cliff ecosystems (NTBG 2009h, p. 1). There have been several reported sightings of *P. bracteata* between 1981 and 2001, at Waihoi Crater Bog, Waikamoi Preserve, Waikamoi flume, and Kipahulu on east Maui, and at Pohakea Gulch on west Maui; however, none of these individuals were extant as of 2009 (PEPP 2009, pp. 89–90). In 2009, one individual was found at Kipahulu, near Delta Camp, on east Maui, but was not relocated on a follow-up survey during that same year (NTBG 2009h, p. 3). Botanists continue to search for *P. bracteata* in previously reported locations, as well as in other areas with potentially suitable habitat (NTBG 2009h, p. 3; PEPP 2009, pp. 89–90).

Phyllostegia haliakalae (NCN), a vine in the mint family (Lamiaceae), is known from Molokai, Lanai, and east Maui (Wagner 1999, p. 269). The type specimen was collected by Wawra in 1869 or 1870, in a dry ravine at the foot of Haleakala. An individual was found in flower on the eastern slope of Haleakala, in the wet cliff ecosystem, in 2009; however, this plant has died (TNC 2007; Oppenheimer 2010b, in litt.). Collections were made before the plant died, and propagules outplanted in the Puu Mahoe Arboretum (three plants) and Olinda Rare Plant Facility (four plants) (Oppenheimer 2011b, in litt.). In addition, this species has been outplanted in the lowland wet, montane wet, and montane mesic ecosystems of Haleakala National Park (HNP 2012, in litt.). Botanists continue to search in areas with potentially suitable habitat for wild individuals of this plant (Oppenheimer 2010b, in litt.). *Phyllostegia haliakalae* was last reported from the lowland mesic ecosystem on Molokai in 1928, and from the dry cliff and wet cliff ecosystems on Lanai in the early 1900s (TNC 2007; HBMP 2008). Currently no individuals are known in the wild on Maui, Molokai, or Lanai; however, over 100 individuals have been outplanted (HNP 2012, in litt).

Phyllostegia pilosa (NCN), a vine in the mint family (Lamiaceae), is known from east Maui (Wagner 1999, p. 274). There are two occurrences totaling seven individuals west of Puu o Kakae on east Maui, in the montane wet ecosystem (TNC 2007; HBMP 2008). The individuals identified as *P. pilosa* on Molokai, at Kamoku Flats (montane wet ecosystem) and at Mooloa (lowland mesic ecosystem), have not been observed since the early 1900s (TNC 2007; HBMP 2008).

Pittosporum halophilum (hoawa), a shrub or small tree in the pittosporum family (Pittosporaceae), is found on Molokai (Wood 2005, pp. 2, 41). This species was reported from Huelo islet, Mokapu Island, Okala Island, and Kukaiwaa peninsula. On Huelo islet, there were two individuals in 1994, and in 2001, only one individual remained (Wood *et al.* 2001, p. 12; Wood *et al.* 2002, pp. 18–19). The current status of this species on Huelo islet is unknown. On Mokapu Island, there were 15 individuals in the coastal ecosystem in 2001, and in 2005, 10 individuals remained. On Okala Island, there were two individuals in 2005, and one individual on the sea cliff at Kukaiwaa peninsula (Wainene) (Wood 2005, pp. 2, 41). As of 2010, there were three occurrences totaling five individuals: Three individuals on Mokapu Island, one individual on Okala Island, and one individual on Kukaiwaa peninsula (Bakutis 2010, in litt.; Hobdy 2010, in litt.; Perlman 2010, in litt.). At least 17 individuals have been outplanted at 3 sites on the coastline of the nearby Kalaupapa peninsula (Garnett 2010a, in litt.).

Pleomele fernaldii (hala pepe), a tree in the asparagus family (Asparagaceae), is found only on the island of Lanai (Wagner *et al.* 1999i, p. 1,352; Wagner and Herbst 2003, p. 67). Historically known throughout Lanai, this species is currently found in the lowland dry, lowland mesic, lowland wet, dry cliff, and wet cliff ecosystems, from Hulopaa and Kanoa gulches southeast to

Waiakeakua and Puhielelu (St. John 1947, pp. 39–42 cited in St. John 1985, pp. 171, 177–179; HBMP 2006; HBMP 2008; PEPP 2008, p. 75; Oppenheimer 2010d, in litt.). Currently, there are several hundred to perhaps as many as 1,000 individuals. The number of individuals has decreased by about one-half in the past 10 years (there were more than 2,000 individuals in 1999), with very little recruitment observed recently (Oppenheimer 2008d, in litt.).

Santalum haleakalae var. *lanaiense* (iliahi, Lanai sandalwood) is a tree in the sandalwood family (Santalaceae). Currently, *S. haleakalae* var. *lanaiense* is known from Molokai, Lanai, and Maui, in 26 occurrences totaling fewer than 100 individuals (Wagner *et al.* 1999c, pp. 1,221–1,222; HBMP 2008; Harbaugh *et al.* 2010, pp. 834–835). On Molokai, there are more than 12 individuals in 4 occurrences from Kikiakala to Kamoku Flats and Puu Kokekole, with the largest concentration at Kumueli Gulch, in the montane mesic and lowland mesic ecosystems (Harbaugh *et al.* 2010, pp. 834–835). On Lanai, there are approximately 10 occurrences totaling 30 to 40 individuals: Kanepuu, in the lowland mesic ecosystem (5 individuals); the headwaters of Waiopae Gulch in the lowland wet ecosystem (3 individuals); the windward side of Hauola on the upper side of Waiopae Gulch in the lowland mesic ecosystem (1 individual); the drainage to the north of Puhielelu Ridge and exclosure, in the headwaters of Lopa Gulch in the lowland mesic ecosystem (3 individuals); 6 occurrences near Lanaihale in the montane wet ecosystem (21 individuals); and the mountains east of Lanai City in the lowland wet ecosystem (a few individuals) (HBMP 2008; Harbaugh *et al.* 2010, pp. 834–835; HBMP 2010; Wood 2010a, in litt.). On west Maui, there are eight single-individual occurrences: Hanaulaiki Gulch in the lowland dry ecosystem; Kauaula and Puehuehunui Gulches in the lowland mesic, montane mesic, and wet cliff ecosystems; Kahanahaiki Gulch and Honokowai Gulch in the lowland wet ecosystem; Wakihuli in the wet cliff ecosystem; and Manawainui Gulch in the montane mesic and lowland dry ecosystems (HBMP 2008; Harbaugh *et al.* 2010, pp. 834–835; Wood 2010a, in litt.). On east Maui, there are 4 occurrences (10 individuals) in Auwahi, in the montane mesic, montane dry, and lowland dry ecosystems (TNC 2007; HBMP 2008; Harbaugh *et al.* 2010, pp. 834–835).

Schiedea jacobii (NCN), a perennial herb or subshrub in the pink family (Caryophyllaceae), occurs only on Maui (Wagner *et al.* 1999j, p. 284). Discovered in 1992, the single occurrence consisted of nine individuals along wet cliffs between Hanawi Stream and Kuhiwa drainage (in Hanawi Natural Area Reserve), in the montane wet ecosystem on east Maui (Wagner *et al.* 1999j, p. 286). By 1995, only four plants could be relocated in this location. It appeared that the other five known individuals had been destroyed by a landslide (Wagner *et al.* 1999j, p. 286). In 2004, one seedling was observed in the same location, and in 2010, no individuals were relocated (Perlman 2010, in litt.). The State of Hawaii plans to outplant propagated individuals in a fenced area in Hanawi Natural Area Reserve in 2011 (Oppenheimer 2010a, in litt.; Perlman 2010, in litt.).

Schiedea laui (NCN), a perennial herb or subshrub in the pink family (Caryophyllaceae), is found only on Molokai (Wagner *et al.* 2005b, pp. 90–92). In 1998, when this species was first observed, there were 19 individuals located in a cave along a narrow stream corridor at the base of a waterfall in the Kamakou Preserve, in the montane wet ecosystem (Wagner *et al.* 2005b, pp. 90–92). By 2000, only 9 individuals with a few immature plants and seedlings were relocated, and in 2006, 13 plants were seen (Wagner *et al.* 2005b, pp. 90–92; PEPP 2007, p. 57). Currently, there are 24 to 34 individuals in the same location in Kamakou Preserve (Bakutis 2010, in litt.).

Schiedea salicaria (NCN), a shrub in the pink family (Caryophyllaceae), occurs on Maui (Wagner *et al.* 1999j, pp. 519–520). It is historically known from a small area on west Maui, from Lahaina to Waikapu. Currently, this species is found in three occurrences: Kaunoahua gulch (500 to 1,000 individuals), Puu Hona (about 50 individuals), and Waikapu Stream (3 to 5 individuals), in the lowland dry ecosystem on west Maui (TNC 2007; Oppenheimer 2010k, in litt.; Oppenheimer 2010l, in litt.). Hybrids and hybrid swarms (hybrids between parent species, and subsequently formed progeny from crosses among hybrids and crosses of hybrids to parental species) between *S. salicaria* and *S. menziesii* are known on the western side of west Maui (Wagner *et al.* 2005b, p. 138). However, according to Weller (2012, in litt.) the hybridization process is natural when *S. salicaria* and *S. menziesii* co-occur and because of the dynamics in this hybrid zone, traits of *S. salicaria* prevail and replace those of *S. menziesii.* Weller (2012, in litt.) notes that populations of both species will likely remain distinct because the two species do not overlap throughout much of their range.

Stenogyne kauaulaensis (NCN), a vine in the mint family (Lamiaceae), occurs on Maui. This recently described (2008) plant is found only along the southeastern rim of Kauaula Valley, in the montane mesic ecosystem on west Maui (TNC 2007; Wood and Oppenheimer 2008, pp. 544–545). At the time *S. kauaulaensis* was described, the authors reported a total of 15 individuals in one occurrence. However, one of the authors reports that due to the clonal (genetic duplicate) growth habit of this species, botanists believe it is currently represented by only three genetically distinct individuals (Oppenheimer 2010k, in litt.).

Wikstroemia villosa (akia), a shrub or tree in the akia family (Thymelaeaceae), is found on Maui (Peterson 1999, pp. 1,290–1,291). Historically known from the lowland wet, montane wet, and montane mesic ecosystems on east and west Maui, this species is currently known from a recent discovery (2007) of one individual on the windward side of Haleakala (on east Maui), in the montane wet ecosystem (Peterson 1999, p. 1,291; TNC 2007; HBMP 2008). As of 2010, there was one individual and one seedling at the same location (Oppenheimer 2010m, in litt.). In addition, three individuals have been outplanted in Waikamoi Preserve (Oppenheimer 2010m, in litt.).

Animals

Newcomb's tree snail (*Newcombia cumingi*), a member of the family Achatinellidae and the endemic Hawaiian subfamily Achatinellinae (Newcomb 1853, p. 25), is known only from the island of Maui (Cowie *et al.* 1995, p. 62). All members of this species have sinistral (left-coiling), oblong, spindle-shaped shells of five to seven whorls that are coarsely sculptured (Cooke and Kondo 1960, pp. 9, 33). Newcomb's tree snail reaches an adult length of approximately 0.8 in (21 mm) and its shell is mottled in shades of brown that blend with the bark of its native host plant, *Metrosideros polymorpha* (ohia) (Pilsbry and Cooke 1912–1914, p. 10; Thacker and Hadfield 1998, p. 4). The exact life span and fecundity of Newcomb's tree snails is unknown, but they attain adult size within 4 to 5 years (Thacker and Hadfield 1998, p. 2). Newcomb's tree snail is believed to exhibit the low reproductive rate of other Hawaiian tree snails belonging to the same family (Thacker and Hadfield 1998, p. 2). It feeds on fungi and algae that grow on the leaves and trunks of its host plant (Pilsbry and Cooke 1912–1914, p. 103). Historically, this species was distributed from the west Maui mountains (near Lahaina and Wailuku) to the slopes of Haleakala (Makawao) on east Maui (Pilsbry and Cooke 1912–1914, p. 10). In 1994, a small population of Newcomb's tree snail was found on a single ridge on the northeastern slope of the west Maui mountains, in the lowland wet ecosystem (Thacker and Hadfield 1998, p. 3; TNC 2007). Eighty-six snails were documented in the same location in 1998; in 2006, only nine individuals were located; and, in 2012, only one individual was located (Thacker and Hadfield 1998, p. 2; Hadfield 2007, p. 8; Higashino 2013, in litt.).

Partulina semicarinata (Lanai tree snail, pupu kani oe), a member of the family Achatinellidae and the endemic Hawaiian subfamily Achatinellinae, is known only from the island of Lanai (Pilsbry and Cooke 1912–1914, p. 86). The shell may coil to the right (dextral) or left (sinistral), but appears to be constant within a population. The oblong to ovate shells of the adult are 0.6 to 0.8 in (16 to 20 mm) long, have 5 to 7 whorls, and range in color from rusty brown to white, with some individuals having bands around the shells. The shell has a distinctive keel that runs along the last whorl, and is more distinctive in juveniles (Pilsbry and Cooke 1912–1914, pp. 86–88). Adults may attain an age exceeding 15 to 20 years, and reproductive output is low, with an adult snail giving birth to 4 to 6 live young per year (Hadfield and Miller 1989, pp. 10–12). *Partulina semicarinata* is arboreal and nocturnal, and grazes on fungi and algae growing on leaf surfaces (Pilsbry and Cooke 1912–1914, p. 103). This snail species is found on the following native host plants: *Metrosideros polymorpha, Broussaisia arguta* (kanawao), *Psychotria* spp. (kopiko), *Coprosma* spp. (pilo), *Melicope* spp. (alani), and dead *Cibotium glaucum* (tree fern, hapuu). Occasionally the snail is found on nonnative plants such as *Psidium guajava* (guava), *Cordyline australis* (New Zealand tea tree), and *Phormium tenax* (New Zealand flax) (Hadfield 1994, p. 2). Historically, *P. semicarinata* was found in wet and mesic *M. polymorpha* forests on Lanai. There are no historical population estimates for this snail, but qualitative accounts of Hawaiian tree snails indicates they were widespread and abundant, possibly numbering in the tens of thousands between the 1800s and early 1900s (Hadfield 1986, p. 69). In 1993, 105 individuals of *P. semicarinata* were found during surveys conducted in its historical range. Subsequent surveys in 1994, 2000, 2001, and 2005 documented 55, 12, 4, and 29 individuals, respectively, in the lowland wet, montane wet, and wet cliff ecosystems in central Lanai (Hadfield 2005, pp. 3–5; TNC 2007).

Partulina variabilis (Lanai tree snail, pupu kani oe), a member of the family Achatinellidae and the endemic Hawaiian subfamily Achatinellinae, is known only from the island of Lanai (Pilsbry and Cooke 1912–1914, p. 86). The shell may coil to the right (dextral) or left (sinistral), and both types can be found within a single population. The oblong to ovate shells of the adult are 0.5 to 0.6 in (14 to 16 mm) long, have 5 to 7 whorls, and have a white base color with no bands or a variable number of spiral bands around the shells (Pilsbry and Cooke 1912–1914, pp. 67, 83–86). Adults may attain an age exceeding 15 to 20 years, and reproductive output is low, with an adult snail giving birth to 4 to 6 live young per year (Hadfield and Miller 1989, pp. 10–12). *Partulina variabilis* is arboreal and nocturnal, and grazes on fungi and algae growing on leaf surfaces (Pilsbry and Cooke 1912–1914, p. 103). This snail is found on the following native host plants: *Metrosideros polymorpha, Broussaisia arguta, Psychotria* spp., *Coprosma* spp., *Melicope* spp., and dead *Cibotium glaucum*. Occasionally *Partulina variabilis* is found on nonnative plants such as *Psidium guajava* and *Cordyline australis* (Hadfield 1994, p. 2). Historically, *Partulina variabilis* was found in wet and mesic *M. polymorpha* forests on Lanai. There are no historical population estimates for this snail, but qualitative accounts of Hawaiian tree snails indicate they were widespread and abundant, possibly numbering in the tens of thousands between the 1800s and early 1900s (Hadfield 1986, p. 69). In 1993, 111 individuals of *P.variabilis* were found during surveys conducted in its historical range. Subsequent surveys in 1994, 2000, 2001, and 2005 documented 175, 14, 6, and 90 individuals, respectively, in the lowland wet, montane wet, and wet cliff ecosystems in central Lanai (Hadfield 2005, pp. 3–5; TNC 2007).

Summary of Comments and Recommendations

On June 11, 2012, we published a proposed rule to list 38 Maui Nui species (35 plants and 3 tree snails) as endangered and reevaluate the listing of 2 Maui Nui plant species as endangered throughout their ranges, and to designate critical habitat for 135 species (77 FR 34464). The proposed rule opened a 60-day comment period. On August 9, 2012 (77 FR 47587), we extended the comment period for the proposed rule for an additional 30 days, ending September 10, 2012. We requested that all interested parties submit comments or information concerning the proposed listing and designation of critical habitat for 135 species. 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 June 20, 2012, in the local Honolulu Star Advertiser, Maui Times, and Molokai Dispatch newspapers, at the beginning of the comment period. We received three requests for public hearings. On January 31, 2013, we published a notice (78 FR 6785) reopening the comment period on the June 11, 2012, proposed rule (77 FR 34464), 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. This comment period closed on March 4, 2013. In addition, in that same notice (January 31, 2013; 78 FR 6785) we announced a public information meeting and hearing, which we held in Kihei, Maui, on February 21, 2013.

During the comment periods, we received a total of 47 comment letters on the proposed listing of 38 species, reevaluation of listing for 2 species, and proposed designation of critical habitat. For the reasons stated above, in this final rule we address only the comments regarding the proposed listing of 38 species and reevaluation of listing for 2 species. Ten of the 47 letters contained comments on both the proposed listing and proposed designation of critical habitat. Two of the 47 letters contained comments only on the proposed listing of 38 species and reevaluation of listing for 2 species. Three of the four peer reviewers who provided comments commented on the proposed listing of one or more of the 38 species or on the proposed listing and proposed critical habitat designation. One commenter was a State of Hawaii agency (Hawaii Department of Health), one was a Federal agency (Kalaupapa National Historical Park), and eight were nongovernmental organizations or individuals. During the February 21, 2013, public hearing, 25 individuals or organizations made comments on the proposed listing.

All substantive information provided during the comment periods related to the listing decisions has either been incorporated directly into this final determination or is addressed below. Information we received related to the proposed critical habitat designation will be addressed in that final rule. Comments received are grouped into general issues specifically relating to the proposed listing status of the 35 plants or the proposed listing status of the 3 tree snails, and are addressed in the following summary and incorporated into the final rule as appropriate. No comments were received regarding the reevaluation of listing for *Cyanea grimesiana* ssp. *grimesiana* or *Santalam healeakalae* var. *lanaiense.* No comments were received regarding the delisting of *Gahnia lanaiensis* due to taxonomic error.

