

# Big Island II: Addendum to the Recovery Plan for the Big Island Plant Cluster



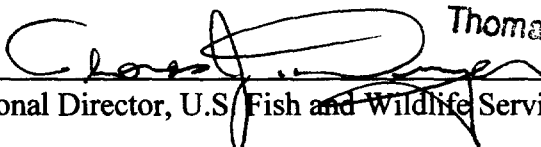
*Clermontia drepanomorpha* (from Wagner et al. 1990).

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**BIG ISLAND II:  
ADDENDUM TO THE RECOVERY PLAN  
FOR THE BIG ISLAND PLANT CLUSTER**

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## **ACKNOWLEDGEMENTS**

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## EXECUTIVE SUMMARY

**Current Species Status:** This serves as an addendum to the Recovery Plan for the Big Island II Plant Cluster Recovery Plan (Service 1996b). This addendum covers 13 plant taxa endemic to the island of Hawaii (Big Island), all listed as endangered under the Endangered Species Act of 1973, as amended. The current known numbers of populations and total numbers of individuals are as follows, listed by wild populations and populations that are cultivated in gardens or outplanted into exclosures:

Taxon	wild		cultivated/outplanted	
	populations	individuals	pops.	individuals
<i>Clermontia drepanomorpha</i>	6	237–292		
<i>Cyanea platyphylla</i>	2	9	1	12
<i>Hibiscadelphus giffardianus</i>			1	9
<i>Hibiscadelphus hualalaiensis</i>			3	30
<i>Melicope zahlbruckneri</i>	2	30–35		
<i>Neraudia ovata</i>	3	11		
<i>Phyllostegia racemosa</i>	3	35–45		
<i>Phyllostegia velutina</i>	5	63–116		
<i>Phyllostegia warshaueri</i>	4	5–10		
<i>Pleomele hawaiiensis</i>	9	274–324		
<i>Pritchardia schattaueri</i>	3	12	2	72
<i>Sicyos alba</i>	2	21		
<i>Zanthoxylum dipetalum</i> var. <i>tomentosum</i> .	1	24	1	20 (approx.)

All of these taxa are endemic to the Big Island.

**Habitat Requirements and Limiting Factors:** The Big Island is the largest, highest, and youngest of the Hawaiian Islands, and was built by at least six volcanic mountains. As a result, the taxa included in this addendum grow in a variety of vegetative communities (shrublands, forest, and mixed communities), elevational zones (lowland to montane), and moisture regimes (dry to wet). They and their habitats are currently threatened by one or more of the following: habitat degradation by feral or domestic animals (goats, pigs, cattle, and sheep); competition for space, light, water, and nutrients by introduced vegetation; fire, a threat which is exacerbated by introduced grasses; direct human perturbation such as recreational and military activities; pest invertebrates; disease; and vulnerability to random events and genetic limitations due to small population size.

**Recovery Objectives:** The ultimate objective for all taxa is delisting. Interim, downlisting, and delisting criteria are provided. It is suggested that recovery of Big Island II Plant Cluster taxa be pursued via the establishment of management units in order to make the most efficient use of available resources and to conserve not only these taxa, but their habitats.

**Recovery Criteria:** The following criteria may be revised as more information is obtained about specific taxa.

#### Interim criteria

The interim objective is to stabilize all existing populations of the Big Island II taxa. To be considered stable, each taxon must be managed to control threats (e.g., fenced) and be represented in an *ex situ* collection. In addition, a minimum total of three populations of each taxon should be documented on the Big Island. Each of these populations must be naturally reproducing and increasing in number, with a minimum of 25 mature individuals per population (minimum of 75 mature plants) for long-lived perennials, a minimum of 50 mature individuals per population (minimum of 150 mature plants) for short-lived perennials, and a minimum of 100 mature individuals per population (minimum of 300 mature plants) for annuals.

#### Downlisting criteria

For downlisting, a total of five to seven populations of each taxon should be documented on the Big Island. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, a minimum of 300 mature individuals per population for short-lived perennials, and a minimum of 500 mature individuals per population for annuals. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered.

#### Delisting criteria

For delisting, a total of 8 to 10 populations of each taxon should be documented on the Big Island. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, a minimum of 300 individuals per population for short-lived perennials, and a minimum of 500 mature individuals per population for annuals. Each population should persist at this level for a minimum of 5 consecutive years.

**Actions Needed:**

1. Protect current populations and manage threats.
2. Conduct essential research.
3. Expand existing wild populations, as necessary.
4. Create new populations within historical range, as necessary.
5. Evaluate and validate recovery objectives.

**Total Estimated Cost of Recovery (\$1,000) for the Big Island and Big Island II Plants Clusters.** Some costs are yet to be determined\*:

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Total
1996	279	0	91	146	0	516
1997	542	0	91	146	0	779
1998	752	0	131	214	0	1097
1999	723	0	131	214	0	1068
2000	680	0	131	214	0	1025
2001	649	238	129	214	0	1230
2002	629	238	111	85	0	1063
2003	480	238	111	85	0	914
2004	480	238	111	85	0	944
2005	480	238	111	85	30	944
2006	345	238	55	71	30	501
2007	345	0	26	62	30	433
2008	345	0	26	62	0	433
2009	345	0	26	62	0	433
2010	345	0	26	62	0	433
2011	345	0	26	62	0	433
2012	345	0	26	62	0	433
2013	345	0	26	62	0	433
2014	345	0	26	62	0	433
2015	345	0	26	62	0	433
2016	169	0	10	24	0	203
<b>Total</b>	<b>9,313</b>	<b>1,190</b>	<b>1,447</b>	<b>2,141</b>	<b>90</b>	<b>14,181</b>

\*Recovery costs for the taxa in this addendum are based on a ratio of 13/22 from the original estimates of the Recovery Plan for the Big Island Plant Cluster. Original cost estimates were provided by cooperators currently implementing similar actions.

**Date of Recovery:** To be determined once more is known about the biology and population dynamics of the Big Island II Plant Cluster.



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# INTRODUCTION

## 1. Brief Overview

Much of this section was taken directly from the listing package covering these taxa (US. Fish and Wildlife Service [Service] 1996a), with minor modifications based on current status information.

This addendum to the Recovery Plan for the Big Island Plant Cluster (Recovery Plan) covers 13 plant taxa that were added to the Federal list of endangered and threatened species in October of 1996 (61 FR 53137–53153) (Big Island II Plant Cluster). The taxa included in this plan are: *Clermontia drepanomorpha*, *Cyanea platyphylla*, *Hibiscadelphus giffardianus*, *Hibiscadelphus hualalaiensis*, *Melicope zahlbruckneri*, *Neraudia ovata*, *Phyllostegia racemosa*, *Phyllostegia velutina*, *Phyllostegia warshaueri*, *Pleomele hawaiiensis*, *Pritchardia schattaueri*, *Sicyos alba*, and *Zanthoxylum dipetalum* var. *tomentosum*.