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 10 knowledgeable individuals with scientific expertise on the Maui Nui plants, snails, and forest birds and their habitats, including familiarity with the species, the geographic region in which these species occur, and conservation biology principles. We received responses from four of the peer reviewers. Of these four peer reviewers, one provided comments only on the proposed critical habitat designation for two endangered forest birds. These comments are not addressed in this final rule, which addresses only the listing of the 38 Maui Nui species (35 plants and 3 tree snails), and the reaffirmation of listing of 2 Maui Nui plant species. Three peer reviewers provided comments on the listing of the 38 Maui Nui species and reevaluation of listing for 2 species. These peer reviewers generally supported our methodology and conclusions. Two 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 three reviewers provided new information on one or more of the Maui Nui species, which we incorporated into this final rule. In addition, peer reviewers provided information on citations for published studies on ungulate exclusions and nonnative plant control. We reviewed all comments we received from the peer reviewers for substantive issues and new information regarding the listing of 38 species and reevaluation of the listing of 2 species. Peer reviewer comments are addressed in the following summary and incorporated into the final rule as appropriate.

General Peer Review Comments

(1) *Comment:* One peer reviewer noted the absence of a literature cited section for the proposed rule.

Our Response: Although not included with the proposed rule itself, information on how to obtain a list of our supporting documentation used was provided in the proposed rule under Public Comments and References Cited (77 FR 34464; June 11, 2012). In addition, lists of references cited in the proposed rule (77 FR 34464; June 11, 2012) and in this final rule are available on the Internet at *http://www.regulations.gov* at Docket No. FWS–R1–ES–2011–0098, and upon request from the Pacific Islands Fish and Wildlife Office (see **FOR FURTHER INFORMATION CONTACT**).

(2) *Comment:* One peer reviewer provided additional information regarding the biogeographical differences between east and west Maui.

Our Response: We have included this information in this final rule and corrected statements about the range of annual rainfall on east Maui (Giambelluca *et al.* 2011), the diversity of vegetation in the mesic and wet ecosystems of east Maui relative to west Maui (Price 2004, p. 493), and the geologic age of the youngest lava flows found within the Cape Kinau region of east Maui (Sherrod *et al.* 2007, p. 40) (see *The Islands of Maui Nui,* above).

Peer Review Comments on Plants

(3) *Comment:* One peer reviewer suggested that the proposed rule's discussion about invasive plant species did not emphasize a comparison of the wide-ranging level of impacts between the various invasive plant species.

Our Response: In the proposed rule, we provided a list of 71 nonnative plant species that have been documented as serious and ongoing threats to 36 of the 40 species proposed or reevaluated for listing throughout their ranges by destroying or modifying habitat. We provided a short description for each of the 71 nonnative plant species that included the best available information on growth form, place of origin, reproductive biology, dispersal, competition with native species, environmental tolerance, and measures for their control in Hawaiian habitats, as well as synergistic impacts with other habitat modifying threat factors such as nonnative ungulates, agricultural development, and fire. In addition, we identified the nonnative plant species documented as threats in each of the 10 ecosystems. Finally, we identified each species that is considered invasive by one or more of the following sources: Hawaii-Pacific Weed Risk Assessment, U.S. Department of Agriculture-Natural Resources Conservation Service (USDA–NRCS) plant database (2011), or the Hawaii State noxious weed list (H.A.R. Title 4, Subtitle 6, Chapter 68). Therefore, we believe the information we provided in the proposed rule adequately emphasizes a comparison of the wide-ranging level of impacts between the various invasive plant species.

(4) *Comment:* One peer reviewer suggested that we understated the seriousness of the effects of the invasive plant species *Blechnum appendiculatum* and provided additional information about the ecology of this species to better illustrate its impacts.

Our Response: We appreciate the information provided for the invasive plant *Blechnum appendiculatum* and have included it in our final rule (see Summary of Changes From Proposed Rule, below).

(5) *Comment:* One peer reviewer recommended that we include, where applicable, further elaboration on the synergistic interactions between nonnative plants and animals, and global climate change, and their confluent impacts upon native habitats described in the proposed rule.

Our Response: We discuss the synergistic effects of climate change and nonnative species under ''Habitat Destruction and Modification by Climate Change'' and ''Summary of Habitat Destruction and Modification,'' below; however, the magnitude and intensity of the impacts of global climate change and increasing temperatures on native Hawaiian ecosystems are unknown at this time.

(6) *Comment:* Although drought was not identified as a threat to *Schiedea laui* in our proposed rule, one peer reviewer suggested that it may also be a threat to this species. According to the reviewer, between 1998 and 2000, 7 of the 16 known mature individuals died from prolonged drought. In addition, the reviewer suggested that drought should be considered a threat to *S. salicaria* as it exacerbates the likelihood of fire, which is identified as a threat to this species.

Our Response: Drought was indicated as a threat to *Schiedea laui* with the observation of the extirpation of 7 of the 16 individuals by 2000 in Wagner *et al.* (2005b); however, we have information from more recent botanical surveys and observations that the current threats to individuals at this location are flooding and landslides (MNTF 2010). In the long term, drought may be a threat if this species is dependent upon the constant water source provided at the grotto in which it occurs, and annual precipitation amounts fall due to weather changes associated with the global warming trend. Also, we agree that drought can lead to increased incidences of wildfire, especially in the area of west Maui where *S. salicaria* occurs. We appreciate the information provided by the reviewer and have incorporated it, as appropriate, into TABLE 4—SUMMARY OF PRIMARY THREATS IDENTIFIED FOR EACH OF THE 40 MAUI NUI SPECIES and ''Habitat Destruction and Modification Due to Landslides, Rockfalls, Treefalls, Flooding, and Drought'' in this final rule (see below).

(7) *Comment:* One peer reviewer noted that our proposed rule states that nonnative plants in the lowland mesic ecosystem and the lowland dry ecosystem are a threat to the plant *Schiedea salicaria.* According to the reviewer, *S. salicaria* is usually found in lowland dry habitats, not in lowland mesic habitat.

Our Response: In our proposed rule, *Schiedea salicaria* is reported from three occurrences in the lowland dry ecosystem on west Maui (77 FR 34464, Table 2C and p. 34481; June 11, 2012). This species was included as one of the proposed species affected by nonnative plants in the lowland mesic ecosystem (see ''Nonnative Plants in the Lowland Mesic Ecosystem'' in the proposed rule) in error. We appreciate the correction.

(8) *Comment:* One peer reviewer corrected our description of hybrid swarms in the discussion of the proposed plant *Schiedea salicaria* to say that a hybrid swarm consists of hybrids between parent species, and subsequently formed progeny from crosses among hybrids and crosses of hybrids to parental species. While this process is noted as a threat to *S. salicaria* in Table 3 and in Proposed Determination for 40 Species in our proposed rule, the reviewer points out that the hybridization process is natural when *S. salicaria* and *S. menziesii* co-occur and because of the dynamics in this hybrid zone, traits of *S. salicaria* prevail and replace those of *S. menziesii.* The reviewer notes, however, that populations of both species will likely remain distinct because the two species do not overlap throughout much of their range.

Our Response: We appreciate the peer reviewer's comments and have added that the traits of *Schiedea salicaria* prevail and replace those of *S. menziesii* in hybrid zones (see Description of the 40 Maui Nui Species, above). In addition, we have removed hybridization as a threat to *S. salicaria* in this final rule; however, wildfires could possibly adversely impact the remaining non-hybridizing occurrences of *S. salicaria* on west Maui (see ''Habitat Destruction and Modification by Fire,'' below).

(9) *Comment:* One peer reviewer suggested that we highlight the positive interactions between drought and nonnative plant species, to the detriment of native plant species, in our discussion of ''Climate Change and Precipitation.'' According to this reviewer, these effects may be subtle, as demonstrated by *Blechnum appendiculatum* (see *Comment 4,* above), or dramatic, as demonstrated during a fire on west Maui that occurred in the area of the two largest populations of *Schiedea salicaria,* and likely spread rapidly due to the presence of invasive nonnative grasses and drought conditions.

Our Response: We agree that in the Hawaiian Islands there is a positive correlation between drought (caused by a reduction in moisture availability due to long periods of decline in annual precipitation), the presence of nonnative plants (particularly fire-prone grasses), and wildfire. We discuss the effects of the grass/fire cycle and the contribution to this cycle by drying trends caused by global warming (see ''Habitat Destruction and Modification by Fire,'' and ''Climate Change and Precipitation,'' below).

(10) *Comment:* One peer reviewer suggested that our discussion of the effects of the nonnative grass *Pennisetum setaceum* (*Cenchrus setaceus;* fountain grass) on dry forests on Hawaii Island should include direct competition with native species in addition to the threat it poses to native habitat from wildfires.

Our Response: The peer reviewer is referring to our discussion of ''Habitat Destruction and Modification by Fire.'' In that discussion, we note that on a post-burn survey at Puu Waawaa on Hawaii Island no regeneration of native canopy plants was occurring within the burn area. According to Takeuchi (1991, pp. 4, 6) nonnative *Pennisetum* sp. increased the number of fires and suppressed the establishment of native plants after a fire. We appreciate the additional information provided by the reviewer, including citations for published articles on the effects of nonnative fountain grass on wildfire and competition with native plant species, and we have added the information to our final rule (see ''Habitat Destruction and Modification by Fire,'' below).

(11) *Comment:* One peer reviewer noted that the discussion on invasive plant species did not include sufficient information regarding those species for which the State of Hawaii has introduced biological control agents. The peer reviewer specifically highlighted four invasive plants, *Psidium cattleianum* (strawberry guava), *Clidemia hirta* (Koster's curse), *Hedychium gardnerianum* (kahili ginger), and *Cyathea cooperi* (*Sphaeropteris cooperi,* Australian tree fern) and suggested that we include further discussion on the potential importance of biocontrol in addressing the very severe threats posed by these otherwise intractable invasive plant species.

Our Response: We agree that the use of biological control is a significant contribution to a multi-layered approach at management of the various nonnative plants threatening Hawaiian native flora. Between 1902 and 2010, approximately 84 insect and fungal agents have been introduced in Hawaii to control approximately 24 target nonnative plants (Conant *et al.* [in press], pp. 1–2, 15–19). Approximately 42 of these biological control agents are established in the Hawaiian Islands, and 12 of these have demonstrated substantial effects (i.e., the targeted nonnative plant species have been suppressed over a large portion of their ranges) toward control of their intended nonnative plant target, including *Ageratina adenophora* (Maui pamakani), *A. riparia* (Hamakua pamakani), and *Lantana camara* (lantana) (McFadyen 2000, pp. 4–7; Conant *et al.* [in press], pp. 1–2, 15–19). These three nonnative plants pose serious and ongoing threats to habitat in six of the ecosystems (lowland dry, lowland wet, montane mesic, montane wet, dry cliff, and wet cliff), that support one or more of the 40 species addressed in this final rule (see ''Habitat Destruction and Modification by Nonnative Plants'' in the June 11, 2012 (77 FR 34464), proposed rule). The Service remains cautiously optimistic about the use of biological control agents as a potentially significant contribution to a multi-layered approach to management of the various nonnative plants threatening Hawaiian native flora, including the recent introductions to control the ubiquitous, nonnative strawberry guava that poses a serious and ongoing threat to habitat in five of the ecosystems (lowland mesic, lowland wet, montane dry, montane mesic, and montane wet) that support one or more of the 40 species addressed in this final rule (see ''Habitat Destruction and Modification by Nonnative Plants'' in the June 11, 2012

(77 FR 34464), proposed rule). However, the lack of post-introduction monitoring for most past introductions is of concern, and the largely anectodal evaluations of past introductions precludes our ability to sufficiently evaluate and conjecture, upon their long-term success.

Peer Review Comment on Lanai Tree Snails

(12) *Comment:* One peer reviewer recommended additional emphasis on the impacts of axis deer and mouflon sheep upon the habitat of the snails. The reviewer stated that the feeding and trampling activities of these ungulates removes the fern and vegetation layer around the snails' host trees, so that dispersal of snails between host substrates is either prevented or greatly reduced.

Our Response: We agree with the peer reviewer that the feeding and trampling activities of ungulates removes the fern and vegetation layer around the snails' host trees, and we have included information regarding the impact of axis deer and mouflon sheep upon the habitat of the Lanai tree snails in this final rule (see TABLE 4–SUMMARY OF PRIMARY THREATS IDENTIFIED FOR EACH OF THE 40 MAUI NUI SPECIES and ''Habitat Destruction and Modification by Introduced Ungulates,'' below).

Comments From the State of Hawaii

(13) *Comment:* The Hawaii Department of Health stated that they had no comments on the proposed rule but reserved the right to future comments. In addition, their letter directed us to their Standard Comments on their Web site (*http://www.hawaii.gov/health/environmental/env-planning/landuse/landuse.html*) and stated that any comments specifically applicable to our proposed rule should be adhered to.

Our Response: We reviewed the Department of Health's Web site, and specifically the Landuse Planning Review Program, and determined that the Standard Comments referred to above do not apply to our June 11, 2012, proposed rulemaking or to this final rule. Standard Comments provided by the seven environmental programs (Hazard Evaluation and Emergency Response Office, Clean Air Branch, Clean Water Branch, Safe Drinking Water Branch, Solid and Hazardous Waste Branch, Wastewater Branch, and Indoor and Radiological Health Branch) within the Hawaii Department of Health are intended to help developers to better prepare land use planning documents such as environmental assessments, environmental impact statements, or permit applications.

Comments From Federal Agencies

Haleakala National Park (Park) provided information on one or more of the 37 plant species addressed in this final rule which occur in the Park, and this information was incorporated, as appropriate, into Description of the 40 Maui Nui Species, above.

(14) *Comment:* Kalaupapa National Historical Park (KNHP) agreed with and supported the ecosystem-based approach in our June 11, 2012, proposed rule, for grouping plants and defining their habitat consistently. According to KNHP, this approach will aid the management of endangered and threatened plants as part of the collection of native communities across the landscape. Descriptions of individual listed species, habitat, and threats will be a good resource to managers and will serve as a basis for planning future conservation measures. The proposed listing of the ''rarest of the rare'' PEPP [Plant Extinction Prevention Program] species will provide a benefit to the National Park Service by improving their ability to gain funds for the protection, propagation, and outplanting of these rare plants. Improved funding will help with KNHP's ongoing collaboration with partners, including the Molokai Plant Extinction Prevention Program and The Nature Conservancy.

Our Response: We appreciate the Park's comments regarding the proposal to list the 38 Maui Nui species and to reevaluate the listing of 2 species. We agree that using an ecosystem-based approach to organize this rule will help provide for more focused conservation efforts and concerted management efforts to address the common threats that occur across these ecosystems.

Public Comments on the Proposed Listing of 38 Species and Reevaluation of Listing of 2 Species

(15) *Comment:* One commenter stated that much of the referenced material is not available for public review. The commenter further stated that reliance on certain ''unpublished, non-public data deprives the public of the opportunity to review and comment on the basis for the Service's asserted justification in the proposed rule.'' According to the commenter, ''such action is arbitrary, capricious and an abuse of the Service's discretion, otherwise not in accordance with law, in excess of statutory jurisdiction, authority, or limitations, and short of statutory right, without observance of procedure required by law; and unsupported by substantial evidence.''

Our Response: See also *Comment* (1) *Response,* above. Complete lists of references, including unpublished information, cited in the proposed rule (77 FR 34464; June 11, 2012) and in this final rule are available on the Internet at *http://www.regulations.gov* at Docket No. FWS–R1–ES–2011–0098, and upon request from the Pacific Islands Fish and Wildlife Office (see **ADDRESSES,** above). In addition, as stated in our proposed rule, all supporting documentation used in preparing the proposed rule was available upon request and for public inspection, by appointment, at the U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office. All supporting documentation used in our rulemakings is a matter of public record; however, the number of sources referenced are often voluminous or subject to copyright restrictions. Therefore, it is not possible for us to post all information sources used on the Internet. However, any of our supporting references cited in this or any rulemaking are always available upon request.

(16) *Comment:* One commenter objected to the proposed listing of the two Lanai tree snails, *Partulina semicarinata* and *Partulina variabilis,* because, in their view, the Service does not have sufficient information regarding the historical population estimates and the lack of comprehensive surveys. The commenter disagreed with our determination in the proposed rule that these tree snails are ''vulnerable to extinction due to threats associated with low number of individuals and populations'' (77 FR 34507; June 11, 2012).

Our Response: 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 40 Maui Nui Species, below), and we are required to make listing determinations solely on the basis of the best available scientific and commercial data available (see 16 U.S.C. 1533(a)(1) and (b)(1)(A)). The threats to the two Lanai tree snail species, as well as other endangered tree snails in the Hawaiian Islands, are well-documented (see Summary of Factors Affecting the 40 Maui Nui Species, below). Although there are no historical population estimates for these two tree snails, qualitative accounts of Hawaiian tree snails indicate they were widespread and abundant, possibly numbering in the tens of thousands between the 1800s and early 1900s (Hadfield 1986, p. 69). However, the best available survey information, conducted between 1993 and 2005, indicates that currently *Partulina semicarinata* and *Partulina variabilis* total fewer than 120 individuals on Lanai (Hadfield 2005, pp. 3–5). Based on the information regarding the current status of the species and ongoing threats to the remaining few individuals, we have determined that these species are presently in danger of extinction; definitive quantitative data regarding historical population numbers are not necessary to make this determination. The problems associated with small population size (e.g., inbreeding depression for snails) and vulnerability to random demographic fluctuations or natural catastrophes are magnified by synergistic interactions with other threats (e.g., predation by nonnative rats or habitat destruction or modification by nonnative ungulates). Therefore, we disagree with the commenter, and believe these two tree snail species are vulnerable to extinction due to their low number of individuals and populations.

(17) *Comment:* Several commenters noted the threat of deer and goats to *Canavalia pubescens* throughout its range on Maui, with specific impacts to populations on the Palauea lava flow and Ahihi-Kinau. The commenters also recommended that fenced areas and regular monitoring are necessary to protect this species from the threat of ungulates in these areas.

Our Response: We agree that deer and goats constitute a threat to the coastal and lowland dry ecosystems in which *Canavalia pubescens* is known to occur (see ''Habitat Destruction and Modification by Introduced Ungulates,'' below). In this final rule, we noted the destruction of *Canavalia pubescens* at Ahihi-Kinau Natural Area Reserve in 2010 (see Description of the 40 Maui Nui Species, above) and acknowledge the threat of herbivory by deer and goats on *Canavalia pubescens* (see ''Introduced Ungulates'' in *Disease or Predation,* below).

(18) *Comment:* Several commenters noted the occurrence of *Canavalia pubescens* or awikiwiki on lands owned by Honuaula Partners.

Our Response: We appreciate this information and note that information in our files indicates that *Canavalia pubescens* or awikiwiki occurs in this area.

Summary of Changes From Proposed Rule

In preparing this final rule, we reviewed and fully considered comments from the public on the proposed listing for 38 species and reevaluation of listing for 2 species. This final rule incorporates the following substantive changes to our proposed listing, based on the comments we received:

(1) We added the montane mesic ecosystem to the listed plant *Phyllostegia haliakalae* in the following locations in this final rule: Description of the 40 Maui Nui Species (above), Table 3 (above), and Table 4 (below), based on comments we received.

(2) We are revising the specific negative impacts of the nonnative plant *Blechnum appendiculatum* as follows, based on peer review comments:

Blechnum appendiculatum (NCN) is a fern with fronds to 23 in (60 cm) long that forms large colonies, outcompeting many native fern species (Palmer 2003, p. 81). This species is far more drought tolerant than native fern species. It forms thick mats that prevent regeneration from seeds of native species, and appears to successfully outcompete native ferns. All of these attributes compound the effects of the presence of this nonnative fern on native habitat (Weller *et al.* 2011, pp. 676–677).

(3) We added drought as a threat to the listed plants *Canavalia pubescens* and *Schiedea salicaria* in the following locations in this final rule: Table 4 and ''Habitat Destruction and Modification Due to Landslides, Rockfalls, Treefalls, Flooding, and Drought,'' below, based on comments we received.

Status Assessment for the 40 Maui Nui Species

Summary of Factors Affecting the 40 Maui Nui 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. Each of these factors is discussed below.

In considering what factors might constitute threats to a species we must look beyond the exposure of the species to a particular factor to evaluate whether the species may respond to that factor in a way that causes actual impacts to the species. If there is exposure to a factor and the species responds negatively, the factor may be a threat and, during the status review, we attempt to determine how significant a threat it is. The threat is significant if it drives, or contributes to, the risk of extinction of the species such that the species warrants listing as endangered or threatened as those terms are defined in the Act. However, the identification of factors that could impact a species negatively may not be sufficient to warrant listing the species under the Act. The information must include evidence sufficient to show that these factors are operative threats that act on the species to the point that the species meets the definition of endangered or threatened under the Act.

If we determine that the level of a 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 40 Maui Nui species are summarized in Table 4, and discussed in detail below.

Assumptions

We acknowledge that the specific nature of the threats to the individual species in this final rule are not completely understood. Scientific research directed toward each of the 40 species is limited because of their rarity and the challenging logistics associated with conducting field work in Hawaii (e.g., areas are typically remote, difficult to access and work in, and expensive to survey in a comprehensive manner). However, there is information available on many of the threats that act on Hawaiian ecosystems, and, for some ecosystems, these threats are well studied and understood. Each of the native species that occurs in Hawaiian ecosystems suffers from exposure to those threats. For the purposes of our listing determination, our assumption is that the threats that act at the ecosystem level also act on each of the species that occurs in those ecosystems (although in some cases we have additionally identified species-specific threats, such as predation by nonnative invertebrates).

The following constitutes a list of ecosystem-level threats that affect the 40 species in 10 ecosystems on the islands of Maui Nui:

(1) Foraging and trampling of native plants by ungulates, including feral pigs (*Sus scrofa*), goats, cattle (*Bos taurus*), axis deer (*Axis axis*), or mouflon sheep (*Ovis gmelini musimon*), which can result 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) Disturbance of soils by feral pigs from rooting, which can create fertile seedbeds for alien plants (Cuddihy and Stone 1990, p. 65).

(3) Increased nutrient availability as a result of pigs rooting in nitrogen-poor soils, which facilitates establishment of alien weeds. Alien weeds are more adapted to nutrient rich soils than native plants (Cuddihy and Stone 1990, p. 63), and rooting activity creates open areas in forests allowing alien species to completely replace native stands.

(4) Ungulate destruction of seeds and seedlings of native plant species (Cuddihy and Stone 1990, p. 63), which facilitates the conversion of disturbed areas from native to nonnative vegetative communities.

(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 can reduce 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 4.

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TABLE 4.–SUMMARY OF PRIMARY THREATS IDENTIFIED FOR EACH OF THE 40 MAUI NUI SPECIES

Species	Ecosystem	Factor A						Factor B	Factor C				Factor D	Factor E
		Agriculture and urban develop-ment	Ungulates	Non native plants	Fire	Stochastic Events	Climate Change	Over-utilization	Disease	Predation/ Herbivory by ungulates	Predation/ Herbivory by other NN verte-brates	Predation/ Herbivory by NN inverte-brates	Inadequate existing regulatory mechanisms	Other species-specific threats
Plants														
Bidens campylotheca ssp. *pentamera*	LD, LM, MM, MW, DC, WC		P, G, D	X	X	H	Pt			P, G, D	R		X	HY
Bidens campylotheca ssp. *waihoiensis*	LW, MW, WC		P, G, D	X		F, H	Pt			P, G, D	R	S	X	HY
Bidens conjuncta	LW, MW, WC		P, G	X		H	Pt			P, G	R	S	X	
Calamagrostis hillebrandii	MW		P	X		H	Pt			P			X	

TABLE 4.–SUMMARY OF PRIMARY THREATS IDENTIFIED FOR EACH OF THE 40 MAUI NUI SPECIES

Species	Ecosystem	Factor A						Factor B	Factor C				Factor D	Factor E
		Agriculture and urban develop-ment	Ungulates	Non native plants	Fire	Stochastic Events	Climate Change	Over-utilization	Disease	Predation/ Herbivory by ungulates	Predation/ Herbivory by other NN verte-brates	Predation/ Herbivory by NN inverte-brates	Inadequate existing regulatory mechanisms	Other species-specific threats
Canavalia pubescens	CO, LD	X	P, G, D. C	X	X	H, DR	Pt			P, G, D, C			X	
Cyanea asplenifolia	LM, LW		P, G, D, C	X		L, H	Pt			P, G, D, C	R	S	X	
Cyanea duvalliorum	LW, MW		P	X		F, H	Pt			P	R	S	X	
Cyanea grimesiana ssp. *grimesiana*	LW, WC		P, G, D	X		L, H	Pt			P, G, D	R	S	X	LN
Cyanea horrida	MM, MW, WC		P	X		DR, F, L, TF, H	Pt			P	R	S	X	LN
Cyanea kunthiana	LW, MM, MW		P	X		H	Pt			P	R	S	X	
Cyanea magnicalyx	LW, MM, WC		P	X	X	L, TF, H	Pt			P	R	S	X	LN

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Species	Ecosystem	Factor A						Factor B	Factor C				Factor D	Factor E
		Agriculture and urban develop-ment	Ungulates	Non native plants	Fire	Stochastic Events	Climate Change	Over-utilization	Disease	Predation/ Herbivory by ungulates	Predation/ Herbivory by other NN verte-brates	Predation/ Herbivory by NN inverte-brates	Inadequate existing regulatory mechanisms	Other species-specific threats
Cyanea maritae	LW, MW		P	X		L, TF, H	Pt			P	R	S	X	LN, T
Cyanea mauiensis	LM, DC		P	X	X	L, TF, H	Pt			P	R	S	X	LN
Cyanea munroi	WC		G, D	X		TF, H	Pt			G, D	R	S	X	LN
Cyanea obtusa	LD, MM		P, G, D, C	X	X	H	Pt			P, G, D, C	R	S	X	HY, LN
Cyanea profuga	LM, MW		P, G	X		F, L, RF, TF, H	Pt			P, G	R	S	X	LN
Cyanea solanacea	LM, LW, MM, MW		P, G	X		L, H	Pt			P, G	R	S	X	LN
Cyrtandra ferripilosa	MM, MW		P, G			H	Pt			P, G			X	LN

TABLE 4.–SUMMARY OF PRIMARY THREATS IDENTIFIED FOR EACH OF THE 40 MAUI NUI SPECIES

Species	Ecosystem	Factor A						Factor B	Factor C				Factor D	Factor E
		Agriculture and urban develop-ment	Ungulates	Non native plants	Fire	Stochastic Events	Climate Change	Over-utilization	Disease	Predation/ Herbivory by ungulates	Predation/ Herbivory by other NN verte-brates	Predation/ Herbivory by NN inverte-brates	Inadequate existing regulatory mechanisms	Other species-specific threats
Cyrtandra filipes	LM, LW, WC		P, G, D	X		L, H	Pt			P, G, D		S	X	
Cyrtandra oxybapha	MM, MW		P, G, C	X		H	Pt			P, G, C			X	
Festuca molokaiensis	LM		G	X	X	DR, H	Pt			G			X	LN
Geranium hanaense	MW		P	X		H	Pt			P			X	
Geranium hillebrandii	MM, MW		P	X		H	Pt			P		S	X	
Mucuna sloanei var. *persericea*	LW		P, C	X		H	Pt			P, C	R		X	
Myrsine vaccinioides	MW		P	X		H	Pt			P	R	S	X	

TABLE 4.–SUMMARY OF PRIMARY THREATS IDENTIFIED FOR EACH OF THE 40 MAUI NUI 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
Peperomia subpetiolata	MW		P	X		H	Pt			P	R	S	X	HY, LN
Phyllostegia bracteata	LW, MM, MW, SB, WC		P, C	X	X	H	Pt			P, C		S	X	LN
Phyllostegia haliakalae	LM, MM, DC, WC		C	X	X	H	Pt			C		S	X	LN
Phyllostegia pilosa	LM, MW		P, G	X		H	Pt			P, G		S	X	LN
Pittosporum halophilum	CO		P	X	X	H	Pt			P	R		X	LN
Pleomele fernaldii	LD, LM,		D, M	X	X	H	Pt			D, M	R		X	NR

TABLE 4.–SUMMARY OF PRIMARY THREATS IDENTIFIED FOR EACH OF THE 40 MAUI NUI SPECIES

Species	Ecosystem	Factor A						Factor B	Factor C				Factor D	Factor E
		Agriculture and urban develop-ment	Ungulates	Non native plants	Fire	Stochastic Events	Climate Change	Over-utilization	Disease	Predation/ Herbivory by ungulates	Predation/ Herbivory by other NN verte-brates	Predation/ Herbivory by NN inverte-brates	Inadequate existing regulatory mechanisms	Other species-specific threats
	LW, DC, WC													
Santalum haleakalae var. *lanaiensis*	LD, LM, LW, MD, MM, MW, WC		P, G, D, M	X	X	H	Pt			P, G, D, M	R	S	X	
Schiedea jacobii	MW		G, D, C			DR, L, TF, H	Pt			G, D, C		S	X	LN
Schiedea laui	MW			X		F, L, H	Pt				R	S	X	LN
Schiedea salicaria	LD		G, D, C	X	X	DR, H	Pt			D, C, G			X	
Stenogyne				X	X	DR, L,	Pt					S	X	LN

TABLE 4.–SUMMARY OF PRIMARY THREATS IDENTIFIED FOR EACH OF THE 40 MAUI NUI SPECIES

Species	Ecosystem	Factor A						Factor B	Factor C				Factor D	Factor E
		Agriculture and urban develop-ment	Ungulates	Non native plants	Fire	Stochastic Events	Climate Change	Over-utilization	Disease	Predation/ Herbivory by ungulates	Predation/ Herbivory by other NN verte-brates	Predation/ Herbivory by NN inverte-brates	Inadequate existing regulatory mechanisms	Other species-specific threats
kauaulaensis	MM					RF, H								
Wikstroemia villosa	LW, MM, MW		P	X		L, H	Pt			P	R	S	X	LN, T
Snails														
Newcombia cumingi (Newcomb's tree snail)	LW			X		DR, H	Pt	Pt	Pt		R, JC	Flatworm Pt Snails	X	LN
Partulina semicarinata (Lanai tree snail)	LW, MW, WC		D, M			DR, H	Pt	Pt	Pt		R, JC	Flatworm Pt Snails	X	LN
Partulina variabilis (Lanai tree snail)	LW, MW, WC		D, M			DR, H	Pt	Pt	Pt		R, JC	Flatworm Pt	X	LN

TABLE 4.–SUMMARY OF PRIMARY THREATS IDENTIFIED FOR EACH OF THE 40 MAUI NUI SPECIES

Species	Ecosystem	Factor A						Factor B	Factor C				Factor D	Factor E
		Agriculture and urban develop-ment	Ungulates	Non native plants	Fire	Stochastic Events	Climate Change	Over-utilization	Disease	Predation/ Herbivory by ungulates	Predation/ Herbivory by other NN verte-brates	Predation/ Herbivory by NN inverte-brates	Inadequate existing regulatory mechanisms	Other species-specific threats
												Snails		

Factor A = Habitat Modification	CO = Coastal	P = Pigs	F = Flooding	LN = Limited Numbers
Factor B = Overutilization	LD = Lowland Dry	G = Goats	DR = Drought	HY = Hybridization
Factor C = Disease or Predation	LM = Lowland Mesic	D = Axis Deer	H = Hurricane	NN = Nonnative
Factor D = Inadequacy of Regulatory Mechanisms	LW = Lowland Wet	M = Mouflon	L = Landslide	NR = No Regeneration
Factor E = Other Species-Specific Threats	MD = Montane Dry	C = Cattle	T = Trampling	Pt = Potential
	MM = Montane Mesic	R = Rats	RF = Rockfalls	
	MW = Montane Wet	S = Slugs	TF = Treefalls	
	SB = Subalpine	JC = Jackson's		
	DC = Dry Cliff	chameleon		
	WC = Wet Cliff			

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A. The Present or Threatened Destruction, Modification, or Curtailment of Its 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. 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.* 1999l, pp. 3–6). For example, Carlquist (in Carlquist and Cole 1974, p. 29) notes ''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., *Calamagrostis hillebrandii*) are particularly vulnerable to changes (from nonnative species, hurricanes, fire, and climate change) in their habitat (Carlquist and Cole 1974, pp. 28–29; Loope 1992, pp. 3–6; Stone 1989, pp. 88–95).

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), 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). In addition, Hawaii's population 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 2010).

Development and urbanization of coastal and lowland dry ecosystems on Maui are a serious threat to one species in this final rule, *Canavalia pubescens,* which is dependent on these ecosystems and is currently found only in east Maui. Two individuals at Palauea-Keahou were destroyed by development prior to 2001 (Oppenheimer 2000, in litt.). Future development plans for this area include a golf course and associated infrastructure, and housing (Altenberg 2007, p. 2–5; Greenlee 2013, in litt.). Although fewer than 20 individuals were known in this area as recently as 2010, no individuals have been found in site visits over the last 2 years (Altenberg 2010, in litt.; Greenlee 2013, in litt.).

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. Impacts to the native species and ecosystems of Hawaii accelerated following the arrival of Captain James Cook in 1778. The Cook expedition and subsequent explorers intentionally introduced a European race of pigs or boars and other livestock, such as goats, to serve as food sources for seagoing explorers (Tomich 1986, pp. 120–121; Loope 1998, p. 752). The mild climate of the islands, combined with the lack of competitors or predators, led to the successful establishment of large populations of these introduced mammals, to the detriment of native Hawaiian species and ecosystems. 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 Molokai, Lanai, and Maui. Ten ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, subalpine, dry cliff, and wet cliff) on Molokai, Lanai, and Maui and their associated species are currently impacted by threats of the destruction or degradation of habitat due to nonnative ungulates (hoofed mammals), including pigs, goats, axis deer, mouflon, and cattle. Thirty-five of the 37 plant species and both species of *Partulina* tree snails (*Partulina semicarinata* and *P. variabilis*) in this final rule are exposed to direct and indirect negative impacts of feral ungulates (pigs, goats, axis deer, mouflon, and cattle), which result in the destruction and degradation of habitat for these native Maui Nui species (Table 4).

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 in Hawaii (Aplet *et al.* 1991, p. 56; Anderson and Stone 1993, p. 195). European pigs, introduced to Hawaii by Captain James Cook in 1778, hybridized with domesticated Polynesian pigs, became feral, and invaded forested areas, especially wet and mesic forests and dry areas at high elevations. The Hawaii Territorial Board of Agriculture and Forestry started a feral pig eradication project in the early 1900s that continued through 1958, removing 170,000 pigs from forests Statewide (Diong 1982, p. 63). Feral pigs are currently present on Niihau, Kauai, Oahu, Molokai, Maui, and Hawaii.

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 trampling plants and seedlings. It has been estimated that at a conservative rooting rate of 2 square (sq)-yards (yd) per minute, with only 4 hours of foraging a day, a single pig could disturb over 1,600 sq-yd of groundcover per week (Anderson *et al.* 2007, p. 2).

Pigs may also reduce or eliminate plant regeneration by damaging or eating seeds and seedlings (further discussion of predation by nonnative ungulates is provided under Factor C, 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 poka) and *Psidium cattleianum* (strawberry guava), spreading the seeds of these invasive species through their feces as they travel in search of food. 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). Ten of the Maui Nui ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, subalpine, dry cliff, and wet cliff) and their associated species are adversely impacted by the destruction or degradation of habitat due to pigs (see Table 4, above).

Goats native to the Middle East and India were also successfully introduced to the Hawaiian Islands in the late 1700s. Actions to control feral goat populations began in the 1920s (Tomich 1986, pp. 152–153); however, they still occupy a wide variety of habitats on Molokai and Maui and to a lesser degree on Lanai, 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 2010, 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 are believed to have completely eliminated some plant species from islands (Atkinson and Atkinson 2000, p. 21). Goats can 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). Nine of the described ecosystems on Molokai, Lanai, and Maui (coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, dry cliff, and wet cliff) and their associated species are adversely impacted by the destruction or degradation of habitat due to goats (see Table 4, above).