All 13 taxa are endemic to the Big Island and grow in a variety of vegetation communities (shrublands, forests, and mixed communities), elevational zones (lowland to montane), and moisture regimes (dry to wet). The 13 plant taxa and their habitats are threatened by one or more of the following: competition for space, light, water, and nutrients by naturalized, introduced vegetation; habitat degradation by wild, feral, or domestic animals (cattle, pigs, goats, and sheep); agricultural and residential development and recreational activities; habitat loss and damage to plants from fires; predation by animals (cattle, pigs, goats, sheep, insects, and rats); and natural disasters such as volcanic activity. Due to the small number of existing individuals and their very narrow distributions, these 13 taxa and their populations are subject to an increased likelihood of extinction and/or reduced reproductive vigor from natural disasters.

Part I of this addendum has been constructed in a species-by-species format allowing the reader to find all information about a particular species in one section. The aim of this effort is to produce a comprehensive analysis of the threats to these taxa as well as a species-by-species analysis of recovery actions needed for stabilization and recovery. As ecosystem management units are

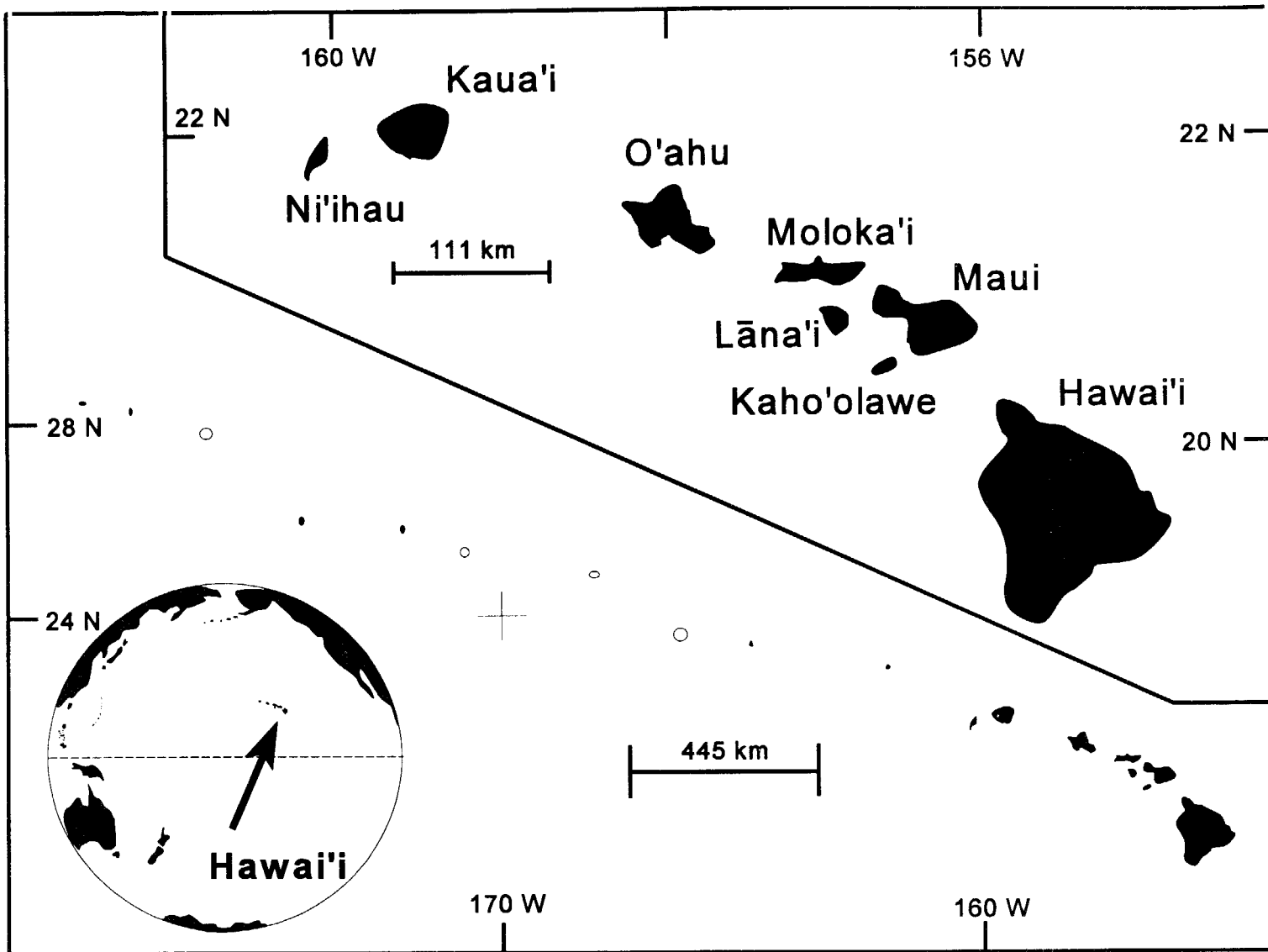
identified, multiple populations and species may be managed in a coordinated fashion in order to make recovery actions as efficient as possible.

The Hawaiian Islands (Figure 1) are classified as a distinct floristic region by phytogeographers because of their unique flora (Takhtajan 1986). Plants ancestral to Hawaii arrived by long distance dispersal, colonizing the islands at a rate of about one species per 70,000 years over a 70 million year history (Carlquist 1980). Isolation by about 2,500 miles (4,000 kilometers) of water and a conducive climate created biological vacancies. Over millions of years of evolution, Hawaiian ecosystems became diverse in plant taxa. Today's 1,817 native Hawaiian plant species (1,963 taxa) probably adapted and diversified from 272 original colonists (Fosberg 1948, Wagner et al. 1990).

The objective of this addendum is to provide a framework for the recovery of the Big Island II Plant Cluster, so that their protection by the Endangered Species Act (Act) is no longer necessary. This addendum summarizes available information about each taxon, reviews the threats posed to their continued existence, and lists management actions that are needed to remove these threats. Recovery of these taxa should be through efficient use of available resources in an effort to conserve not only these taxa, but their habitats as well.

Immediate actions needed to prevent extinction of these plants include fencing to exclude ungulates; alien plant control; protection from fire; monitoring and management of populations and plant communities; *ex situ* propagation; and augmentation of populations, as appropriate. Additional long-term activities needed to perpetuate these plants in their natural habitats include baseline and long-term research; public education; maintenance of fenced areas; long-term monitoring and management of populations and communities; and re-establishment of populations within their historic ranges.

Appendix I contains line drawings of some of the species covered by this addendum. Appendix J contains illustrations of historic and current distributions, and Appendix K provides a summary of land ownership/management for the Big Island II Plant Cluster. Appendix L provides a summary of comments received during the public review period of the draft.



## **2. General Description of Habitat**

Climatic contrasts, topography, substrate, geological history, and isolation from continental land masses resulted in a native flora so unique that the mosaic of vegetation patterns are as numerous and diverse as those of continental areas (Wagner et al. 1990). Mueller-Dombois et al. (1981) stated that nearly all major plant formations occur in Hawaii.

Most populations of the 13 taxa covered in this addendum are in lowland dry and mesic forest, lowland wet forest, montane dry and mesic forest, or montane wet forest. Table 1 summarizes the habitat types and associated plant species of the 13 taxa. For more detailed descriptions of Big Island geology, climate, and vegetation, please refer to pages 6–12 of the Recovery Plan for the Big Island Plant Cluster (Service 1996b).