Axis deer were first introduced to Molokai in 1868, Lanai in 1920, and Maui in 1959 (Hobdy 1993, p. 207; Erdman 1996, pers. comm. cited in Waring 1996, in litt., p. 2; Hess 2008, p. 2). On Molokai, axis deer have likely spread throughout the island at all elevations (from the coast to the summit area at 4,961 ft (1,512 m)) (Kessler 2011, pers. comm.). The most current population estimate of axis deer on Molokai is between 4,000 and 5,000 individuals (Anderson 2003, p. 130). It is likely this is an underestimate of the total number of individuals as it was published almost a decade ago, and little management for deer control has been implemented. On Lanai, as of 2007, axis deer were reported to number approximately 6,000 to 8,000 individuals (The Aloha Insider 2008, in litt.; WCities 2010, in litt.). On Maui, five adults were released east of Kihei in 1959 (Hobdy 1993, p. 207; Hess 2008, p. 2). By 1968, the population was estimated to be 85 to 90 animals, and by 1995, there were over 500 individuals on Ulupalakua Ranch alone (Erdman 1996, pers. comm. cited in Waring 1996, in litt., p. 2). As of 2001, there was concern that their numbers on Maui could expand to between 15,000 to 20,000 or more individuals within a few years (Anderson 2001, in litt.; Nishibayashi 2001, in litt.). According to Medeiros (2010a, pers. comm.) axis deer can be found in all but the uppermost ecosystems (subalpine and alpine) and montane bogs on Maui. Medeiros (2010a, pers. comm.) also observed that axis deer are increasing at such high rates on Maui that native forests are changing in unprecedented ways. According to Medeiros (2010a, pers. comm.), native plants will only survive in habitat that is fenced or otherwise protected from the grazing and trampling effects of axis deer. Kessler (2010, pers. comm.) and Hess (2010, pers. comm.) report axis deer up to 9,000 ft (2,743 m) in elevation on Maui, and Kessler suggests that no ecosystem is safe from the negative impacts of these animals. Montane bogs are also susceptible to impacts from axis deer. As the native vegetation dies off from the combined effects of grazing and trampling by axis deer, the soil dries out, and invasive nonnative plants gain a foothold. Eventually, the bog habitat and its associated native plants and animals are replaced by a grassland, shrubland, or forest habitat dominated by nonnative plants.

Axis deer are primarily grazers, but also browse numerous palatable plant species including those grown as commercial crops (Waring 1996, p. 3; Simpson 2001, in litt.). They prefer the lower, more openly vegetated areas for browsing and grazing; however, during episodes of drought (e.g., from 1998–2001 on Maui (Medeiros 2010a, 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 can 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 can 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). Browsing and trampling by axis deer also removes vegetation surrounding the host trees of the two Lanai tree snails so that dispersal of snails between host substrates is either prevented or greatly reduced (Duvall 2012, in litt.). Nine of the described Maui Nui ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, dry cliff, and wet cliff) and their associated species are adversely impacted by the destruction or degradation of habitat due to axis deer (see Table 4, above).

The mouflon sheep, 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). 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 hunted as a game animal (Hess 2008, p. 3). Mouflon only form large groups when breeding, thus limiting control techniques and hunting efficiency (Hess 2008, p. 3). Mouflon sheep 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). In range studies done on the effects of mouflon grazing and browsing on the island of Hawaii, plant species found to be most affected were *Argyroxiphium sandwicense* ssp. *sandwicense* (ahinahina), an endangered species; *Acacia koa; Geranium* spp. (nohoanu or hinahina); *Sophora chrysophylla; Vaccinium* spp. (ohelo); and native grasses (Giffin 1981, pp. 22–23; Scowcroft and Conrad 1992, pp. 628–662; 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 leads to a change from native rainforest to grassy scrublands (Hess 2008, p. 3). Duvall (2012, in litt.) reports that mouflon sheep browsing and trampling removes vegetation surrounding host trees of the two Lanai tree snails, thus reducing or preventing snail dispersal between host trees. Seven of the described ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane wet, dry cliff, and wet cliff) on Lanai and their associated species are adversely impacted by the destruction or degradation of habitat due to mouflon sheep (see Table 4, above).

Cattle, the wild ancestors of which were native to Europe, northern Africa, and southwestern Asia, were introduced to the Hawaiian Islands in 1793. Large feral herds (as many as 12,000 on the island of Hawaii) developed as a result of restrictions on killing cattle decreed by King Kamehameha I (Cuddihy and Stone 1990, p. 40). While small cattle ranches were developed on Kauai, Oahu, Molokai, west Maui, and Kahoolawe, very large ranches of tens of thousands of acres were created on east Maui and Hawaii Island (Stone 1985, pp. 256, 260; Broadbent 2010, in litt.). Logging of native *Acacia koa* was combined with establishment of cattle ranches, quickly converting native forest to grassland (Tomich 1986, p. 140; Cuddihy and Stone 1990, p. 47). Feral cattle can presently be found on the islands of Maui and Hawaii, where ranching is still a major commercial activity. According to Kessler (2011, pers. comm.), there are approximately 300 individuals roaming east Maui up to the alpine ecosystem (i.e., 1,000 to 9,900 ft (305 to 3,000 m) elevation) with occasional observations on west Maui. 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). Five of the described ecosystems (lowland dry, lowland mesic, lowland wet, montane mesic, and montane wet) on Maui and their associated species are adversely impacted by the destruction or degradation of habitat due to feral cattle (see Table 4, above).

In summary, 37 of the 40 species dependent upon the 10 ecosystems identified in this final rule (coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, subalpine, dry cliff, and wet cliff) are exposed to both direct and indirect negative impacts of feral ungulates (pigs, goats, axis deer, mouflon, and cattle). These negative impacts result in the destruction and degradation of habitat for these 37 native species on Molokai, Lanai, and Maui. The effects of these nonnative animals include the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; 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. 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, close to 70 species have altered the habitat of 36 of the 40 species in this final rule (only *Cyrtandra ferripilosa, Schiedea jacobii, Partulina semicarinata,* and *P. variabilis* are not directly impacted by nonnative plants; see Table 4). Some of the nonnative plants were brought to Hawaii by various groups of people, including the Polynesians, for food or cultural reasons. Plantation owners (and the territorial government of Hawaii), alarmed at the reduction of water resources for their crops caused by the destruction of native forest cover by grazing feral and domestic animals, introduced nonnative trees for reforestation. Ranchers intentionally introduced pasture grasses and other nonnative plants for agriculture, and sometimes inadvertently introduced weeds as well. Other plants were brought to Hawaii for their potential horticultural value (Scott *et al.* 1986, pp. 361–363; Cuddihy and Stone 1990, p. 73).

Nonnative plants adversely impact native habitat in Hawaii, including the 10 Maui Nui ecosystems that support the 40 species identified in this final rule, and directly adversely impact 36 of these species, by: (1) Modifying the availability of light; (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). Nonnative plants (and animals) have contributed to the extinction of native species in the lowlands of Hawaii and have been a primary cause of extinction in upland habitats (Vitousek *et al.* 1987, in Cuddihy and Stone 1990, p. 74). The most-often cited effects of nonnative plants on native plant species are displacement through competition. Competition may be for water or nutrients, or it may involve allelopathy (chemical inhibition of other plants) (Smith 1985, in Cuddihy and Stone 1990, p. 74). 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 in Cuddihy and Stone 1990, p. 74).

Alteration of fire regimes clearly represents an ecosystem-level change caused by the invasion of nonnative grasses (D'Antonio and Viousek 1992, p. 73). The grass life form supports standing dead material that burns readily, and grass tissues have large surface-to-volume ratios and can dry out quickly (D'Antonio and Viousek 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 Viousek 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 Viousek 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 Viousek 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 occurs more rapidly than in forest or woodlands (D'Antonio and Viousek 1992, p. 73). Thus, conditions that favor fires are much more frequent in grasslands (D'Antonio and Viousek 1992, p. 73). In summary, nonnative plants directly and indirectly affect 36 of the 40 species in this final rule by modifying or destroying their terrestrial habitat. Please refer to the proposed rule (77 FR 34464; June 11, 2012) for a list of nonnative plants and a discussion of their specific negative effects on the 36 affected Maui Nui species.

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 of 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 13 native plant species found in the coastal, lowland dry, lowland mesic, montane dry, montane mesic, and dry cliff ecosystems addressed in this final rule: *Bidens campylotheca* ssp. *pentamera, Canavalia pubescens, Cyanea magnicalyx, C. mauiensis, C. obtusa, Festuca molokaiensis, Phyllostegia bracteata, P. haliakalae, Pittosporum halophilum, Pleomele fernaldii, Santalum haleakalae* var. *lanaiense, Schiedea salicaria,* and *Stenogyne kauaulaensis* (see Table 4). 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. Drought-tolerant grasses and ferns, particularly those that produce mats of dry material or retain a mass of standing dead leaves (e.g., *Pennisetum setaceum, Blechnum appendiculatum*) invade native forests and shrublands and 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; Weller *et al.* 2011, pp. 676–677; Weller 2012, in litt.). Other nonnative plants such as *Clidemia hirta* and pines (*Pinus* spp.) rapidly outcompete native plants and dominate areas opened by fire (Weller 2012, in litt.). Native woody plants may recover from fire to some degree, but fire shifts the competitive balance toward alien species (National Park Service 1989, in Cuddihy and Stone 1990, p. 93). On a post-burn survey at Puuwaawaa on the island of Hawaii, 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 which 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 (Gima 1998, in litt.; Pacific Disaster Center 2011; Hamilton 2009, in litt.; Honolulu Advertiser, 2010). The islands of Molokai, Lanai, Maui, and Kahoolawe have experienced 1,291 brush fires between the years 1972 and 1999 that burned a total of 64,248 ac (26,000 ha) (Pacific Disaster Center 2011; County of Maui 2009, Chapter 3, p. 3). Between 2000 and 2003, the annual number of wildfires on Molokai, Lanai, and Maui jumped from 118 to 271, many of which each consumed more than 5,000 ac (2,023 ha) (Pacific Disaster Center 2011).

During the summer of 1998, a raging fire that began in Kaunakakai consumed over 15,000 ac (6,070 ha) on Molokai, including a portion of the Molokai Forest Reserve, consuming roughly 10 percent of the entire island (Gima 1998, in litt.). Molokai experienced three 10,000 ac (4,047 ha) wildfires between the years 2003 and 2004 (Pacific Disaster Center 2011). In late August through early September 2009, a massive wildfire burned for days and consumed approximately 8,000 ac (3,237 ha), including 600 ac (243 ha) of the remote Makakupaia section of the Molokai Forest Reserve, a small portion of TNC's Kamakou Preserve, and encroached upon Onini Gulch, Kalamaula and Kawela (Hamilton 2009, in litt.). Three species reported from Molokai's coastal and lowland mesic ecosystems (*Festuca molokaiensis, Phyllostegia haliakalae,* and *Pittosporum halophilum*) are at risk of negative impacts by fire because individuals of these species or their habitat are located in or near areas that were burned in previous fires.

The island of Lanai has experienced several wildfires in the last decade. In 2006, a wildfire burned 600 ac (243 ha) between Manele Road and the Palawai basin (2.5 mi (4 km) south of Lanai City) (The Maui News 2006, in litt.). In 2007, a brush fire occurred in the Mahana area, burning an estimated 30 ac (12 ha), and in 2008, another 1,000 ac (405 ha) were burned by wildfire in the Palawai basin (The Maui News 2007, in litt.; KITV Honolulu 2008, in litt.). All known individuals of *Pleomele fernaldii* lie just southeast of the area burned during the Mahana fire and east of the Palawai basin fires. Many of these individuals could be decimated by one large fire.

Between the years 2007 and 2010, wildfires burned more than 8,650 ac (3,501 ha) on west Maui (Shimogawa 2010, in litt.; Honolulu Advertiser 2010, in litt.). In 2007, a fire that started along Honoapiilani Highway on the south coast of west Maui burned a total of 1,350 ac (546 ha), encroached into the West Maui Natural Area Reserve (Panaewa section), and placed at risk *Phyllostegia bracteata* and *Schiedea salicaria* (HDLNR 1989, pp. 53–63; KITV 2007, in litt.). In May 2010, another fire occurred farther south along the same highway, moved up the ridges of Olowalu, and eventually encompassed 1,100 ac (445 ha). Later the same year, a fire that started at Maalaea initially destroyed 200 ac (81 ha), and because of strong winds and drought conditions, continued to burn for 8 days, moved up Kealaloloa and nearby ridges, and encompassed a total of 6,200 ac (2,509 ha). This fire is on record as the largest brush fire that has occurred on Maui. Nine species reported from Maui's lowland dry, lowland mesic, montane dry, montane mesic, and dry cliff ecosystems (*Bidens campylotheca* ssp. *pentamera, Canavalia pubescens, Cyanea magnicalyx, C. mauiensis, C. obtusa, Phyllostegia bracteata, Santalum haleakalae* var. *lanaiense, Schiedea salicaria,* and *Stenogyne kauaulaensis*) are adversely impacted by fire 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 the presence of highly flammable nonnative grasses and pine trees.

Habitat Destruction and Modification by Hurricanes

Hurricanes adversely impact native Hawaiian terrestrial habitat, including each of the 10 Maui Nui ecosystems addressed here and their associated species identified in this final rule. 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,'' in our June 11, 2012, proposed rule (77 FR 34464)) (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 40 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.* 2005, pp. 3–4).

Hurricanes affecting Hawaii were only rarely reported from ships in the area from the 1800s until 1949. Between 1950 and 1997, 22 hurricanes passed near or over the Hawaiian Islands, 5 of which caused serious damage (Businger 1998, pp. 1–2). In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (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). Historically (prior to the introduction of nonnative, invasive plants to the Hawaiian Islands), it is likely that areas affected by hurricanes would eventually have been repopulated by native plants. However, any area affected by hurricanes will likely be invaded by nonnative plants as nonnative plants are present in all ecosystems throughout the Hawaiian Islands and competition with nonnative plants is exacerbated by hurricanes. Therefore, hurricanes represent a threat to each of the 10 ecosystems and to all of the 37 plant species addressed in this final rule. In addition, biologists have reported that hurricanes are a threat to the three tree snails in this final rule (*Newcombia cumingi, Partulina semicarinata,* and *P. variabilis*). High winds and intense rains from hurricanes can dislodge snails from the leaves and branches of their host plants and deposit them on the forest floor where they may be crushed by falling vegetation or exposed to predation by nonnative rats and snails (see *Disease or Predation,* below) (Hadfield 2011, pers. comm.). Although there is historical evidence of only one hurricane that approached from the east and impacted the islands of Maui and Hawaii (Businger 1998, p. 3), damage by future hurricanes could further decrease the remaining native plant-dominated habitat areas that support the Maui Nui ecosystems (Bellingham *et al.* 2005, p. 681).

Habitat Destruction and Modification Due to Landslides, Rockfalls, Treefalls, Flooding, and Drought

Landslides, rockfalls, treefalls, and flooding destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which 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.* 1999b; adapted from Price (1983) and Carlquist (1980)), pp. 38 and 39). During storms, rain may fall at 3 in (76 mm) per hour or more, and sometimes may reach nearly 40 in (1,000 mm) in 24 hours, causing destructive flash-flooding in streams and narrow gulches (Wagner *et al.* 1999b; adapted from Price (1983) and Carlquist (1980)), pp. 38–39). Due to the steep topography of much of the areas on Molokai, Lanai, and Maui where these 40 species remain, erosion and disturbance caused by introduced ungulates exacerbate the potential for landslides, rockfalls, or flooding, which in turn negatively impact native plants. For those species that occur in small numbers in highly restricted geographic areas, such events have the potential to eradicate all individuals of a population, or even all populations of a species, resulting in extinction.

Landslides, rockfalls, and treefalls likely adversely impact 14 of the species addressed in this proposed rule, including *Cyanea asplenifolia, C. grimesiana* ssp. *grimesiana, C. horrida, C. magnicalyx, C. maritae, C. mauiensis, C. munroi, C. profuga, C. solanacea, Cyrtandra filipes, Schiedea jacobii, S. laui, Stenogyne kauaulaensis,* and *Wikstroemia villosa,* as documented in observations by field botanists and surveyors (HBMP 2008). Monitoring data from PEPP and the HBMP suggest that these 14 species face threats from landslides or falling rocks, as they are found in landscape settings susceptible to these events (e.g., steep slopes and cliffs). Field survey data presented by Oppenheimer documented the direct damage from landslides to individuals of *Cyanea solanacea* located along a stream bank and steep slope beneath a cliff (PEPP 2007, p. 41). Since *C. solanacea* is known from a total of 26 individuals in steep-walled stream valleys, one or several landslides could lead to near extirpation of the species by direct destruction of the individual plants, mechanical damage to individual plants that could lead to their death, destabilization of the cliff habitat leading to additional landslides, and alteration of hydrological patterns (e.g., affecting the availability of soil moisture). In addition, Perlman (2009b, in litt.) noted the threat of rolling or falling rocks to one population of *Cyanea magnicalyx.*

Monitoring data presented by HBMP and the PEPP program suggest that flooding is a likely threat to five plant species included in this final rule, *Bidens campylotheca* ssp. *waihoiensis, Cyanea duvalliorum, C. horrida, C. profuga,* and *Schiedea laui.* Field survey data presented by PEPP (2008, pp. 107–108) and by Bakutis (2010, in litt.) suggest that catastrophic flooding or landslides are possible at one population of *Schiedea laui* located in a cave along a narrow stream corridor at the base of a waterfall in the Kamakou Preserve.

Six plant species, *Canavalia pubescens, Cyanea horrida, Festuca molokaiensis, Schiedea jacobii, S. salicaria,* and *Stenogyne kauaulaensis,* and the three tree snails in this rule may be affected by habitat loss or degradation associated with droughts, which are not uncommon in the Hawaiian Islands. Between 1860 and 2006, there have been 30 periods of Statewide drought that have also affected the islands of Molokai, Lanai, and Maui (Giambelluca *et al.* 1991, pp. 3–4; Hawaii Commission on Water Resource Management 2009a and 2009b). In 2006, Maui County was designated a primary disaster area because of a severe drought from April to September 2006 (Pacific Disaster Center, 2010). More recently, the U.S. Department of Agriculture has designated Maui County as a primary natural disaster area due to losses caused by an ongoing drought, beginning January 1, 2012 (*http://www.fsa.usda.gov/FSA,* accessed January 17, 2013). It is suggested that *Festuca molokaiensis,* a purported annual plant, has not been observed at its known location in recent years due to drought conditions on Molokai (Oppenheimer 2011, pers. comm.). Drought also leads to an increase in the number of forest and brush fires (Giambelluca *et al.* 1991, p. v), causing a reduction of native plant cover and habitat (D'Antonio and Vitousek 1992, pp. 77–79) and a reduction in availability of host plants for the three tree snails. Recent episodes of drought have also driven axis deer farther into urban and forested areas for food, increasing their negative impacts to native vegetation from herbivory and trampling (see *Disease or Predation,* below) (Waring 1996, in litt., p. 5; Nishibayashi 2001, in litt.).

Habitat Destruction and Modification by Climate Change

Our analyses under the Endangered Species Act include consideration of ongoing and projected changes in climate. The terms ''climate'' and ''climate change'' are defined by the Intergovernmental Panel on Climate Change (IPCC). ''Climate'' refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007, p. 78). The term ''climate change'' thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007, p. 78). 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 10 Maui Nui ecosystems described in this final rule, or the 40 species at issue in this rule. Based on the best available information, climate change impacts could lead to the decline or loss of native species that comprise the communities in which the 40 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 (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). 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 40 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 40 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 40 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 °Centigrade (C)) with a range of 2.7 °F to 6.7 °F (1.5 °C to 3.7 °C) by 2100 worldwide (IPCC 2007). These changes would increase the monthly average temperature of the Hawaiian Islands from the current value of 74 °F (23.3 °C) to between 77 °F to 86 °F (25 °C to 30 °C). 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 (IPCC 2007). However, at high elevations, the rate of increase (0.48 °F

(0.27 °C) per decade) greatly exceeds the global rate (IPCC 2007).

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). 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).

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 2007; Marshall *et al.* 2008, p. 273; U.S. Climate Change Science Program 2008; Flannigan *et al.* 2009, p. 483; US–GCRP 2009; 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 2007; 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).

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; US–GCRP 2009). 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; US–GCRP 2009). Over the the past 100 years, the Hawaiian Islands have experienced an overall decline in annual precipitation of just over 9 percent (US–NSTC 2008). Other data on precipitation in Hawaii, which includes 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, p. 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 2007). 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). 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 (such as nonnative grasses adapted to fire), fire, and erosion (US–GCRP 2009; Warren 2011, pp. 221–226) (see ‘‘Habitat Destruction and Modification by Fire,’’ above). These impacts may negatively affect the 40 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- to large-scale low-pressure 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 with 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).

In general, tropical cyclones with the intensities of hurricanes have been a rare occurrence in the Hawaiian Islands. 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). Sea level rose at an average rate of 0.1 in (1.8 mm) per year between 1961 and 2003 (IPCC 2007, p. 5), 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 2007, p. 13). 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). There is no specific information available on how sea level rise and coastal inundation will impact the coastal ecosystems on Maui and Molokai where two of the species in this rule, *Canavalia pubescens* and *Pittosporum halophilum,* are currently found.

Increased interannual variability of ambient temperature, precipitation, hurricanes, and sea level rise and inundation would provide additional stresses on the 10 ecosystems and each of the associated 40 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, p. 8). The 40 species have limited environmental tolerances, 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., 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 are likely to negatively impact these 40 species, and we do not anticipate a reduction in this potential threat in the near future.

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

There are no approved habitat conservation plans (HCPs), safe harbor agreements (SHAs), or candidate conservation agreements (CCAs) that specifically address these 40 species and threats from habitat destruction or modification. We are aware of several memoranda of understanding (MOUs) that are under development that will specifically address one or more of these 40 species and the 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 40 species addressed 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 40 species occur now or occurred historically. Some of the voluntary conservation efforts include the 11 island-based watershed partnerships, including the 4 partnerships in Maui Nui (West Maui Mountains Watershed Partnership, East Maui Watershed Partnership, East Molokai Watershed Partnership, and Lanai Forest and Watershed Partnership). 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, nonnative plant control, 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.

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 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, or outplants 14 plant species that are addressed in this final rule (*Cyanea asplenifolia, C. horrida, C. magnicalyx, C. maritae, C. munroi, C. profuga, C. solanacea, Phyllostegia haliakalae, P. pilosa, Pittosporum halophilum, Schiedea jacobii, S. laui, Stenogyne kauaulaensis,* and *Wikstroemia villosa*) PEPP 2011, pp. 75, 166, 191; PEPP 2012, pp. 6, 13, 34–36, 66–70, 73–81, 150, 159–160). However, the program has not yet been able to directly address broad-scale habitat threats to plants by invasive species.

The State's University of Hawaii receives funding from the Service and other sources to propagate and maintain in captivity the two Lanai tree snails, *Partulina semicarinata* and *P. variabilis,* and Newcomb's tree snail (*Newcombia cumingi*). However, the numbers of individuals of both Lanai tree snail species appear to be declining in captivity, and individuals of Newcomb's tree snail do not survive long in captivity (Hadfield 2008, p. 1–11; Hadfield 2010, pers. comm.; Hadfield 2011, pers. comm.). This program does not address broad-scale threats to tree snail habitat by invasive species. Recently (August 2012), the Service and Maui Land and Pineapple Co., Inc. (MLP), entered into a cooperative agreement to provide funding for the construction of a fenced snail exclosure at the only known site for Newcomb's tree snail (Service 2012, in litt.). The purpose of the fenced exclosure is to protect individuals of this tree snail *in-situ* from predation by rodents (e.g., rats and mice) and predatory nonnative snails. In addition, restoration of snail habitat will be undertaken as funding is available. Construction of the fenced exclosure has not yet been inititated.

Voluntary conservation actions undertaken by The Nature Conservancy of Hawaii (TNC) on their preserves on Maui (Kapunakea Preserve and Waikamoi Preserve), and two of their preserves on Molokai (Kamakou Preserve and Moomomi Preserve), by the Maui Land and Pineapple Company on their Puu Kukui Watershed Preserve on west Maui, by Ulupalakua Ranch and Haleakala Ranch on their lands on Maui, and by East Maui Irrigation Company, Ltd., are described in our June 11, 2012, proposed rule (77 FR 34464). These conservation actions provide a conservation benefit and ameliorate some of the threats from nonnative species to one or more of the 36 plants (not *Cyanea mauiensis*) and 3 tree snails addressed in this final rule.

In addition, other private landowners on Maui are engaged in, or initiating, voluntary conservation actions on their lands, including fencing to exclude ungulates, removing ungulates, controlling nonnative plants, and outplanting native and rare plants. These private landowners include Kaanapali Land Development Company (in cooperation with TNC), Nuu Mauka Ranch, Kaupo Ranch, Makila Land Company, Kahoma Land Company, and Wailuku Water Company. All of these landowners are partners in one of the watershed partnerships on Maui, or cooperate or work collaboratively with watershed partners. The conservation actions provided by these landowners ameliorate some of the threats from nonnative species to one or more of the

36 plants (not *Cyanea mauiensis*) and 3 tree snails addressed in this final rule.

In addition to the the voluntary conservation efforts of TNC on Molokai (see above), we are aware of voluntary conservation efforts by Puu o Hoku Ranch associated with the safe harbor agreement (SHA) for the nene or Hawaiian goose (*Branta sandvicensis*). Although the SHA does not provide specific management actions for the conservation of one or more of the 11 species on Molokai addressed in this final rule, some habitat conservation measures (e.g., enhancement of native plant species) that may be undertaken by the ranch may benefit these species and their habitat.

Recently, the private landowners of the island of Lanai (Lanai Resorts and Castle & Cooke Properties, Inc. (CCPI)) began development of an island-wide conservation plan. This plan, when completed and implemented, should provide landscape-scale management that will benefit the unique native species and their habitats on the entire island of Lanai. The plan should help ameliorate the primary threats to, and needed recovery actions for, the seven species (five plants and two tree snails) addressed in this final rule and Lanai's already listed species and their habitat, including: Control of nonnative species (including ungulates), in-situ protection of tree snails, implementation of immediate protective intervention efforts for rare plants, and restoration of terrestrial habitat for plants and animals.

Summary of Habitat Destruction and Modification

The threats to the habitats of each of the 40 species in this final rule are occurring throughout the entire range of each of the species. These threats include land conversion by agriculture and urbanization, nonnative ungulates and plants, fire, natural disasters, and climate change, 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 40 species, due to the pervasive and expansive nature of the threats resulting in habitat degradation, these measures are insufficient across the landscape to eliminate these threats to any of the 40 species in this final rule.

Development and urbanization of coastal and lowland dry habitat on Maui represents a serious and ongoing threat to the remaining individuals of *Canavalia pubescens* remaining at Palauea-Keahou.

The effects from ungulates are ongoing because ungulates currently occur in the 10 ecosystems that support the 40 species in this 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 4) is serious, because they cause: (1) Trampling and grazing that directly impact the plant communities, which include 35 of the 37 plant species listed in this final rule, and impact host plants used by the two Lanai tree snails, *Partulina semicarinata* and *P. variabilis,* for foraging, shelter, and reproduction; (2) increased soil disturbance, leading to mechanical damage to individuals of the plant species listed in this final rule, and plants used by the two tree snails for foraging, shelter, and reproduction; and (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). These threats are expected to continue or increase without ungulate control or eradication.

Nonnative plants represent a serious and ongoing threat to 36 of the 40 species listed in this final rule (35 plant species and the tree snail *Newcombia cumingi;* see Table 4) 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; and (5) outcompete, and possibly directly inhibit the growth of, native plant species. Each of these threats can convert native-dominated plant communities to nonnative plant communities (Cuddihy and Stone 1990, p. 74; Vitousek 1992, pp. 33–35). This conversion has negative impacts on 35 of the 37 plant species addressed here, as well as the native plant species upon which *Newcombia cumingi* depends for essential life-history needs.

The threat from fire to 13 of the 40 species in this final rule that depend on coastal, lowland dry, lowland mesic, montane dry, montane mesic, and dry cliff ecosystems (*Bidens campylotheca* ssp. *pentamera, Canavalia pubescens, Cyanea magnicalyx, C. mauiensis, C. obtusa, Festuca molokaiensis, Phyllostegia bracteata, P. haliakalae, Pittosporum halophilum, Pleomele fernaldii, Santalum haleakalae* var. *lanaiensis, Schiedea salicaria,* and *Stenogyne kauaulaensis;* see Table 4) 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.

Natural disasters, such as hurricanes, represent a serious threat to the habitats of all 37 plant species addressed in this final rule because they open the forest canopy, modify available light, and create disturbed areas that are conducive to invasion by nonnative pest plants (Asner and Goldstein 1997, p. 148; Harrington *et al.* 1997, pp. 346–347). The discussion under ''Habitat Destruction and Modification by Nonnative Plants,'' above provides additional information related to canopy gaps, light availability, and the establishment of nonnative plant species. In addition, hurricanes can negatively impact the three tree snail species in this final rule because strong winds and intense rainfall can dislodge individual snails from their host plants and deposit them on the ground where they may be crushed by falling debris or eaten by nonnative rats and snails. The impacts of hurricanes and other stochastic natural events can be particularly devastating to the 40 species 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 can happen at any time, although their occurrence is not predictable.

Landslides, rockfalls, treefalls, and flooding adversely impact the habitats of 16 of the species in this final rule (*Bidens campylotheca* ssp. *waihoiensis, Cyanea asplenifolia, C. duvalliorum, C. grimesiana* ssp. *grimesiana, C. horrida, C. magnicalyx, C. maritae, C. mauiensis, C. munroi, C. profuga, C. solanacea, Cyrtandra filipes, Schiedea jacobii, S. laui, Stenogyne kauaulaensis,* and *Wikstroemia villosa;* see Table 4) 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 is a threat to six plant species—*Canavalia pubescens, Cyanea horrida, Festuca molokaiensis, Schiedea jacobii, S. salicaria,* and *Stenogyne kauaulaensis*—and all three tree snails—*Newcombia cumingi, Partulina semicarinata,* and *P. variabilis*—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 have the potential to occur at any time, although their occurrence is not predictable.

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 40 species addressed in this final rule are related to changes in microclimatic conditions in their habitats. These changes may lead to the loss of native species due to direct physiological stress, the loss or alteration of habitat, increased competition from nonnative species, and changes in disturbance regimes (e.g., droughts, fire, storms, and hurricanes). Because the specific and cumulative effects of climate change on these 40 species are presently unknown, we are not able to determine the severity of this possible threat with confidence.

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

Plants

We are not aware of any threats to the 37 plant species addressed in this final rule that are attributable to overutilization for commercial, recreational, scientific, or educational purposes.

Tree Snails

Tree snails can be found around the world in tropical and subtropical regions and have been valued as collectibles for centuries. Evidence of tree snail trading among prehistoric Polynesians was discovered by a genetic characterization of the enigmatic multi-archipelagic distribution of the Tahitian endemic *Partula hyalina* and related taxa (Lee *et al.* 2007, pp. 2,907, 2,910). In their study, Lee *et al.* (2007, pp. 2,908–2,910) found evidence that *Partula hyalina* had been traded as far away as Mangaia in the Southern Cook Islands, a distance of over 500 mi (805 km). The endemic Hawaiian tree snails within the family Achatinellidae (subfamily Achatinellinae) were extensively collected for scientific as well as recreational purposes by Europeans in the 18th to early 20th centuries (Hadfield 1986, p. 322). During the 1800s, collectors observed 500 to 2,000 snails per tree, and sometimes collected over 4,000 snails in just several hours (Hadfield 1986, p. 322). We may infer that the repeated collections of hundreds to thousands of individuals at a time by early collectors resulted in decreased population sizes and reduction of reproduction potential due to the removal of potential breeding adults. The Achatinellinae do not reach reproductive age until nearly 10 years old, after which they produce only 4 to 6 offspring per year (Hadfield 2011, pers. comm.). The allure of tree snails persists to this day, and there is a market for rare tree snails that may serve as an incentive to collect them. A search of the Internet (e.g., *eBay.com, google.com*) reveals Web sites that offer Hawaiian tree snail shells for sale, including other species of the endemic Hawaiian tree snail genus *Partulina.* Based on the history of collection of endemic Hawaiian tree snails, the market for Hawaiian tree snail shells, and the vulnerability of the small populations of *Newcombia cumingi, Partulina semicarinata,* and *P. variabilis* to the negative impacts of any collection, we consider the potential overcollection of these three Hawaiian tree snails to pose a serious and ongoing threat, because it can occur at any time, although its occurrence is not predictable.

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

We are unaware of voluntary conservation efforts to reduce overcollection of the three Hawaiian tree snails. There are no approved HCPs, SHAs, or MOUs, or other voluntary actions that specifically address these three species 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 any the 37 plant species in this final rule. We consider the three species of tree snails vulnerable to the impacts of overutilization due to collection for trade or market. Based on the history of collection of endemic Hawaiian tree snails, the market for Hawaiian tree snail shells, and the inherent vulnerability of the small populations of *Newcombia cumingi, Partulina semicarinata,* and *P. variabilis* to the removal of breeding adults, we consider collection to pose a serious and ongoing threat to these species.

C. Disease or Predation

Disease

We are not aware of any threats to the 37 plant species addressed in this final rule that would be attributable to disease. Disease is a potential threat to the three tree snails in this rule, *Newcombia cumingi, Partulina semicarinata,* and *P. variabilis;* evidence for this is based on attempts to raise these species in captivity. Due to the extremely low numbers and threat of extinction of Hawaiian tree snails in the wild, captive breeding of over 20 species has been implemented over the past decade. Hadfield (2010, pers. comm.) notes that individuals of *Newcombia cumingi* do not survive long in captivity, and individuals of *Partulina* spp. sometimes die off for unknown reasons (Hadfield 2011, pers. comm.). According to Hadfield (2011, pers. comm.), the London Zoo found evidence of protozoan presence in a non-Hawaiian species of *Partulina,* which is indicative of disease. Hadfield (2011, pers. comm.) also suggests there is a negative correlation between reproductive potential in Hawaiian tree snails and time in captivity, likely due to inbreeding depression or environmental conditions, including disease.

Because we have no evidence that disease may be impacting natural populations of the three tree snail species, we cannot conclude that this threat may have contributed to the current population status of *Newcombia cumingi, Partulina semicarinata,* and *P. variabilis.* However, we note that disease is a potential threat to captive bred Hawaiian tree snails and may be of particular concern for *Newcombia cumingi,* which is not successfully surviving or reproducing in captivity, potentially due to disease, and is only known from one individual in one location in the wild. Recovery of this species will likely depend on successful captive propagation and eventual translocation to protected sites in the wild.

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 extant 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), introduced ungulates pose a threat to the following 35 of the 37 plant species in this final rule by trampling and eating individual plants (this information is also presented in Table 4): *Bidens campylotheca* ssp. *pentamera* (pigs, goats, and axis deer), *B. campylotheca* ssp. *waihoiensis* (pigs, goats, and axis deer), *B. conjuncta* (pigs and goats), *Calamagrostis hillebrandii* (pigs), *Canavalia pubescens* (pigs, goats, cattle, and axis deer), *Cyanea asplenifolia* (pigs, goats, cattle, and axis deer), *C. duvalliorum* (pigs), *C. grimesiana* ssp. *grimesiana* (pigs, goats, and axis deer), *C. horrida* (pigs), *C. kunthiana* (pigs), *C. magnicalyx* (pigs), *C. maritae* (pigs), *C. mauiensis* (pigs), *C. munroi* (goats and axis deer), *C. obtusa* (pigs, goats, cattle, and axis deer), *C. profuga* (pigs and goats), *C. solanacea* (pigs and goats), *Cyrtandra ferripilosa* (pigs and goats), *C. filipes* (pigs, goats, and axis deer), *C. oxybapha* (pigs, goats, and cattle), *Festuca molokaiensis* (goats), *Geranium hanaense* (pigs), *G. hillebrandii* (pigs), *Mucuna sloanei* var. *persericea* (pigs and cattle), *Myrsine vaccinioides* (pigs), *Peperomia subpetiolata* (pigs), *Phyllostegia bracteata* (pigs and cattle), *P. haliakalae* (cattle), *P. pilosa* (pigs and goats), *Pittosporum halophilum* (pigs), *Pleomele fernaldii* (axis deer and mouflon), *Santalum haleakalae* var. *lanaiense* (pigs, goats, axis deer, and mouflon), *Schiedea jacobii* (goats, cattle, and axis deer), *S. salicaria* (goats, cattle, and axis deer), and *Wikstroemia villosa* (pigs).

We have direct evidence of ungulate damage to some of these species, but for many, due to their remote locations or lack of study, ungulate damage is presumed based on the known presence of these introduced ungulates in the areas where these species occur and the results of studies conducted in Hawaii and elsewhere (Diong 1982, p. 160). For example, in a study conducted by Diong (1982, p. 160) on Maui, feral pigs were observed browsing on young shoots, leaves, and fronds of a wide variety of plants, of which over 75 percent were endemic species. A stomach content analysis in this study showed that 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 four of the plant species in this final rule, including *Cyanea magnicalyx* (PEPP 2010, p. 49), *C. maritae* (PEPP 2010, p. 50), *Peperomia subpetiolata* (PEPP 2010, p. 97), and *Phyllostegia pilosa* (PEPP 2009, p. 93). As pigs occur in 10 ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, subalpine, dry cliff, and wet cliff) on Molokai and Maui, the results of the studies described above suggest that pigs can also alter these ecosystems and directly damage or destroy native plants by their browsing activity.

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 present at high numbers, mature 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 *Acacia 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 on the island of Hawaii 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 (HDLNR 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). As goats 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), on Molokai, Lanai, and Maui, the results of the studies described above suggest that goats can also alter these ecosystems and directly damage or destroy native plants by their browsing activity. Therefore, goats pose a threat of predation to 18 species in this rule, as delineated in Table 4.