## **3. Reasons for Decline and Current Threats**

A general discussion of threats to the native communities upon which the Big Island II Plant Cluster taxa depend is located on pages 12–16 of the Recovery Plan. Threats specific to each taxon of the Big Island II Plant Cluster are detailed in the species accounts and summarized in Table 2.

TABLE 1. Summary of Big Island II Plant Cluster habitat types and associated plant taxa. E – Endangered. SOC – Species of Concern – may require special management in the future but is not presently a candidate for listing. Associated species listed below are limited to those that best characterize the immediate area of current Big Island taxa habitat.

Habitat Type	Big Island II Plant Cluster	Associated Native Species	Associated Alien Species
<p><u>Lowland Mesic &amp; Dry Forest</u>  elevation:  300–1,500 meters  (984–4,920 feet)</p> <p>rainfall:  500–2,000 millimeters  (29–79 inches) per year</p>	<p><i>Neraudia ovata</i>  <i>Pleomele hawaiiensis</i>  <i>Pritchardia schattaueri</i></p>	<p><i>Bidens micrantha</i> ssp. <i>ctenophylla</i>  (kookoolau) (SOC)  <i>Caesalpinia kawaiiensis</i> (uhiuhi) (E)  <i>Capparis sandwichiana</i> (pua pilo) (SOC)  <i>Cibotium</i> sp. (hapuu)  <i>Cocculus trilobus</i> (huehue)  <i>Colubrina oppositifolia</i> (kauila) (E)  <i>Diospyros sandwicensis</i> (lama)  <i>Erythrina sandwicensis</i> (wiliwili)  <i>Fimbristylis hawaiiensis</i>  (no common name) (ncn) (SOC)  <i>Metrosideros polymorpha</i> (ohia)  <i>Myoporum sandwicense</i> (naio)  <i>Myrsine</i> sp. (kolea)  <i>Nestegis sandwicensis</i> (olopua)  <i>Nothoestrum breviflorum</i> (aiea) (E)  <i>Nototrichium sandwicense</i> (kulu I)  <i>Osteomeles anthyllidifolia</i> (ulei)  <i>Pisonia</i> sp. (papala)  <i>Pittosporum</i> sp. (ho awa)  <i>Reynoldsia sandwicensis</i> (ohe makai)  <i>Santalum</i> sp. (iliahi)  <i>Sida fallax</i> (ilima)  <i>Sophora chrysophylla</i> (mamane)  <i>Psydrax odorata</i> (alahee)</p>	<p><i>Lantana camara</i> (lantana)  <i>Leucaena leucocephala</i>  (koa haole)  <i>Pennisetum clandestinum</i>  (kikuyu grass)  <i>Pennisetum setaceum</i>  (fountain grass)  <i>Psidium cattleianum</i>  (strawberry guava)  <i>Psidium guajava</i> (guava)  <i>Rubus rosifolius</i>  (thimbleberry)  <i>Schinus terebinthifolius</i>  (Christmas berry)</p>

TABLE 1. Continued

Habitat Type	Big Island II Plant Cluster	Associated Native Species	Associated Alien Species
<p><u>Lowland Wet Forest</u>            elevation:            100–1,200 meters            (328–3,936 feet)</p> <p>rainfall:            1,200–3,800 millimeters            (47–150 inches) per year</p>	<p><i>Cyanea platyphylla</i></p>	<p><i>Acacia koa</i> (koa)  <i>Antidesma</i> sp. (hame)  <i>Athyrium sandwichianum</i> (hoio)  <i>Cibotium</i> sp. (hapuu)  <i>Clermontia</i> spp. (oha wai)  <i>Colubrina oppositifolia</i> (kauila) (E)  <i>Cyrtandra</i> spp. (haiwale)  <i>Hedyotis</i> sp. (ncn)  <i>Metrosideros polymorpha</i> (ohia)</p>	<p><i>Passiflora ligularis</i>            (sweet granadilla)  <i>Psidium cattleianum</i>            (strawberry guava)  <i>Psidium guajava</i> (guava)  <i>Rubus rosifolius</i> (thimbleberry)</p>



TABLE 1. Continued

Habitat Type	Big Island II Plant Cluster	Associated Native Species	Associated Alien Species
<p><b><u>Montane Mesic &amp; Dry Forest</u></b>  elevation:  500–2,000 meters  (1,640–6,560 feet)</p> <p>rainfall:  300–1,900 millimeters  (12–75 inches) per year</p>	<p><i>Hibiscadelphus giffardianus</i>  <i>Hibiscadelphus hualalaiensis</i>  <i>Melicope zahlbruckneri</i>  <i>Neraudia ovata</i>  <i>Phyllostegia racemosa</i>  <i>Phyllostegia velutina</i>  <i>Zanthoxylum dipetalum</i> var.  <i>tomentosum</i></p>	<p><i>Acacia koa</i> (koa)  <i>Athyrium sandwichianum</i> (hoio)  <i>Charpentiera</i> sp. (papala)  <i>Cheirodendron trigynum</i> (olapa)  <i>Cibotium</i> sp. (hapuu)  <i>Claoxylon sandwicense</i> (poola)  <i>Coprosma</i> sp. (pilo)  <i>Diospyros sandwicensis</i> (lama)  <i>Dodonaea viscosa</i> (aalii)  <i>Dryopteris wallichiana</i> (ncn)  <i>Ilex anomala</i> (kawa u)  <i>Melicope</i> spp. (alani)  <i>Metrosideros polymorpha</i> (ohia)  <i>Myoporum sandwicense</i> (naio)  <i>Myrsine</i> sp. (kolea)  <i>Nestegis sandwicensis</i> (olopua)  <i>Nothocestrum</i> sp. (aiea)  <i>Pipturus albidus</i> (mamaki)  <i>Pisona</i> sp. (papala)  <i>Pouteria sandwicensis</i> (alaa)  <i>Psychotria</i> sp. (kopiko)  <i>Reynoldsia sandwicensis</i>  (ohe makai)  <i>Rubus hawaiiensis</i> (akala)  <i>Santalum</i> sp. (iliahi)  <i>Sapindus saponaria</i> (ae)  <i>Sophora chrysophylla</i> (mamane)  <i>Vaccinium calycinum</i> (ohelo)</p>	<p><i>Anthoxanthum odoratum</i>  (sweet vernalgrass)  <i>Ehrharta stipoides</i>  (meadow ricegrass)  <i>Grevillea robusta</i> (silk oak)  <i>Lantana camara</i> (lantana)  <i>Leucaena leucocephala</i> (koa haole)  <i>Paspalum conjugatum</i> (Hilo grass)  <i>Paspalum dilatatum</i> (dallis grass)  <i>Paspalum urvillei</i> (vasey grass)  <i>Passiflora mollissima</i> (banana poka)  <i>Pennisetum clandestinum</i>  (kikuyu grass)  <i>Pennisetum setaceum</i>  (fountain grass)</p>