Axis deer were introduced to Molokai in 1868, Lanai in 1920, and Maui in 1959. 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 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 in litt. 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 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-August), axis deer can be found along Maui's coastal roads as they search for food. Hunting pressure 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. comms.) axis deer can be found up to 9,000 ft (2,743 m) elevation.

Other native Hawaiian plant species have been reported as grazed and browsed by axis deer. For example, on Lanai, grazing by axis deer has been reported as a major threat to the endangered *Gardenia brighamii* (nau) (Mehrhoff 1993, p. 11), and on Molokai, browsing by axis deer has been reported on *Erythrina sandwicensis* and *Nototrichium sandwicense* (kului) (Medeiros *et al.* 1996, pp. 11, 19). Swedberg and Walker (1978, cited in Anderson 2003, pp. 124–125) reported that in the upper forests of Lanai, the native plants *Osteomeles anthyllidifolia* (uulei) and *Leptecophylla tameiameiae* (pukiawe) comprised more than 30 percent of axis deer rumen volume. Other native plant species consumed by axis deer include *Abutilon menziesii* and *Geranium multiflorum* (nohoanu) (both endangered species); the species *Bidens campylotheca* ssp. *pentamera* and *B. campylotheca* ssp. *waihoiensis,* which are addressed in this final rule; and *Achyranthes splendens* (NCN), *Chamaesyce lorifolia* (akoko), *Diospyros sandwicensis* (lama), *Lipochaeta rockii* var. *dissecta* (nehe), *Osmanthus sandwicensis* (ulupua), *Panicum torridum* (kakonakona), and *Santalum ellipticum* (laau ala) (Anderson 2002, poster; Perlman 2009c, in litt., pp. 4–5). As axis deer occur in nine of the described ecosystems on Molokai, Lanai, and Maui (coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, dry cliff, and wet cliff), the results from the studies above, in addition to the direct observations from field biologists, suggest that axis deer can also alter these ecosystems and directly damage or destroy native plants by their browsing activity (see Table 4).

Mouflon sheep graze native vegetation, trample undergrowth, spread weeds, and cause erosion. On the island of Hawaii, mouflon 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 Hawaii Volcanoes National Park, mouflon sheep 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 sheep 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). While mouflon sheep were introduced to the islands of Lanai and Hawaii as a managed game species, a private game ranch on Maui has added mouflon to its stock and it is likely that over time some individuals may escape (Hess 2010, pers. comm.; Kessler 2010, pers. comm.). As mouflon occur in seven of the described ecosystems (coastal, lowland dry, lowland mesic, lowland wet, montane wet, dry cliff, and wet cliff) on Lanai, the data from the studies above, in addition to direct observation of field biologists, suggest that mouflon can also alter these ecosystems and directly damage or destroy native plants by their browsing activity (see Table 4).

Cattle, either feral or domestic, are considered one of the most important factors in the destruction of Hawaiian forests (Baldwin and Fagerlund 1943, pp. 118–122). Captain George Vancouver of the British Royal Navy is attributed with introducing cattle to the Hawaiian Islands in 1793 (Fischer 2007, p. 350) by way of a gift to King Kamehameha I on the island of Hawaii. Over time, cattle became established on all of the main Hawaiian Islands, and historically feral cattle were found on the islands of Kauai, Oahu, Molokai, Maui, Kahoolawe, and Hawaii. 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 Hawaii Volcanoes National Park on the island of Hawaii, 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 *Acacia 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. As feral cattle occur in five of the described ecosystems (lowland dry, lowland mesic, lowland wet, montane mesic, and montane wet) on Maui, the results from the above studies, in addition to the direct observations from field biologists, suggest that feral cattle can alter these ecosystems and directly damage or destroy native plants by their browsing activity (see Table 4).

The blackbuck antelope (*Antilope cervicapra*) is an endangered antelope from India brought to a private game reserve on Molokai about 10 years ago from an Indian zoo (Kessler 2010, pers. comm.). According to Kessler (2010, pers. comm.), at some time in the last 10 years, a few individuals escaped from the game reserve and established a wild population of an unknown number of individuals on the lower, dry plains of western Molokai. Blackbuck primarily use grassland habitat for grazing. In India, foraging consumption and nutrient digestibility are high in the moist winter months and low in the dry summer months (Jhala 1997, pp. 1,348; 1,351). Although most plant species are grazed intensely when they are green, some are grazed only after they are dry (Jhala 1997, pp. 1,348; 1,351). While the habitat effects from the blackbuck antelope are unknown at this time, we consider these ungulates a potential threat to native plant species, including the 11 plant species in this final rule found on Molokai (Kessler 2010, pers. comm.), because blackbuck antelope have foraging and grazing habits similar to feral goats, cattle, axis deer and mouflon.

Other Introduced Vertebrates

Rats

There are three species of introduced rats in the Hawaiian Islands. Studies of Polynesian rat (*Rattus exulans*) DNA suggest they first appeared in the Hawaiian Islands along with emigrants from the Marquesas about 400 A.D., with a second interaction around 1100 A.D. (Ziegler 2002, p. 315). The black rat (*R. rattus*) and the Norway rat (*R. norvegicus*) most likely arrived in the Hawaiian Islands more recently, as stowaways on ships sometime in the late 19th century (Atkinson and Atkinson 2000, p. 25). The Polynesian rat and the black rat are primarily found in 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 is a threat to 23 of the 37 plant species, and all 3 species of tree snails, in this final rule (see Table 4).

Rat Impacts on Plants

Rats impact native plants by eating fleshy fruits, seeds, flowers, stems, leaves, roots, and other plant parts (Atkinson and Atkinson 2000, p. 23), and 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 adversely impact many endangered and 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 addressed in this final 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 all 12 species of *Cyanea* (*Cyanea asplenifolia, C. duvalliorum, C. grimesiana* ssp. *grimesiana, C. horrida, C. kunthiana, C. magnicalyx, C. maritae, C. mauiensis, C. munroi, C. obtusa, C. profuga,* and *C. solanacea*), 11 other species of plants in this final rule are adversely impacted by rat predation, including *Bidens campylotheca* ssp. *pentamera, B. campylotheca* ssp. *waihoiensis, B. conjucta* (Bily *et al.* 2003, pp. 1–16), *Mucuna sloanei* var. *persericea, Myrsine vaccinioides, Peperomia subpetiolata, Pittosporum halophilum, Pleomele fernaldii, Santalum haleakalae* var. *lanaiense, Schiedea laui,* and *Wikstroemia villosa* (HBMP 2008; Harbaugh *et al.* 2010, p. 835). As 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) on Molokai, Lanai, and Maui, the results from the above studies, in addition to direct observations from field biologists, suggest that rats can directly damage or destroy native plants.

Rat Impacts on Tree Snails

Rats (*Rattus* spp.) have been suggested as the invasive animal responsible for likely the greatest number of animal extinctions on islands throughout the world, including extinctions of various snail species (Towns *et al.* 2006, p. 88). In the Hawaiian Islands, rats are known to prey upon endemic arboreal snails (Hadfield *et al.* 1993, p. 621). In the Waianae Mountains of Oahu, Meyer and Shiels (2009, p. 344) found shells of the endangered endemic Oahu tree snail (*Achatinella mustelina*) with characteristic rat damage (e.g., damage to the shell opening and cone tip), but noted that rat crushing of shells may limit the ability to adequately quantify the threat. On Lanai, Hobdy (1993, p. 208) found numerous shells of *Partulina variabilis,* one of the tree snails in this final rule, on the ground with damage characteristic of rat predation. Likewise in a 2005 survey on Lanai, Hadfield (2005, pp. 3–4) found shells of *Partulina semicarinata,* another tree snail species in this rule, on the ground with characteristic rat damage. Surveys in 2009 led Hadfield and colleagues to conclude that populations of *Partulina redfieldi* (a tree snail endemic to lowland and montane forests on Molokai) had declined by 85 percent since 1995 due to rat predation (Hadfield and Saufler 2009, p. 1). On Maui, rat predation on the tree snail species *Newcombia cumingi,* addressed in this final rule, has led to a decrease in the number of individuals (Hadfield 2006 in litt., p. 3; 2007, p. 9; 2011, pers. comm.). As rats are found in nine of the described ecosystems on Lanai and Maui (the islands on which *Newcombia cumingi, Partulina semicarinata,* and *P. variabilis* occur), including the three ecosystems (lowland wet, montane wet, and wet cliff) in which the three tree snails in this rule are found, the results of the above studies, in addition to direct observations from field biologists, suggest that rats directly damage or destroy Hawaiian tree snails and are a serious and ongoing threat to the three tree snail species in this final rule.

Jackson's Chameleon

Several dozen Jackson's chameleons (*Chamaeleo jacksonii*), native to Kenya and Tanzania, were introduced to Hawaii in the early 1970s through the pet trade (Holland *et al.* 2010, p. 1,438). Inter-island transport of Jackson's chameleons for the pet trade was unrestricted until 1997, when they were classified as ''injurious wildlife,'' and export as well as inter-island transport was prohibited (State of Hawaii 1996, H.A.R. 13–124–3; Holland *et al.* 2010, p. 1,439). Currently, there are established populations on all of the main Hawaiian Islands, with the greatest number of individuals on the islands of Hawaii, Maui, and Oahu (Holland *et al.* 2010, p.

1,438). Jackson's chameleons prey on native insects and tree snails, including the endangered Oahu tree snail (*Achatinella mustelina*) (Holland *et al.* 2010, p. 1,438; Hadfield 2011, pers. comm.). Jackson's chameleons may be expanding their range in the wild from low-elevation to higher elevation pristine native forest, which may result in catastrophic impacts to native ecosystems and the species supported by those ecosystems, including the lowland wet ecosystems on Maui and Lanai that support the tree snails *Newcombia cumingi, Partulina semicarinata,* and *P. variabilis,* and the montane wet and wet cliff ecosystems on Lanai that support *P. semicarinata* and *P. variabilis.* Because Jackson's chameleons are likely found in, or expanding their range into, all of the ecosystems in which the three tree snails addressed in this final rule are found, and are known to prey on tree snails, predation by Jackson's chameleon is a potentially serious threat to the tree snails *Newcombia cumingi, Partulina semicarinata,* and *P. variabilis.*

Invertebrates

Nonnative Slugs

Predation by nonnative snails and slugs adversely impacts 26 of the 37 plant species (*Bidens campylotheca* ssp. *waihoiensis, B. conjuncta, Cyanea asplenifolia, C. duvalliorum, C. grimesiana* ssp. *grimesiana, C. horrida, C. kunthiana, C. magnicalyx, C. maritae, C. mauiensis, C. munroi, C. obtusa, C. profuga, C. solanacea, Cyrtandra filipes, Geranium hillebrandii, Myrsine vaccinioides, Peperomia subpetiolata, Phyllostegia bracteata, P. haliakalae, P. pilosa, Santalum haleakalae* var. *lanaiense, Schiedea jacobii, S. laui, Stenogyne kauaulaensis,* and *Wikstroemia villosa;* see Table 4) in this final rule through mechanical damage, destruction of plant parts, and mortality (Mitchell *et al.* 2005; Joe 2006, p. 10; HBMP 2008; PEPP 2008, pp. 48–49, 52–53, 57, 70; PEPP 2010, pp. 1–121). 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.; U.S. Army Garrison 2005, pp. 3–34, 3–51). In addition, slugs have damaged individuals of other *Cyanea* and *Cyrtandra* species in the wild (Wood 2001, in litt.; Sailer and Kier 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'' and from Keir (2013, in litt.) indicates that slugs can be a threat to all species of *Cyanea* (U.S. Army Garrison 2005, p. 3–51; Keir 2013, in litt.). 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 2005, 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, p. 190–191; Sailer, pers. comm. 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. As slugs are found in eight of the described ecosystems (lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, dry cliff, and wet cliff) on Molokai, Lanai, and Maui, the data from the above studies, in addition to direct observations from field biologists, suggest that slugs can directly damage or destroy native plants.

Nonnative Snails

Several species of nonnative snails have been inadvertently introduced to Hawaii. However, in 1955, the rosy wolf snail (*Euglandina rosea*) was purposely introduced to Hawaii from Florida in an attempt to control another nonnative, the giant African snail (*Achatina fulica*). The giant African snail is commonly found in Honolulu gardens and is one of the largest snails in the world, in addition to being recognized as one of the world's most damaging pests to crop plants (Peterson 1957, pp. 643–658; Stone and Anderson 1988, p. 134). The giant African snail appears to have declined throughout the Hawaiian Islands although it is unclear if this decline is due to the rosy wolf snail or other unrelated reasons (Cowie 1997, p. 15). The rosy wolf snail is now found on six of the eight main Hawaiian Islands (its presence on Niihau and Kahoolawe has not been confirmed) and has expanded its range on those islands to include cooler, mid-elevation forests where many endemic tree snails are found. This nonnative snail is likely responsible for the decline and extinction of many of Hawaii's native tree snails (Stone and Anderson 1988, p. 134; Hadfield *et al.* 1993, p. 621; Hadfield 2010a, in litt.). In 1979, the rosy wolf snail decimated a population of the endangered Oahu tree snail (*Achatinella mustelina*), as well as all other tree snails at the same study site (Hadfield and Mountain 1980, p. 357). According to Hadfield (2007, pp. 6–9), the rosy wolf snail is currently the greatest threat to the only known population of *Newcombia cumingi,* one of the three tree snails addressed in this final rule. In addition, the nonnative garlic snail (*Oxychilus alliarius*), a predator on the smaller achatinellid snails, may be a potential threat to *Newcombia cumingi* (Hadfield 2010a, in litt.). Hadfield (2007, pp. 6–9) reported finding many shells of the garlic snail within the habitat of *N. cumingi* on Maui. As the rosy wolf snail can be found in three of the described ecosystems (lowland wet, montane wet, and wet cliff) on Lanai and Maui (the islands on which *N. cumingi, Partulina semicarinata,* and *P. variabilis* occur), the results from the studies above, in addition to observations by field biologists, suggest that the rosy wolf snail has the potential to severely impact the three tree snails in this final rule.

Nonnative Flatworms

The extinction of native land snails on several Pacific Islands has been attributed to the terrestrial flatworm *Platydemus manokwari* (Sugiura 2010, p. 1,499). This flatworm has decimated populations of native tree snails on Guam (Hopper and Smith 1992, pp. 78, 82–83). In the Hawaiian Islands, *Platydemus manokwari* has been found on the islands of Oahu and Hawaii, and is likely on all of the main islands (Miller 2011, pers. comm.). Although *P. manokwari* has not been reported from the same locations as the three tree snails addressed in this final rule, it is a potential threat to these species because it likely co-occurs on the islands of Molokai, Lanai, and Maui, and it is a known predator on tree snails.

Conservation Efforts To Reduce Disease or Predation

There are no approved HCPs, SHAs, or CCAs that specifically address these 40 species and threats from predation. In addition, we are unaware of any voluntary actions that address the three species of tree snails and the threat from disease. We are aware of several MOUs that are under development that will specifically address one or more of these 40 species and may address 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 40 species addressed in this final rule due to predation by nonnative animal species, specifically predation by feral ungulates. 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 40 species occur now or occurred historically. See above, ''Conservation Efforts to Reduce Habitat Destruction, Modification, or Curtailment of Its Range,'' for a summary of some voluntary conservation actions to address threats from feral ungulates.

The State's University of Hawaii receives funding from the Service and other sources to propagate and maintain in captivity the two Lanai tree snails and Newcomb's tree snail. However, the numbers of individuals of both Lanai tree snail species appear to be declining in captivity and individuals of Newcomb's tree snail do not survive long in captivity (Hadfield 2008, p. 1–11; Hadfield 2010, pers. comm.; Hadfield 2011, pers. comm.). This program does not address threats to these three tree snails from predation by nonnative species in the wild nor threats from disease in captivity. Recently (August 2012), the Service and MLP entered into a cooperative agreement to provide funding for the construction of a fenced snail exclosure at the only known site for Newcomb's tree snail (Service 2012, in litt.). The purpose of the fenced exclosure is to protect individuals of this tree snail *in-situ* from predation by rodents (e.g., rats and mice) and predatory nonnative snails. Construction of the fenced exclosure has not yet been inititated.

Summary of Disease or Predation

We are unaware of any information that indicates that disease is a threat to the 37 plant species in this final rule. Disease is a potential threat to the three species of tree snails in this rule, as recovery of these species likely will include captive propagation and disease is suspected to be a cause of currently unsuccessful captive propagation of *Newcombia cumingi, Partulina semicarinata,* and *P. variabilis.* However, at this time, we have no evidence to suggest that disease is acting on the wild populations such that it may be considered a significant threat to the species.

Although conservation measures are in place in some areas where each of the 40 species in this final rule occur, information does not indicate that they are ameliorating the threat of predation. Therefore, we consider predation by nonnative animal species (pigs, goats, axis deer, mouflon sheep, cattle, rats, Jackson's chameleon, slugs, snails, and flatworms) to pose an ongoing threat to all 40 species in this final rule throughout their ranges for the following reasons:

(1) Observations and reports have documented that pigs, goats, axis deer, mouflon sheep, and cattle browse and trample 35 of the 37 plant species (see Table 4), 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 30 of the 37 plant species in this rule (see Table 4). All 40 species in this final rule are impacted by either introduced ungulates, as noted in item 1, above, or nonnative rats and slugs, or both.

(3) Rat damage has been observed on shells of dead individuals of the tree snails *Partulina variabilis* and *P. semicarinata* on Lanai, as well as on other native tree snails on Oahu and Molokai, indicating rats are a likely cause of mortality of these species. Predation by rats has been linked with the dramatic declines of some populations of native tree snails (Hobdy 1993, p. 208; Hadfield and Saufler 2009, p. 1; Meyer and Shields 2009, p. 344). Rat predation has been documented on the tree snail species *Newcombia cumingi* (Hadfield 2006 in litt., p. 3; Hadfield 2007, p. 9; Hadfield 2010a, in litt.). Although funding has recently been provided to construct a fenced exclosure to protect individuals of this tree snail *in-situ* from predation by rodents (e.g., rats and mice) and predatory nonnative snails, construction has not yet been inititated. Because rats are found in all of the ecosystems in which the three tree snails addressed in this final rule are found, and rats are known to prey on tree snails, we consider predation by rats to be a serious and ongoing threat to *Newcombia cumingi, Partulina semicarinata,* and *P. variabilis.*

(4) Jackson's chameleon, which preys on native insects and tree snails, has established populations in the wild on all the main Hawaiian Islands. Jackson's chameleon is likely found in, or is in the process of expanding its range to include, all of the ecosystems that support the three tree snails addressed in this final rule. Predation by this nonnative reptile is a potentially serious threat to *Newcombia cumingi, Partulina semicarinata,* and *P. variabilis.*

(5) Hawaiian tree snails are vulnerable to predation by the nonnative rosy wolf snail, which is found on all the main Hawaiian Islands and whose range likely overlaps that of the three tree snail species we are listing. We therefore consider *Newcombia cumingi, Partulina semicarinata,* and *P. variabilis* to be adversely impacted by predation by the nonnative rosy wolf snail. Although funding has recently been provided to construct a fenced exclosure to protect individuals of *Newcombia cumingi in-situ* from predation by rodents and predatory nonnative snails, construction has not yet been inititated. In addition, the nonnative garlic snail may be a potential threat to one of the tree snails addressed in this final rule, *N. cumingi,* because it is a known predator on smaller tree snails in the same family as *N. cumingi* and shells of the garlic snail have been found in *N. cumingi* habitat (Stone and Anderson 1988, p. 134; Hadfield *et al.* 1993, p. 621; Hadfield 2010a, in litt.).