TABLE 1. Continued

Habitat Type	Big Island II Plant Cluster	Associated Native Species	Associated Alien Species
<u>Montane Wet Forest</u> elevation: ~1,000–2,200 meters (3,936–7,216 feet)  rainfall: more than 2,500 millimeters (100 inches) per year	<i>Clermontia drepanomorpha</i> <i>Cyanea platyphylla</i> <i>Phyllostegia racemosa</i> <i>Phyllostegia velutina</i> <i>Phyllostegia warshaueri</i> <i>Sicyos alba</i>	<i>Acacia koa</i> (koa) <i>Antidesma</i> sp. (hame) <i>Astelia menziesii</i> (painiu) <i>Athyrium sandwichianum</i> (hoio) <i>Broussaisia arguta</i> (kanawao) <i>Carex alligata</i> (ncn) <i>Cheirodendron trigynum</i> (olapa) <i>Cibotium glaucum</i> (hapuu) <i>Clermontia</i> spp. (oha wai) <i>Coprosma</i> sp. (pilo) <i>Cyanea</i> spp. (haha) <i>Cyrtandra</i> sp. (haiwale) <i>Dryopteris wallichiana</i> (ncn) <i>Dubautia plantaginea</i> (naenae) <i>Hedyotis</i> sp. (ncn) <i>Ilex anomala</i> (kawa u) <i>Machaerina angustifolia</i> (ukiuki) <i>Melicope clusiifolia</i> (alani) <i>Metrosideros polymorpha</i> (ohia) <i>Myrsine</i> sp. (kolea) <i>Perrottetia sandwicensis</i> (olomea) <i>Pipturus albidus</i> (mamaki) <i>Psychotria</i> sp. (kopiko) <i>Rubus hawaiiensis</i> (akala) <i>Sadleria</i> sp. (amau) <i>Stenogyne</i> sp. (ncn) <i>Styphelia tameiameia</i> (pukiawe) <i>Vaccinium calycinum</i> (ohelo)	<i>Juncus planifolius</i> (ncn) <i>Paspalum urvillei</i> (vasey grass) <i>Passiflora ligularis</i> (sweet granadilla) <i>Passiflora mollissima</i> (banana poka) <i>Pennisetum clandestinum</i> (kikuyu grass) <i>Pennisetum setaceum</i> (fountain grass) <i>Psidium cattleianum</i> (strawberry guava) <i>Psidium guajava</i> (guava) <i>Rubus ellipticus</i> (yellow Himalayan raspberry) <i>Rubus rosifolius</i> (thimbleberry) <i>Setaria palmifolia</i> (palm grass) <i>Tibouchina herbacea</i> (glorybush)

TABLE 2. Summary of threats to taxa in the Big Island II Plant Cluster.

SPECIES	ALIEN MAMMALS					DISEASE/ INSECTS	ALIEN PLANTS	FIRE	NATURAL DISASTERS	LIMITED NUMBERS	HUMAN IMPACT
	Cattle	Pigs	Rats	Sheep	Goats						
<i>Clermontia drepanomorpha</i>		X	X				X		P	X	X
<i>Cyanea platyphylla</i>		X	X				X		X	X1,2	X
<i>Hibiscadelphus giffardianus</i>			X			X	X		X	X1,3,4	
<i>Hibiscadelphus hualalaiensis</i>	P	P	X	P			X	X	X	X1,3,4	X
<i>Melicope zahlbruckneri</i>			P			X	X		X	X1,3	
<i>Neraudia ovata</i>				X	X	X	X		X	X1,3	X
<i>Phyllostegia racemosa</i>	X	X					X		X	X1,3	X
<i>Phyllostegia velutina</i>	X	X		X			X	X	X	X1,3	X
<i>Phyllostegia warshaueri</i>		X					X		X	X1,2	X
<i>Pleomele hawaiiensis</i>	X	X		X	X		X	X	X		X
<i>Pritchardia schattaueri</i>	X	X	X			P	X		X	X1,3	X
<i>Sicyos alba</i>		X					X		X	X1,3	X
<i>Zanthoxylum dipetalum</i> var. <i>tomentosum</i>	X	X		X			X	X	X	X1,3	

KEY: X = Immediate and significant threat. P = Potential threat. 1 = No more than 5 known populations. 2 = No more than 10 known individuals. 3 = No more than 100 known individuals. 4 = All original wild populations extinct; planted individuals only.

#### 4. Overall Conservation Efforts

##### Federal and State

The taxa covered in this addendum were added to the Federal list of endangered and threatened species on October 19, 1996; all as endangered (Service 1996a).

The Federal listing of the taxa (Big Island II Plant Cluster) has afforded each the protection of the Act. When a species is listed as endangered or threatened under this law, it is automatically added to the State of Hawaii's list of protected species (Hawaii Revised Statutes Chapter [HRS] 195D). Hawaii State law prohibits taking of endangered flora and encourages conservation by State government agencies. ("Take" as defined by Hawaii State law means "to harass, harm..., wound, kill..., or collect endangered or threatened... species... or to cut, collect, uproot, destroy, injure, or possess endangered or threatened... species of... land plants, or to attempt to engage in any such conduct" [HRS 195D]). The Act offers additional Federal protection to these taxa since it is a violation of the Act for any person to remove, cut, dig up, damage, or destroy an endangered plant in an area not under Federal jurisdiction in knowing violation of any State law or regulation or in the course of any violation of a State criminal trespass law [Section 9(a)(2) of the Act].

Critical habitat was not designated for any of the taxa in the Big Island II Plant Cluster. Such designation was not deemed prudent because of the possible increased threat to the plants by vandalism, researchers, curiosity seekers, or collectors of rare plants due to the mandated publication of precise maps and descriptions of critical habitat would provide no benefits beyond those that these species would receive by virtue of their being listed as endangered or threatened (Service 1996a).

Hawaii Volcanoes National Park (HVNP) has propagated individuals of *Hibiscadelphus giffardianus* and *Pleomele hawaiiensis*. The only successful outplanting effort was with *Hibiscadelphus giffardianus*. Nine individuals of *Hibiscadelphus giffardianus* were outplanted into the only known location, Kipuka Puaulu, in HVNP. These plants have been fenced, and the fenced area also contains a population of *Melicope zahlbruckneri*. Ungulates have been

removed and a rat control program has begun (L. Pratt, Biological Resources Division, U.S. Geological Survey (BRD), pers. comm. 1997).

Hawaii's Division of Forestry and Wildlife (DOFAW) has outplanted *Cyanea platyphylla*, *Hibiscadelphus hualalaiensis*, *Pleomele hawaiiensis*, *Pritchardia schattaueri*, and *Zanthoxylum dipetalum* var. *tomentosum*. Please refer to the individual species accounts for details.

#### Private

Eleven of the 13 plant taxa treated in this recovery plan are maintained *ex situ* in The National Tropical Botanical Garden (NTBG), Lyon Arboretum, and Waimea Falls Park (WFP) (see Table 3) as part of the Center for Plant Conservation's (CPC) National Collection of Endangered Plants. These taxa are subject to the Center's national collecting and genetic management guidelines for *ex situ* holdings. The Center has been identified as the preferred cooperator by the Service for agencies and organizations wishing to undertake actions associated with the controlled propagation of listed plants. Many conservation, research, education, monitoring, and restoration projects associated with all 13 taxa are being prioritized and coordinated by the Hawaii Rare Plant Restoration Group — a CPC-chaired body.

TABLE 3. Seed, cultures and plants of the Big Island II Plant Cluster in storage and/or propagation in *ex situ* collections. NTBG=National Tropical Botanical Garden, LA=Lyon Arboretum, VRPF=Volcano Rare Plant Facility, WFP=Waimea Falls Park. Ind.=Individual plants.

Taxon	Number of Seeds in Storage	Tissue Accessions/ total number of cultures	Plants in greenhouse/ nursery					Outplantings		
	NTBG	LA	HVNP	NTBG	LA	WFP	VRPF	HVNP	DOFAW	VRPF
<i>Clermontia drepanomorpha</i>	50	13/ 90			5		48			
<i>Cyanea platyphylla</i>	125	30/ 120		18			38		12 ind.	
<i>Hibiscadelphus giffardianus</i>			5	2			9			
<i>Hibiscadelphus hualalaiensis</i>	208			19		4	10		30 ind.	
<i>Melicope zahlbruckneri</i>										
<i>Neraudia ovata</i>				6			2			
<i>Phyllostegia racemosa</i>	300	11/ 43		2			16			
<i>Phyllostegia velutina</i>	251			2			282			
<i>Phyllostegia warshaueri</i>	346			1	2		11			
<i>Pleomele hawaiiensis</i>	829	4/ 5	28	1	3		38		9 ind.	
<i>Pritchardia schattaueri</i>				1	2	6	5		56 ind.	
<i>Sicyos alba</i>	9									
<i>Zanthoxylum dipetalum</i> var. <i>tomentosum</i>										

## 5. Species Accounts

The following are individual species accounts for the Big Island II Plant Cluster. For the purposes of this addendum, verified locations since 1970 are considered the current distribution of each taxon. Each taxon is presented here with its recovery priority number and taxon specific information. The recovery priority number is assigned according to the Recovery Priority System which rates the recovery priority of a taxon on a scale of 1–18 according to its degree of threat, recovery potential and taxonomy. This system is briefly reviewed in Appendix C of the Recovery Plan. The general strategy for the recovery of these taxa can be found in the Overall Recovery Strategy section of the Recovery Plan.

Major sources of information include the Hawaii Heritage Program (HHP), Hawaii Plant Conservation Program (HPCC), Hawaii Division of Forestry and Wildlife (DOFAW), and the National Tropical Botanical Garden (NTBG). The information in this section is largely summarized from the final rule listing these plants as endangered species (Service 1996a), and the HHP and HPCC references retain the same numbering as in the final rule.

### *Clermontia drepanomorpha* (oha wai) – Recovery Priority # 2

#### Description and Taxonomy

Appendix I contains a line drawing of this taxon.

*Clermontia drepanomorpha*, of the bellflower family (Campanulaceae), is a terrestrial or epiphytic (not rooted in the soil), branching tree 2.5 to 7 meters (8.2 to 23 feet) tall. The stalked leaves are 10 to 27 centimeters (4 to 11 inches) long and 1.5 to 4.5 centimeters (0.6 to 1.8 inches) wide. Two to four flowers, each with a stalk 2 to 3.5 centimeters (0.8 to 1.4 inches) long, are positioned at the end of a main flower stalk 5 to 12 centimeters (2 to 5 inches) long. The calyx (fused sepals) and corolla (fused petals) are similar in size and appearance, and each forms a slightly curved, five-lobed tube 4 to 5.5 centimeters (1.6 to 2.2 inches) long and 1.5 to 2 centimeters (0.6 to 0.8 inch) wide which is blackish purple. The berries are orange and 2 to 3 centimeters (0.8 to 1.2 inches) in diameter. This species is distinguished from others in this endemic Hawaiian genus by similar sepals and petals, the long drooping inflorescence, and large blackish purple

flowers (Lammers 1990, Rock 1919). Joseph F. Rock (1913) named *Clermontia drepanomorpha* in 1913 on the basis of specimens collected in the Kohala Mountains of the island of Hawaii in the early 1900's. This taxonomy was retained in the latest treatment of the genus (Lammers 1990).

#### Historic and Current Ranges and Population Status (Appendix J-2)

Historically, *Clermontia drepanomorpha* was known only from the Kohala Mountains (Hawaii Heritage Program (HHP) 1993a1–1993a4; Rock 1913; Skottsberg 1944; Stemmermann and Jacobson 1987). Prior to 1995, 13 to 20 individuals in two populations, bordering private ranch lands, were known to be extant (Corn 1983; HHP 1993a1, 1993a4; Hawaii Plant Conservation Center (HPCC) 1993a; Marie M. Bruegmann, U.S. Fish and Wildlife Service (USFWS), in litt., 1994; Carolyn Corn, Hawaii Division of Forestry and Wildlife (DOFAW), in litt., 1994; Perlman and Wood 1996; Service 1996a). In 1995 NTBG, under contract to the Service, conducted a thorough survey of the Kohala area, which resulted in the discovery of four additional populations. Currently, there are six known populations totaling between 237 to 292 individuals of *Clermontia drepanomorpha* located in and bordering the State-owned Puu O Umi Natural Area Reserve (NAR) and Kohala Forest Reserve (Perlman and Wood 1996).

#### Life History

No life history information is currently available for this species.

#### Habitat Description

This species typically grows in *Metrosideros polymorpha* (ohia), *Cheirodendron trigynum* (olapa), and *Cibotium glaucum* (hapuu) dominated Montane Wet Forests, sometimes epiphytically, at elevations between 1,170 and 1,570 meters (3,850 and 5,150 feet) (Corn 1983; HHP 1993a1, 1993a4; HPCC 1993a). Associated taxa include *Carex alligata*, *Melicope clusiifolia* (alani), *Styphelia tameiameiae* (pukiawe), *Astelia menziesii* (painiu), *Rubus hawaiiensis* (akala), *Cyanea pilosa* (haha), and *Coprosma* sp. (pilo) (HHP 1993a1; HPCC 1993a).

#### Reasons for Decline and Current Threats

The major threats to *Clermontia drepanomorpha* are competition from alien plant taxa such as *Rubus rosifolius* (thimbleberry), habitat disturbance by feral pigs (*Sus scrofa*), girdling of the stems by rats (*Rattus* spp.), and a risk of extinction from



naturally occurring events (such as hurricanes) due to its narrow distribution and small number of populations (Bruegmann 1990; Center for Plant Conservation [CPC] 1990, HHP 1993a1, HPCC 1993a). Road or ditch modification may have eliminated some individuals along the Alakahi and Kawainui Streams headwaters several years ago (C. Corn, DOFAW, in litt. 1994).

### Conservation Efforts

There are 48 plants at the Volcano Rare Plant Facility (VRPF) (P. Moriyasu, VRPF, pers. comm. 1997). NTBG has 50 seeds in storage, but the viability is unknown. Lyon Arboretum contains 13 separate tissue culture accessions and 90 plants from tissue culture. They also have 5 greenhouse plants. No additional species-specific conservation efforts have been undertaken. General conservation efforts for the Big Island II Plant Cluster taxa can be found in the Overall Conservation Efforts section of this addendum.