(6) The nonnative flatworm, *Platydemus manokwari,* is a potential threat to all three species of tree snails addressed in this final rule (Hadfield 2010b, in litt.; Sugiura 2010, pp. 1,499–1,501) because this flatworm has decimated native tree snail populations on other Pacific Islands and likely occurs on all the main Hawaiian Islands, including the islands of Lanai and Maui, where the three tree snails are found.

These threats are serious and ongoing, act in concert with other threats to the species, and are expected to continue or increase in severity and intensity into the future without effective management actions to control or eradicate them. In addition, negative impacts to native Hawaiian plants on Molokai from grazing and browsing by the blackbuck antelope are likely should this nonnative ungulate increase in numbers and range on the island. The combined threat of ungulate, rat, and invertebrate predation on native Hawaiian flora and fauna suggests the need for immediate implementation of recovery and conservation methodologies.

D. The Inadequacy of Existing Regulatory Mechanisms

Inadequate Habitat Protection

Currently, there are no existing Federal, State, or local laws, treaties, or regulations that specifically conserve or protect the 40 species addressed in this final rule, or adequately address the threats described in this rule. Although the State of Hawaii's Plant Extinction Prevention Program supports conservation of the plant species by securing seeds or cuttings from the rarest and most critically endangered native species for propagation, the program is nonregulatory and has not yet been able to directly address broad-scale threats to plants by invasive species.

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 Molokai, Lanai, and Maui 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 remains limited in scope. If current levels of funding and regulatory support for invasive species control are maintained on Molokai, Lanai, and Maui, 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.

Feral Ungulates

Nonnative ungulates pose a major ongoing threat to 35 of the 37 plant species and 2 of the 3 tree snail species—*Partulina semicarninata* and *P. variabilis*—through destruction and degradation of terrestrial habitat, and through direct predation of 35 of the plant species (see Table 4). The State of Hawaii provides game mammal (feral pigs and goats, axis deer, and mouflon sheep) hunting opportunities on 15 State-designated public hunting areas on the islands of Molokai, Lanai, and Maui (State of Hawaii 1999, H.A.R. 13–123; HDLNR 2009, pp. 20–21). 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 (State of Hawaii, H.A.R. 13–123). Thirty-four of the 37 plant species have populations in areas where terrestrial habitat may be manipulated for game enhancement and game populations are maintained at prescribed levels using public hunting (HBMP 2008; State of Hawaii, 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 37 of the 40 species, or the direct predation of 35 of the 37 plant species on Molokai, Lanai, and Maui (see Table 4). 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.

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. The U.S. Department of Homeland Security-Customs and Border Protection (CBP) is responsible for inspecting commercial, private, and military vessels and aircraft and related cargo and passengers arriving from foreign locations. CBP focuses on a wide range of quarantine issues involving non-propagative plant materials (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); federally listed noxious seeds and plants; 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-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 (HDOA 2009). The Service inspects arriving wildlife products, enforces the injurious wildlife provisions of the Lacey Act (18 U.S.C. 42; 16 U.S.C. 3371 *et seq.*), and prosecutes CITES violations.

The State of Hawaii's unique biosecurity needs are not recognized by Federal import regulations. 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; USDA–APHIS–PPQ 2010; CGAPS 2009). 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 and is extremely time-consuming to satisfy. Therefore, that avenue may only provide minimal protection against the large diversity of foreign pests that negatively impact 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; USDA–APHIS–PPQ 2010; CGAPS 2009). 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 enacted in 2011 (H.B. 1568) requires commercial harbors and airports in Hawaii to provide biosecurity and to facilitate cargo inspections. 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.

In 1995, CGAPS, a partnership composed primarily of managers from every major Federal, State, County, and private agency and organization involved in invasive species work in Hawaii, was formed in an effort to improve communication, increase collaboration, and promote public awareness (CGAPS 2009). This group facilitated the formation of the Hawaii Invasive Species Council (HISC), which was created by gubernatorial executive order in 2002, to coordinate local initiatives for the prevention 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 otherwise 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.). Current positions provided by HISC are fewer than those supported in 2009; most of the positions have been lost through attrition and have not been refilled (Atwood 2012, in litt.). In addition, HISC funds fewer projects and provides fewer services (Atwood 2012, in litt.; Clark 2012, in litt.) than in 2009 and earlier. Many projects (such as invasive species and biological control research) that were previously funded by HISC are receiving negligible HISC funding or remain unfunded (Atwood 2012, in litt.; Clark 2012, in litt.).

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; CGAPS 2010). The importation and interstate transport of invasive vertebrates is federally regulated by the Service under the Lacey Act as ''injurious wildlife'' (Fowler *et al.* 2007, pp. 353 – 359); the current list of vertebrates considered as ''injurious wildlife'' is provided at 50 CFR 16. The law in its current form has limited effectiveness in preventing invasive vertebrate introductions into the State of Hawaii because the list of vertebrates considered to be ''injurious wildlife'' under the Lacey Act is relatively limited.

Nonnative Invertebrate Species

Predation by nonnative invertebrate pests (flatworms, slugs, snails) adversely impacts 26 of the plant species and the 3 tree snails addressed in this rule (see Table 4 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. The prevention and control of introduction of pest species in Hawaii is the responsibility of Hawaii State government and Federal agencies, and is being voluntarily addressed by a few private organizations. Even though these agencies have regulations and some controls in place (see above), 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 were introduced to Hawaii per year since 1970, an increase of 25 percent over the previous totals between 1930 and 1970 (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 change to this situation is anticipated in the future.

Nonnative Plant Species

Nonnative plants destroy and modify habitat throughout the ranges of 36 of the 40 species being addressed in this final rule (see Table 4, 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, 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 2009). 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 either 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. The USDA–APHIS–PPQ is in the process of finalizing rules to include a weed risk assessment for newly imported plants. Although the State has general guidelines for the importation of plants, and regulations are in place regarding the plant crops mentioned above, the intentional or inadvertent introduction of nonnative plants outside the regulatory process and movement of species between islands and from one watershed to the next continues, and represents a threat to native flora 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.).

On the basis of the above information, existing State and Federal regulatory mechanisms are not preventing introduction of nonnative species into Hawaii via interstate and international mechanisms, or via intrastate movement of nonnative species between islands and watersheds in Hawaii. Therefore, State and Federal regulatory mechanisms do not adequately protect the 40 species being addressed in this final rule from the threat of new introductions of nonnative species or the continued expansion of nonnative species populations on and between islands and watersheds. Nonnative species may prey upon, modify or destroy habitat of, or directly compete with one or more of the 40 species for food, space, and other necessary resources. The impacts from these introduced threats are ongoing and are expected to continue into the future.

Summary of Inadequacy of Existing Regulatory Mechanisms

Existing State and Federal regulatory mechanisms are not preventing the introduction into Hawaii of nonnative species or the spread of nonnative species between islands and watersheds. Habitat-altering nonnative plant species (Factor A) and predation by nonnative animal species (Factor C) pose a major ongoing threat to the 40 species being addressed in this final rule. Thirty-five of the 37 plant species experience threats from habitat degradation and loss by nonnative plants (Factor A), and all 37 plants experience threats from nonnative animals (Factor A and Factor C). All three tree snail species experience threats from habitat degradation and loss by nonnative plants (*Newcombia cumingi*) or nonnative animals (*Partulina semicarinata* and *P. variabilis*). The three tree snails experience threats from predation by nonnative animals (Factor C). Therefore, we conclude these existing regulatory mechanisms are inadequate to sufficiently reduce these threats to all 40 species.

E. Other Natural or Manmade Factors Affecting Their Continued Existence

Other factors that pose threats to some or all of the 40 species include small numbers of individuals and small numbers of populations, hybridization, lack of regeneration, and human trampling as a result of hiking and other activities. Each threat is discussed in detail below, along with identification of which species are affected by these threats.

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, landslides, rockfalls, drought, 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). A single, stochastic event can result in the extinction of an entire species, if all the representatives of that species are concentrated in a single area. In addition, 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 snails), and hybridization (plants). 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 Factors A and C, above).

Plants

The following 20 plant species in this final rule face the threat of limited numbers (i.e., they total fewer than 50 individuals in the wild): *Cyanea grimesiana* ssp. *grimesiana, C. horrida, C. magnicalyx, C. maritae, C. mauiensis, C. munroi, C. obtusa, C. profuga, C. solanacea, Cyrtandra ferripilosa, Festuca molokaiensis, Peperomia subpetiolata, Phyllostegia bracteata, P. haliakalae, P. pilosa, Pittosporum halophilum, Schiedea jacobii, S. laui, Stenogyne kauaulaensis,* and *Wikstroemia villosa.* We consider small population size to be a threat to these species for the following reasons:

- *Cyanea grimesiana* ssp. *grimesiana* has not been observed since 1991 on Molokai (PEPP 2010, p. 45).
- The only known wild occurrences of *Cyanea horrida, C. magnicalyx, C. maritae,* and *C. munroi* are susceptible to threats from habitat degradation or loss by flooding, landslides, or tree falls, or a combination of these, because of their locations in lowland wet, montane wet, and wet cliff ecosystems (TNC 2007; TNCH 2010a; HBMP 2008; PEPP 2009, pp. 23–24, 49–58).
- The last confirmed observation of *Cyanea mauiensis* in the wild was over 100 years ago. Botanists believe individuals of this species still remain, as potentially suitable habitat has not been searched. However, there are no tissues, propagules, or seeds in storage or propagation (Lammers 2004, pp. 84–85; TNC 2007).
- *Cyanea obtusa* is susceptible to predation by feral pigs, goats, axis deer, and cattle, and to direct destruction and habitat degradation and loss by fire because the only two known individuals of this species are not protected from direct predation by ungulates, or from fire (Lau 2001, in litt.; PEPP 2007, p. 40; HBMP 2008; PEPP 2008, p. 55; Duvall 2010, in litt.).
- *Cyanea profuga* and *C. solanacea* are each known from fewer than five scattered occurrences in the montane wet ecosystem. These two plant species are susceptible to predation by nonnative pigs and goats, as well as habitat degradation or destruction by these nonnative animals and by landslides, rock and tree falls, or flooding, or a combination of these (HBMP 2008; PEPP 2009, pp. 23–24, 49–58; Bakutis 2010, in litt.; Perlman 2010, in litt.; Oppenheimer 2010a, in litt.; TNCH 2011, pp. 21, 57).
- *Cyrtandra ferripilosa* is known from two disparate occurrences totaling only a few individuals that are not protected from direct predation by nonnative pigs and goats (Oppenheimer 2010f, in litt.; Welton 2010b, in litt.).
- *Festuca molokaiensis,* known only from its original collection location on Molokai, has not been relocated for 2 years. Threats to this species include habitat destruction or direct predation by nonnative goats, nonnative plants, and fire (Oppenheimer 2011a, pers. comm.).
- Historically known from lower Waikamoi on east Maui, the identification of wild individuals of *Peperomia subpetiolata* has not been confirmed since 2001, although hybrids between this species and other species of *Peperomia* are reported in this area (HBMP 2008; NTBG 2009g, p. 2; Oppenheimer 2010a, in litt.; PEPP 2010, p. 96).
- Only one individual of *Phyllostegia bracteata* was known as recently as 2009, but even this single individual was not relocated later in the same year. Botanists continue to search potentially suitable habitat near the last known location for this ephemeral species (NTBG 2009h, p. 3; PEPP 2009, pp. 89–90; Oppenheimer 2010c, in litt.).
- The last known wild individual of *Phyllostegia haliakalae* on Maui had died by 2010, although there are outplantings of this species near the location of this individual. Botanists continue to search potentially suitable

habitat on Maui for this species. *Phyllostegia haliakalae* has not been relocated on Molokai or Lanai for close to 100 years (TNC 2007; HBMP 2008; Oppenheimer 2010c, in litt.; Oppenheimer 2011b, in litt.).

• The seven known individuals of *Phyllostegia pilosa* are not protected from direct predation by feral pigs and goats on Maui. This species has not been observed on Molokai for over 100 years (TNC 2007; HBMP 2008).

• *Pittosporum halophilum* is known from three disparate locations, each with one to three individuals, on Molokai and its offshore islets. These individuals are not protected from predation by feral pigs or rats, or from the threat of fire (Wood 2005, pp. 2, 41; Bakutis 2010, in litt.; Hobdy 2010, in litt.; Perlman 2010, in litt.).

• The only known wild individuals of *Schiedea jacobii* were likely destroyed by landslides because of their location along wet cliffs between Hanawi Stream and Kuhiwa drainage in the montane wet ecosystem on east Maui. The State plans to outplant propagated individuals in Hanawi Natural Area Reserve in 2011 (Wagner *et al.* 1999j, p. 286; HBMP 2008; Oppenheimer 2010a, in litt.; Perlman 2010, in litt.).

• The 24 to 34 individuals of *Schiedea laui* are facing imminent threats from flooding and landslides because of their location in a grotto (HBMP 2008; Bakutis 2010, in litt.).

• *Stenogyne kauaulaensis* is only known from three individuals. These plants face imminent threats from landslides and rockfalls because of their location on steep slopes, and from drought and fire in the montane mesic ecosystem on west Maui (Wood and Oppenheimer 2008, pp. 544–545; Oppenheimer 2010a, in litt.).

• *Wikstroemia villosa* is known only from a single occurrence, with two individuals (Peterson 1999, p. 1,291; TNC 2007; HBMP 2008; Oppenheimer 2010a, in litt.).

Tree Snails

Like most native island biota, the endemic Hawaiian tree snails are particularly sensitive to disturbances due to low population numbers and small geographic ranges (Hadfield *et al.* 1993, p. 610). We consider the three tree snail species at risk of decline and extinction due to threats associated with low numbers of individuals and populations because:

• *Newcombia cumingi* is known only from a single wild population of one individual and has not been successfully maintained in captivity (Hadfield 2007, pp. 2, 8; Hadfield 2008, p. 10; Higashino 2013, in litt.).

• The only known wild populations of *Newcombia cumingi, Partulina semicarinata,* and *P. variabilis* face serious threats from predation by nonnative rats, Jackson's chameleons, and snails (Solem 1990, p. 35; Hadfield 1986, p. 325; Hadfield *et al.* 1993, p. 611; Hadfield 2007, p. 9; Hadfield 2009, p. 11; Hadfield and Saufler 2009, p. 1595; Holland *et al.* 2010, p. 1,437).

• The number of individuals of *Partulina semicarinata* and *P. variabilis* has declined by approximately 50 percent between 1993 and 2005 at known locations (Hadfield 2005, p. 305).

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; Levin *et al.* 1996, pp. 10–16; Rhymer and Simberloff 1996, p. 85). Hybridization, however, is especially problematic for rare species that come into contact with species that are abundant or more common (Rhymer and Simberloff 1996, p. 83). We consider hybridization to adversely impact four species in this final rule because it may lead to extinction of one or both of the original genotypically distinct species. Hybrids have been reported between *Bidens campylotheca* ssp. *pentamera* and *B. campylotheca* ssp. *waihoiensis,* two subspecies in this rule that occur in close proximity on east Maui. In addition, on east Maui, the species *Cyanea obtusa* is known from two individuals, but only hybrids between *C. obtusa* and the more abundant *C. elliptica* are known on west Maui. Furthermore, the current status of the species *Peperomia subpetiolata* is unknown because only hybrids between *P. subpetiolata* and *P. cookiana,* and perhaps *P. hertapetiola,* are known from its historically reported locations on east Maui.

Regeneration

Lack of, or low levels of, regeneration (reproduction and recruitment) in the wild has been observed and is a threat to *Pleomele fernaldii* (Oppenheimer 2010a, in litt.). Although there are currently approximately several hundred to 1,000 individuals, very little recruitment has been observed at the known locations over the past 10 years (Oppenheimer 2008d, in litt.). The reasons for this are not clearly understood.

Human Trampling and Hiking

Human impacts, including trampling by hikers, have been documented as a threat to *Cyanea maritae* and *Wikstroemia villosa* (Oppenheimer 2010o, in litt.; PEPP 2010, p. 51; Welton 2010b, in litt.) because individuals of these species are found near climbing or hiking trails. Individuals climbing and hiking off established trails could trample individual plants and contribute to soil compaction and erosion, preventing growth and establishment of seedlings (Oppenheimer 2010a, in litt.), as has been observed with other native species (Wood 2001, in litt.; MLP 2005, p. 23).

Conservation Efforts to Reduce Other Natural or Manmade Factors Affecting Its Continued Existence

There are no approved HCPs, SHAs, CCAs, MOUs, or other voluntary actions that specifically address the threats to these 40 species from other natural or manmade factors. The State's PEP Program collects, propagates, or outplants 14 plant species that are addressed in this final rule (*Cyanea asplenifolia, C. horrida, C. magnicalyx, C. maritae, C. munroi, C. profuga, C. solanacea, Phyllostegia haliakalae, P. pilosa, Pittosporum halophilum, Schiedea jacobii, S. laui, Stenogyne kauaulaensis,* and *Wikstroemia villosa*) (PEPP 2011, pp. 75, 166, 191; PEPP 2012, pp. 6, 13, 34–36, 66–70, 73–81, 150, 159–160). While these actions are a step toward increasing the overall numbers and populations of these species in the wild, these actions are insufficient to eliminate the threat of limited numbers to the 14 plant species because the actions are relatively recent (i.e., in the last few years) and 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 four plant species from hybridization, the threat of lack of regeneration to *Pleomele fernaldii,* or the threat from human trampling to *Cyanea maritae* and *Wikstroemia villosa.*

The State's University of Hawaii receives funding from the Service and other sources to propagate and maintain in captivity the two Lanai tree snails, *Partulina semicarinata* and *P. variabilis,* and Newcomb's tree snail (*Newcombia cumingi*). While these actions appear to be a step toward increasing the overall numbers of these species in captivity, both Lanai tree snail species appear to be declining in captivity and individuals of Newcomb's tree snail do not survive long in captivity (Hadfield 2008, p. 1–11; Hadfield 2010, pers. comm.; Hadfield 2011, pers. comm.) (see *Disease* or *Predation,* above).