### Needed Recovery Actions

- 1) Construct fenced exclosures on State lands in the Kohala Mountains around the known populations, and initiate removal of feral ungulates and weeds from its habitat.

Without this protection, this species will continue to decline due to degradation of habitat by feral pigs. Once fencing is erected, those areas should undergo management to remove alien plant species like thimbleberry.

- 2) Reduce threats from rodent predation.

Steps should be taken to control rats within and surrounding the exclosures. This should include the use of the currently approved Diphacinone bait blocks and ultimately a more broad-scale method such as aerial dispersal of rodenticide.

Additional recovery actions, as discussed in the Stepdown Narrative of the Recovery Plan for the Big Island Plant Cluster, beginning on page 134 of that plan, are also appropriate for this species.

## *Cyanea platyphylla* (haha) – Recovery Priority # 2

### Description and Taxonomy

No line drawing is available for this taxon.

*Cyanea platyphylla*, of the bellflower family, is an unbranched palm-like shrub 1 to 3 meters (3 to 10 feet) tall with stems that are covered with short, sharp, pale spines on the upper portions, especially as juveniles. This species has different leaves in the juvenile and adult plants. The juvenile leaves are 10.5 to 25 centimeters (4.1 to 10 inches) long and 4 to 7.5 centimeters (1.6 to 3.0 inches) wide, with prickles on leaves and stalks. Adult leaves are 34 to 87 centimeters (13 to 34 inches) long and 7 to 22 centimeters (2.8 to 8.7 inches) wide, and are only sparsely prickled.

Six to 25 flowers are clustered on the end of a main stalk 20 to 90 centimeters (8 to 35 inches) long, and each flower has a stalk 1 to 2.5 centimeters (0.4 to 1 inch) long. The hypanthium is topped by five small, triangular calyx lobes. Petals, which are white or yellowish white with magenta stripes, are fused into a curved tube with five spreading lobes. The corolla is 4.2 to 5.4 centimeters (1.7 to 2.1 inches) long and 5 to 10 millimeters (0.2 to 0.4 inch) wide. Berries are pale orange, 8 to 10 millimeters (0.3 to 0.4 inch) long, and 6 to 8 millimeters (0.2 to 0.3 inch) wide.

The species differs from others in this endemic Hawaiian genus by its juvenile and adult leaves, precocious flowering, and smaller flowers (Lammers 1990). Asa Gray named *Delissea platyphylla* in 1861 from a specimen collected by Horace Mann and W.T. Brigham in the Puna District of the island of Hawaii. Wilhelm Hillebrand (1888) transferred the species to *Cyanea*, creating *Cyanea platyphylla*. Harold St. John (1987a, St. John and Takeuchi 1987), believing there to be no generic distinction between *Cyanea* and *Delissea*, transferred the species back in 1987 to the genus *Delissea*, the older of the two generic names. The current treatment of the family (Lammers 1990), however, maintains the separation of the two genera. The following taxa have been synonymized with *Cyanea platyphylla*: *C. bryanii*, *C. crispohirta*, *C. fernaldii*, *C. nolimetangere*, *C. pulchra*, and *C. rollandioides*. However, some field biologists feel that *C. fernaldii*, represented by the Laupahoehoe populations, is a distinct entity that should be resurrected as a separate species (Frederick Warshauer, USGS National Biological Service [now the Biological Resources Div.], pers. comm., 1994).

### Historic and Current Ranges and Population Status (Appendix J-3)

Historically, *Cyanea platyphylla* was found in the Kohala Mountains near Hiilawe Falls and also the Hamakua Ditch Trail; in Honaunau; in the Puna District near Glenwood, on Kalapana Road in Pahoā, and in Puu Kauka; in Waiakea Forest Reserve; and in an unknown location called “Kalanilehua” (HHP 1991a1–1991a4, 1991a7, 1991a8, 1991a11, 1991a12, 1993b; Rock 1917, 1919, 1957; Skottsberg 1926; Wimmer 1943, 1968). Two additional populations in Laupahoehoe NAR have not been seen since 1982 and could not be relocated in 1989. This species is extant in two natural populations, one of nine individuals located on State land in Laupahoehoe NAR and one recently located along Saddle Road on private land, (C. Corn, pers. comm. 1998). An unknown number of plants occur at the Saddle Road site. There is one outplanted population of 12 individuals in the Waiakea Forest Reserve (S. Bergfeld, DOFAW, pers. comm. 1997).

### Life History

No life history information is currently available for this species.

### Habitat Description

*Cyanea platyphylla* is typically found in *Metrosideros polymorpha* (ohia)-*Acacia koa* (koa) Lowland and Montane Wet Forests at elevations between 120 and 915 meters (390 and 3,000 feet) (Lammers 1990). Associated taxa include *Cibotium* sp. (hapuu), *Athyrium sandwichianum* (hoio), *Antidesma* sp. (hame), *Clermontia* spp. (oha wai), *Hedyotis* sp. (pilo), and *Cyrtandra* spp. (haiwale) (HHP 1991a6; HPCC 1991a).

### Reasons for Decline and Current Threats

The major known threats to *Cyanea platyphylla* are pigs that adversely modify the habitat; competition with introduced plant taxa, including *Psidium cattleianum* (strawberry guava), *Psidium guajava* (guava), *Passiflora ligularis* (sweet granadilla), and thimbleberry; rats, which may eat the fruit; and volcanic activity (Cuddihy et al. 1982; HHP 1991a6, 1991a9; HPCC 1991a; M. Bruegmann, in litt., 1994; L. Pratt, pers. comm., 1994). Disturbance of habitat and destruction of enclosure fencing by humans is also a threat (M. Bruegmann, pers. comm. 1997). Another threat is the risk of extinction from naturally occurring events and/or reduced reproductive vigor due to the low numbers of populations and individuals.

### Conservation Efforts

VRPF has 38 plants, and also donated 12 plants to DOFAW for outplanting (P. Moriyasu, pers. comm. 1997). These 12 plants have been outplanted into Waiakea Forest Reserve and fenced (S. Bergfeld, pers. comm. 1997). NTBG has 18 plants in their nursery and they have 125 seeds in storage. The Lyon Arboretum is attempting propagation by tissue culture. The extant Laupahoehoe population (HHP 1991a5, 1991a10) was spot-fenced by DOFAW in 1996 to protect it from pig depredation; however, this fence was vandalized in 1996 (M. Bruegmann, pers. comm. 1997). The Institute of Pacific Islands Forestry (IPIF) is working with the University of Hawaii's Cooperative Parks Studies Unit (CPSU) to develop a biocontrol program for strawberry guava (M. Isherwood, Jr., Hawaii Department of Agriculture, pers. comm. 1997). General conservation efforts for the Big Island II Plant Cluster taxa can be found in the Overall Conservation Efforts section of this addendum.

### Needed Recovery Actions

1) Remove alien plants inside completed exclosures.