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 40 species addressed in this final rule. We consider the limited numbers of populations and few individuals (less than 50) to be a serious and ongoing threat to 20 of the 37 plant species in this final rule (*Cyanea grimesiana* ssp. *grimesiana, C. horrida, C. magnicalyx, C. maritae, C. mauiensis, C. munroi, C. obtusa, C. profuga, C. solanacea, Cyrtandra ferripilosa, Festuca molokaiensis, Peperomia subpetiolata, Phyllostegia bracteata, P. haliakalae, P. pilosa, Pittosporum halophilum, Schiedea jacobii, S. laui, Stenogyne kauaulaensis,* and *Wikstroemia villosa*) 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 three tree snails *Newcombia cumingi, Partulina semicarinata,* and *P. variabilis* from limited numbers of populations and individuals is ongoing and is expected to continue into the future because: (1) These species may experience reduced reproductive vigor due to 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 (e.g., hurricane, drought) may result in extirpation of remaining populations and extinction of these species. The limited distribution of these three species thus compounds the severity of the impact of the other threats discussed in this final rule.

In addition, the threat to *Bidens campylotheca* ssp. *pentamera, B. campylotheca* ssp. *waihoiensis, Cyanea obtusa,* and *Peperomia subpetiolata* from hybridization is ongoing and expected to continue into the future because hybrids are reported between these species and other, more abundant species, and no efforts are being implemented in the wild to prevent potential hybridizations. In addition, we consider the threat to *Pleomele fernaldii* from lack of regeneration to be ongoing and to continue into the future because the reasons for the lack of recruitment in the wild are unknown and uncontrolled, and any competition from nonnative plants or habitat modification by ungulates or fire, or predation by ungulates or rats, could lead to the extirpation of this species. Also, ongoing human activities (e.g., trampling and hiking) are a threat to *Cyanea maritae* and *Wikstroemia villosa* and are expected to continue into the future because field biologists have reported trampling of vegetation near populations of *Cyanea maritae* and the two remaining wild individuals of *Wikstroemia villosa,* and the effects of these activities could lead to injury and death of individual plants, potentially resulting in extirpation from the wild.

Summary of Factors

The primary factors that pose serious and ongoing threats to one or more of the 40 species throughout their ranges in this final rule include: Habitat degradation and destruction by agriculture and urbanization, nonnative ungulates and plants, fire, natural disasters, and climate change, and the interaction of these threats (Factor A); overutilization due to collection of the three tree snail species for trade or market (Factor B); predation by nonnative animal species (pigs, goats, axis deer, mouflon sheep, cattle, rats, Jackson's chameleon, slugs, snails, and flatworms) (Factor C); inadequate regulatory mechanisms to address the threats posed by nonnative species (Factor D); and limited numbers of populations and individuals, hybridization, lack of regeneration, and ongoing human activities (e.g., trampling and hiking) (Factor E). While we acknowledge the voluntary conservation measures described above may help to ameliorate one or more of the threats to the 40 species addressed 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 data available regarding the past, present, and future threats to each of the 40 Maui Nui species. We find that all of these species face significant threats to their existence, which are ongoing and expected to continue into the future throughout their ranges, from the present destruction and modification of their habitats, primarily from nonnative feral ungulates and nonnative plants. Thirteen of the plant species (*Bidens campylotheca* ssp. *pentamera, Canavalia pubescens, Cyanea magnicalyx, C. mauiensis, C. obtusa, Festuca molokaiensis, Phyllostegia bracteata, P. haliakalae, Pittosporum halophilum, Pleomele fernaldii, Santalum haleakalae* var. *lanaiense, Schiedea salicaria,* and *Stenogyne kauaulaensis*) experience threats from habitat destruction and modification from fire, and 16 plant species (*Bidens campylotheca* ssp. *waihoiensis, Cyanea asplenifolia, C. duvalliorum, C. grimesiana* ssp. *grimesiana, C. horrida, C. magnicalyx, C. maritae, C. mauiensis, C. munroi, C. profuga, C. solanacea, Cyrtandra filipes, Schiedea jacobii, S. laui, Stenogyne kauaulaensis,* and *Wikstroemia villosa*) experience threats from habitat destruction and modification from landslides, rockfalls, treefalls, or flooding. The plants *Canavalia pubescens, Cyanea horrida, Festuca molokaiensis, Schiedea jacobii, S. salicaria,* and *Stenogyne kauaulaensis,* as well as the tree snails *Newcombia cumingi, Partulina semicarinata,* and *P. variabilis,* experience threats from habitat loss or degradation due to drought. All 40 species experience threats from the destruction and modification of their habitats from hurricanes, although their occurrence is not predictable. In addition, we are concerned about the effects of projected climate change on all species, particularly rising temperatures, but recognize there is limited information on the exact nature of impacts that these species may experience (Factor A).

Overcollection for commercial and recreational purposes poses a serious potential threat to all three tree snail species (Factor B). Predation and herbivory on all 37 plant species by feral pigs, goats, cattle, axis deer, mouflon, rats, and slugs poses a serious and ongoing threat, as does predation of all three tree snail species (*N. cumingi, P. semicarinata,* and *P. variabilis*) by rats, nonnative snails, and potentially Jackson's chameleon (Factor C). Existing regulatory mechanisms are inadequate to reduce current and ongoing threats posed by nonnative plants and animals to all 40 species (Factor D). There are current and ongoing threats to 20 plant species (*Cyanea grimesiana* ssp. *grimesiana, C. horrida, C. magnicalyx, C. maritae, C. mauiensis, C. munroi, C.*

obtusa, C. profuga, C. solanacea, Cyrtandra ferripilosa, Festuca molokaiensis, Peperomia subpetiolata, Phyllostegia bracteata, P. haliakalae, P. pilosa, Pittosporum halophilum, Schiedea jacobii, S. laui, Stenogyne kauaulaensis, and *Wikstroemia villosa*) and the three tree snails due to factors associated with small numbers of populations and individuals; to *Bidens campylotheca* ssp. *pentamera, B. campylotheca* ssp. *waihoiensis, Cyanea obtusa,* and *Peperomia subpetiolata* from hybridization; to *Pleomele fernaldii* from the lack of regeneration in the wild; and to *Cyanea maritae* and *Wikstroemia villosa* from hiking and trampling (Factor E) (see Table 4). 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 endemic species is presently in danger of extinction throughout its entire range, based on the immediacy, severity, and scope of the threats described above. Based on our analysis, we have no reason to believe that population trends for any of the species addressed in 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 data, we are listing, or—in the case of *Cyanea grimesiana* ssp. *grimesiana* and *Santalum haleakalae* var. *lanaiense*—reaffirming the listing of, the following 40 species as endangered in accordance with section 3(6) of the Act: the plants *Bidens campylotheca* ssp. *pentamera, Bidens campylotheca* ssp. *waihoiensis, Bidens conjuncta, Calamagrostis hillebrandii, Canavalia pubescens, Cyanea asplenifolia, Cyanea duvalliorum, Cyanea grimesiana* ssp. *grimesiana, Cyanea horrida, Cyanea kunthiana, Cyanea magnicalyx, Cyanea maritae, Cyanea mauiensis, Cyanea munroi, Cyanea obtusa, Cyanea profuga, Cyanea solanacea, Cyrtandra ferripilosa, Cyrtandra filipes, Cyrtandra oxybapha, Festuca molokaiensis, Geranium hanaense, Geranium hillebrandii, Mucuna sloanei* var. *persericea, Myrsine vaccinioides, Peperomia subpetiolata, Phyllostegia bracteata, Phyllostegia haliakalae, Phyllostegia pilosa, Pittosporum halophilum, Pleomele fernaldii, Santalum haleakalae* var. *lanaiense, Schiedea jacobii, Schiedea laui, Schiedea salicaria, Stenogyne kauaulaensis,* and *Wikstroemia villosa;* and the tree snails *Newcombia cumingi, Partulina semicarinata,* and *Partulina variabilis.*

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 40 endemic Maui Nui species 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' range and are not restricted to any particular portion of that range. Accordingly, our assessment and determination applies to each species throughout its entire range.

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 (composed of species experts, Federal and State agencies, non-government 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, control of nonnative plants), management of threats from predation (e.g., feral ungulate control, rat control), 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 40 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 listed 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 under 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 40 plants and animals listed or reaffirmed as endangered 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 (NRCS), the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, and branches of the Department of Defense (DOD). Examples of these types of actions include activities funded or authorized under the Farm Bill Program, Environmental Quality Incentives Program, Ground and Surface Water Conservation Program, Clean Water Act (33 U.S.C. 1251 *et seq.*), Partners for Fish and Wildlife Program, and DOD construction activities related to training or other military missions.

The Act and its implementing regulations set forth a series of general prohibitions and exceptions that apply to all endangered wildlife and plants. The prohibitions, codified at 50 CFR 17.21 and 17.61, 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 and plant species under certain circumstances. Regulations governing permits are codified at 50 CFR 17.22 and 17.62 for endangered species. 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. With regard to endangered plants, a permit must be issued for the following purposes: 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 a listed species. The following activities could potentially result in a violation of section 9 of the Act; this list is not comprehensive:

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

(2) Activities that take or harm the three tree snail species by causing significant habitat modification or degradation such that it causes actual injury by significantly impairing essential behavioral patterns. This may include introduction of nonnative species that compete with or prey upon the three species of tree snails or the unauthorized release of biological control agents that attack any life stage of these three species; and

(3) Damaging or destroying any of the 37 listed plants in violation of the Hawaii State law prohibiting the take of listed species.

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

The State of Hawaii's endangered species law (HRS, Section 195–D) is automatically invoked when a species is listed, and provides supplemental protection, including prohibiting take of these species and encouraging 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 listed 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–2011–0098 and upon request from the Pacific Islands Fish and Wildlife Office (see **ADDRESSES,** above).

Authors

The primary authors of this document 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; 16 U.S.C. 1531–1544; 16 U.S.C. 4201–4245; Pub. L. 99–625, 100 Stat. 3500; unless otherwise noted.

■ 2. Amend § 17.11(h), the List of Endangered and Threatened Wildlife, by adding entries for ''Snail, Lanai tree'' (*Partulina semicarinata*), ''Snail, Lanai tree'' (*Partulina variabilis*), and ''Snail, Newcomb's tree'' (*Newcombia cumingi*), in alphabetical order under SNAILS, to read as follows:

§ 17.11 Endangered and threatened wildlife.

* * * * *

(h) * * *

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
*	*	*	*	*	*		*
SNAILS							
*	*	*	*	*	*		*
Snail, Lanai tree	*Partulina semicarinata*	U.S.A. (HI)	NA	E	815	NA	NA
Snail, Lanai tree	*Partulina variabilis*	U.S.A. (HI)	NA	E	815	NA	NA
*	*	*	*	*	*		*
Snail, Newcomb's tree	*Newcombia cumingi*	U.S.A. (HI)	NA	E	815	NA	NA
*	*	*	*	*	*		*

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

■ a. By removing the entries for *Gahnia lanaiensis* and *Santalum freycinetianum* var. *lanaiense* under FLOWERING PLANTS;

■ b. By revising the entry for *Cyanea grimesiana* ssp. *grimesiana* under FLOWERING PLANTS; and

■ c. By adding entries for *Bidens campylotheca* ssp. *pentamera, Bidens campylotheca* ssp. *waihoiensis, Bidens conjuncta, Calamagrostis hillebrandii, Canavalia pubescens, Cyanea asplenifolia, Cyanea duvalliorum, Cyanea horrida, Cyanea kunthiana, Cyanea magnicalyx, Cyanea maritae, Cyanea mauiensis, Cyanea munroi, Cyanea obtusa, Cyanea profuga, Cyanea solanacea, Cyrtandra ferripilosa, Cyrtandra filipes, Cyrtandra oxybapha, Festuca molokaiensis, Geranium hanaense, Geranium hillebrandii, Mucuna sloanei* var. *persericea, Myrsine vaccinioides, Peperomia subpetiolata, Phyllostegia bracteata, Phyllostegia haliakalae, Phyllostegia pilosa, Pittosporum halophilum, Pleomele fernaldii, Santalum haleakalae* var. *lanaiense, Schiedea jacobii, Schiedea laui, Schiedea salicaria, Stenogyne kauaulaensis,* and *Wikstroemia villosa* in alphabetical order under FLOWERING PLANTS, to read as follows:

§ 17.12 Endangered and threatened plants.

* * * * *

(h) * * *

Species		Historic range	Family	Status	When listed	Critical habitat	Special rules
Scientific name	Common name						
FLOWERING PLANTS							
*	*	*	*	*	*		*
Bidens campylotheca ssp. *pentamera*.	Kookoolau	U.S.A. (HI)	Asteraceae	E	815	NA	NA
*	*	*	*	*	*		*
Bidens campylotheca ssp. *waihoiensis*.	Kookoolau	U.S.A. (HI)	Asteraceae	E	815	NA	NA
*	*	*	*	*	*		*
Bidens conjuncta	Kookoolau	U.S.A. (HI)	Asteraceae	E	815	NA	NA
*	*	*	*	*	*		*
Calamagrostis hillebrandii	None	U.S.A. (HI)	Poaceae	E	815	NA	NA

Species		Historic range	Family	Status	When listed	Critical habitat	Special rules
Scientific name	Common name						
* *	*	*	*		*	*	
Canavalia pubescens	Awikiwiki	U.S.A. (HI)	Fabaceae	E	815	NA	NA
* *	*	*	*		*	*	
Cyanea asplenifolia	Haha	U.S.A. (HI)	Campanulaceae	E	815	NA	NA
* *	*	*	*		*	*	
Cyanea duvalliorum	Haha	U.S.A. (HI)	Campanulaceae	E	815	NA	NA
* *	*	*	*		*	*	
Cyanea grimesiana ssp. *grimesiana*.	Haha	U.S.A. (HI)	Campanulaceae	E	592, 815	17.99(c), (e)(1), and (i).	NA
* *	*	*	*		*	*	
Cyanea horrida	Haha nui	U.S.A. (HI)	Campanulaceae	E	815	NA	NA
* *	*	*	*		*	*	
Cyanea kunthiana	Haha	U.S.A. (HI)	Campanulaceae	E	815	NA	NA
* *	*	*	*		*	*	
Cyanea magnicalyx	Haha	U.S.A. (HI)	Campanulaceae	E	815	NA	NA
* *	*	*	*		*	*	
Cyanea maritae	Haha	U.S.A. (HI)	Campanulaceae	E	815	NA	NA
* *	*	*	*		*	*	
Cyanea mauiensis	Haha	U.S.A. (HI)	Campanulaceae	E	815	NA	NA
* *	*	*	*		*	*	
Cyanea munroi	Haha	U.S.A. (HI)	Campanulaceae	E	815	NA	NA
* *	*	*	*		*	*	
Cyanea obtusa	Haha	U.S.A. (HI)	Campanulaceae	E	815	NA	NA
* *	*	*	*		*	*	
Cyanea profuga	Haha	U.S.A. (HI)	Campanulaceae	E	815	NA	NA
* *	*	*	*		*	*	
Cyanea solanacea	Popolo	U.S.A. (HI)	Campanulaceae	E	815	NA	NA
* *	*	*	*		*	*	
Cyrtandra ferripilosa	Haiwale	U.S.A. (HI)	Gesneriaceae	E	815	NA	NA
* *	*	*	*		*	*	
Cyrtandra filipes	Haiwale	U.S.A. (HI)	Gesneriaceae	E	815	NA	NA
* *	*	*	*		*	*	
Cyrtandra oxybapha	Haiwale	U.S.A. (HI)	Gesneriaceae	E	815	NA	NA
* *	*	*	*		*	*	
Festuca molokaiensis	None	U.S.A. (HI)	Poaceae	E	815	NA	NA
* *	*	*	*		*	*	
Geranium hanaense	Nohoanu	U.S.A. (HI)	Geraniaceae	E	815	NA	NA
* *	*	*	*		*	*	
Geranium hillebrandii	Nohoanu	U.S.A. (HI)	Geraniaceae	E	815	NA	NA
* *	*	*	*		*	*	
Mucuna sloanei var. *persericea*	Sea bean	U.S.A. (HI)	Fabaceae	E	815	NA	NA
* *	*	*	*		*	*	
Myrsine vaccinioides	Kolea	U.S.A. (HI)	Myrsinaceae	E	815	NA	NA
* *	*	*	*		*	*	
Peperomia subpetiolata	Alaala wai nui	U.S.A. (HI)	Piperaceae	E	815	NA	NA
* *	*	*	*		*	*	
Phyllostegia bracteata	None	U.S.A. (HI)	Lamiaceae	E	815	NA	NA
* *	*	*	*		*	*	
Phyllostegia haliakalae	None	U.S.A. (HI)	Lamiaceae	E	815	NA	NA

Species		Historic range	Family	Status	When listed	Critical habitat	Special rules
Scientific name	Common name						
*	*	*	*	*	*	*	
Phyllostegia pilosa	None	U.S.A. (HI)	Lamiaceae	E	815	NA	NA
*	*	*	*	*	*	*	
Pittosporum halophilum	Hoawa	U.S.A. (HI)	Pittosporaceae	E	815	NA	NA
*	*	*	*	*	*	*	
Pleomele fernaldii	Hala pepe	U.S.A. (HI)	Asparagaceae	E	815	NA	NA
*	*	*	*	*	*	*	
Santalum haleakalae var. *lanaiense*.	Lanai sandalwood or iliahi.	U.S.A. (HI)	Santalaceae	E	215, 815	NA	NA
*	*	*	*	*	*	*	
Schiedea jacobii	None	U.S.A. (HI)	Caryophyllaceae	E	815	NA	NA
*	*	*	*	*	*	*	
Schiedea laui	None	U.S.A. (HI)	Caryophyllaceae	E	815	NA	NA
*	*	*	*	*	*	*	
Schiedea salicaria	None	U.S.A. (HI)	Caryophyllaceae	E	815	NA	NA
*	*	*	*	*	*	*	
Stenogyne kauaulaensis	None	U.S.A. (HI)	Lamiaceae	E	815	NA	NA
*	*	*	*	*	*	*	
Wikstroemia villosa	Akia	U.S.A. (HI)	Thymelaeaceae	E	815	NA	NA

*   *   *   *   *

Dated: May 14, 2013.

Stephen Guertin,

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

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