The fenced areas should be surveyed for strawberry guava, guava, sweet granadilla, and thimbleberry, and other alien plants. Efforts should be made to remove and prevent reintroduction of alien plants.

2) Outplant new populations in area of reduced threat.

Attempts should be made to establish this species in outplanting sites free from impacts of feral ungulates and rats. Prior to outplanting, the sites should be fenced and ungulates and alien plants should be removed. Possible outplanting sites for this taxon include Management Units 1 (Kohala Mountains) and 2 (Laupahoehoe NAR). Descriptions of the Management Units can be found on pages 135–137 of the Recovery Plan and also page 57 of this addendum.

3) Reduce threats from rodent predation.

Steps should be taken to control rats within and surrounding the exclosures. This should include the use of the currently approved Diphacinone bait blocks and ultimately a more broad-scale method such as aerial dispersal of rodenticide.

Additional recovery actions, as discussed in the Stepdown Narrative of the

Recovery Plan for the Big Island Plant Cluster, beginning on page 134, are also appropriate for this species.

***Hibiscadelphus giffardianus* (hau kuahiwi) – Recovery Priority # 5**

Description and Taxonomy

No line drawing is available for this taxon.

*Hibiscadelphus giffardianus*, of the mallow family (Malvaceae), is a tree up to 7 meters (23 feet) tall with the trunk up to 30 centimeters (12 inches) in diameter and whitish bark. The leaf blades are heart-shaped and 10 to 30 centimeters (4 to 12 inches) long with a broad tip, a notched base, and stalks nearly as long as the blades. Flowers are typically solitary in the axils of the leaves and have stalks 1.5 to 4 centimeters (0.6 to 1.6 inches long). Five to seven filament-like bracts are borne below each flower and the calyx is pouch-like. The overlapping petals form a curved bisymmetrical flower with the upper petals longer, typical of bird-pollinated flowers. The flowers are grayish green on the outside and dark magenta within, and 5 to 7 centimeters (2 to 3 inches long). The fruit is woody with star-shaped hairs. This species differs from others in this endemic Hawaiian genus by its flower color, flower size, and filamentous bracts (Baker and Allen 1976b; Bates 1990; Degener 1932a; Degener and Degener 1977; Radlkofer and Rock 1911). Rock named his new genus *Hibiscadelphus*, meaning “brother of Hibiscus” (Bryan 1971). The specific epithet, *giffardianus*, honors W.M. Giffard, who first saw the taxon in 1911. Rock’s taxonomy was retained in the latest treatment of the genus (Bates 1990).

Historic and Current Ranges and Population Status (Appendix J-4)

Only one tree of *Hibiscadelphus giffardianus* has ever been known in the wild, from Kipuka Puaulu (or Bird Park) in HVNP. This tree died in 1930. Individuals were cultivated by Territorial Forestry (Hawaii’s Department of Land and Natural Resources [DLNR] prior to Hawaii’s statehood) from this parent tree.

Approximately eleven plants were outplanted into Kipuka Puaulu somewhere between 1951 and 1964 (L. Pratt, pers. comm. 1997). There are currently nine mature plants and two suckers surviving at this site (Baker and Allen 1977; Bishop and Herbst 1973; HHP 1991b; HPC 1991b1, 1991b2; M. Brueggemann, in litt., 1994). The cultivated plants in Kipuka Puaulu spontaneously produced

fertile hybrids with cultivated plants of *Hibiscadelphus hualalaiensis* that were also planted into Kipuka Puauulu and Kipuka Ki. Both the *Hibiscadelphus hualalaiensis* and the hybrids have been removed from the Park (Baker and Allen 1976a, 1977; Carr and Baker 1977).

#### Life History

No life history information is currently available for this species.

#### Habitat Description

This taxon grows in mixed Montane Mesic Forest at elevations between 1,200 and 1,310 meters (3,900 and 4,300 feet) (Bates 1990; HHP 1991b; HPCC 1991b1, 1991b2). Associated taxa include ohia, koa, *Sapindus saponaria* (ae), hoio, *Coprosma* sp. (pilo), *Pipturus albidus* (mamaki), *Psychotria* sp. (kopiko), *Nestegis sandwicensis* (olopua), *Melicope* sp. (alani), *Dodonaea viscosa* (aalii), *Myoporum sandwicense* (naio), and introduced grasses (HHP 1991b; HPCC 1991b1, 1991b2).

#### Reasons for Decline and Current Threats

The major threats to *Hibiscadelphus giffardianus* are bark, flower, and fruit feeding by roof rats (*Rattus rattus*); leaf damage in the form of stippling and yellowing by *Sophonia rufofascia* (two-spotted leafhopper) and yellowing by the native plant bug *Hyalopeplus pellucidus*; competition from the alien grasses *Ehrharta stipoides* (meadow ricegrass), *Paspalum conjugatum* (Hilo grass), and *Paspalum dilatatum* (Dallis grass); habitat change from volcanic activity; and risk of extinction from naturally occurring events and/or reduced reproductive vigor due to the small number of existing cultivated individuals, all from a single parent (Baker and Allen 1978; M. Bruegmann, in litt., 1994; L. Pratt, pers. comm., 1994). Cattle (*Bos taurus*) were known in the area before it became a National Park and probably had a large destructive influence on the habitat as well (Anonymous 1920, Rock 1913, St. John 1981).

#### Conservation Efforts

HVNP has 5 plants in their nursery. VPRF has 9 plants in their facility. NTBG has 2 plants. HVNP fenced the outplanted Kipuka Puauulu population in the 1960s and weed control efforts have been undertaken (L. Pratt, pers. comm. 1997). There has been some effort at rodent trapping (L. Pratt, pers. comm. 1997). No

additional species-specific conservation efforts have been undertaken. The Hawaii Department of Agriculture (HDOA) is researching potential biocontrol agents for the two-spotted leaf hopper (M. Isherwood, Jr., pers. comm. 1997). General conservation efforts for the Big Island II Plant Cluster taxa can be found in the Overall Conservation Efforts section of this addendum.

#### Needed Recovery Actions

1) Outplant new populations in areas of reduced threat.

Attempts should be made to establish this species in outplanting sites free from impacts of feral ungulates and rats. Prior to outplanting, the sites should be fenced and ungulates and alien plants should be removed. Possible outplanting sites should be in suitable habitat starting within Management Unit 4 (Hawaii Volcanoes National Park, Figure 2).

2) Reduce threats from rodent predation.

Rats should be immediately controlled in and around the fenced population. This should include the use of the currently approved Diphacinone bait blocks and ultimately a more broad-scale method such as aerial dispersal of rodenticide.

3) Control insect damage.

Efforts should be made to control damage of the two-spotted leaf hopper via manual spraying and treatment and research on more suitable control methods.

Additional recovery actions, as discussed in the Stepdown Narrative of the Recovery Plan, beginning on page 134, are also appropriate for this species.

#### ***Hibiscadelphus hualalaiensis*(hua kuahiwi) – Recovery Priority # 5**

##### Description and Taxonomy

Appendix I contains a line drawing of this taxon.

*Hibiscadelphus hualalaiensis*, of the mallow family, is a tree 5 to 7 meters (16 to 23 feet) tall with the trunk up to 30 centimeters (12 inches in diameter and whitish bark. The leaf blades are heart-shaped and 10 to 15 centimeters (4 to 6 inches) long with a broad tip, a notched base, stellate hairs, and stalks 4 to 10 centimeters (1.5 to 4 inches) long. One or two flowers are borne in the axils of the leaves and

have stalks 1.5 to 14 centimeters (0.6 to 5.5 inches) long. Five toothlike bracts are borne below each flower and the calyx is tubular or pouch-like. The overlapping petals form a curved bisymmetrical flower with longer upper petals, typical of bird-pollinated flowers. The flowers are greenish yellow on the outside and yellowish green, fading to purplish within, and 2 to 5.5 centimeters (0.8 to 2.2 inches) long. The fruit is woody and the seeds have a dense covering of hairs. The species differs from others in this endemic Hawaiian genus by its flower color, smaller flower size, and toothlike bracts (Baker and Allen 1976b, Bates 1990, Degener 1932b, Radlkofer and Rock 1911). Rock (1913) named *Hibiscadelphus hualalaiensis* in 1911 after Hualalai, the volcano on which the plant was found in 1909. This taxonomy was retained in the latest treatment of the genus (Bates 1990).

#### Historic and Current Ranges and Population Status (Appendix J-5)

*Hibiscadelphus hualalaiensis* was historically known from three populations, located in the Puu Waawaa region of Hualalai, on the island of Hawaii (HHP 1993c1–1993c3; HPCC 1990a, 1991c, 1992a). The last known wild tree was in Puu Waawaa Wildlife Sanctuary, owned and managed by DOFAW. This tree died in 1992.

#### Life History

*Hibiscadelphus hualalaiensis* has been seen in flower in May and in fruit in June and July (C. Corn, pers. comm. 1998). No other life history information is currently available for this species.

#### Habitat Description

This species grows in mixed Dry to Mesic Forest remnants on lava fields, at elevations between 915 and 1,020 meters (3,000 and 3,350 feet) (Bates 1990; HHP 1993c3; HPCC 1991c, 1992a). Associated taxa include ohia, *Diospyros sandwicensis* (lama), *Sophora chrysophylla* (mamane), naio, *Pouteria sandwicensis* (alaa), *Charpentiera* sp. (papala), *Nothoestrum* sp. (aiea), *Claoxylon sandwicense* (poola), and *Pennisetum clandestinum* (kikuyu grass) (HHP 1993c3; HPCC 1991c, 1992a; J. Lau, in litt., 1991).



### Reasons for Decline and Current Threats

The major threats to *Hibiscadelphus hualalaiensis* are fire; flower and seed feeding by roof rats; competition from alien plants such as kikuyu grass, fountain grass, and *Lantana camara* (lantana); ranching activities; habitat change from volcanic activity; and a risk of extinction from naturally occurring events and/or reduced reproductive vigor due to the small number of known cultivated individuals from a single parent (Anonymous 1920; Baker and Allen 1978; HHP 1993c3; HPCC 1991c, 1992a; M. Bruegmann, in litt., 1994). Potential threats include domestic and feral cattle, feral pigs, and sheep (*Ovis aries*) that may adversely modify the habitat and browse the leaves. The outplanted populations in Puu Waawaa are surrounded by lands leased for cattle ranching.

### Conservation Efforts

Twelve trees cultivated by DOFAW were planted on State land within one fenced enclosure in Puu Waawaa Wildlife Sanctuary and currently ten survive (HHP 1993c2; M. Bruegmann, in litt., 1994; Joel Lau, HHP, in litt., 1991; S. Bergfeld, pers. comm. 1997). An additional five plants were outplanted in this enclosure on November 25, 1997 (Lyman Perry DOFAW, pers. comm. 1997). Another five plants were outplanted on State land in another enclosure within Puu Waawaa (L. Perry, pers. comm. 1997). In addition, approximately ten plants were cultivated and outplanted by DOFAW near Koaia Sanctuary in Kawaihae (HPCC 1990a; Steven Bergfeld, pers. comm., 1994). Cultivated individuals were planted in Kipuka Puaulu and Kipuka Ki in HVNP, but were removed to prevent further hybridization with the *Hibiscadelphus giffardianus* plants that are native to the kipuka (Baker and Allen 1977, 1978). VRPF has 10 plants in their nursery. NTBG has 19 plants from three accessions, along with 208 seeds in storage (David H. Lorence NTBG, pers. comm. 1998). Waimea Falls Park (WFP) has 4 plants; however, they are doing poorly (D. Orr, WFP, in litt. 1997). Small areas have been fenced around all outplanted populations to exclude livestock and feral ungulates. No additional species-specific conservation efforts have been undertaken. General conservation efforts for the Big Island II Plant Cluster taxa can be found in the Overall Conservation Efforts section of this plan.

### Needed Recovery Actions

1) Reduce threats from rodent predation.

Steps should be taken to control rats within and surrounding the exclosures. This should include the use of the currently approved Diphacinone bait blocks and ultimately a more broad-scale method such as aerial dispersal of rodenticide.

2) Outplant new populations in areas of reduced threat.

Attempts should be made to establish more populations of this species in Management Unit 9 (Puu Waawaa Wildlife Sanctuary; Figure 2) in areas free from impacts of ungulates and rats. Prior to outplanting, the sites should be fenced and ungulates and alien plants removed.

3) Protect populations from fire.

Steps should be taken to prevent the extirpation of the outplanted populations and future outplantings from wildfires. This includes but is not limited to removing the alien grasses that increase the fuel load.

Additional recovery actions, as discussed in the Stepdown Narrative of the Recovery Plan, beginning on page 134, are also appropriate for this species.

### ***Melicope zahlbruckneri* (alani) – Recovery Priority # 2**

#### Description and Taxonomy

No line drawing is available for this taxon.

*Melicope zahlbruckneri*, of the citrus family (Rutaceae), is a medium-sized tree 10 to 12 meters (33 to 40 feet) tall. New growth is covered with yellowish brown, fine, short, curly hairs. The opposite, stalked, elliptically oblong leaves are 6 to 24 centimeters (2.4 to 9.5 inches) long and 4 to 12.5 centimeters (1.6 to 4.9 inches) wide, with well defined lateral veins. Clusters of two to five flowers have main flowering stalks 15 to 20 centimeters (5.9 to 7.9 inches) long and each flower has a stalk about 0.4 centimeters (0.2 inch) long. Female flowers consist of four sepals about 1.5 millimeters (0.05 inch) long, four petals about 3 millimeters (0.1 inch) long, an eight-lobed nectary disk, eight reduced and nonfunctional stamens, and a hairless four-celled ovary. Male flowers consist of four sepals 3.5 millimeters (0.1 inch) long, four petals about 6 millimeters (0.2

inch) long, and eight functional stamens in two whorls equal to or longer than the petals. The fruit is squarish, 12 to 14 millimeters (0.4 to 0.5 inch) long, and up to 30 millimeters (1.2 inch) wide. *Melicope zahlbruckneri* is distinguished from other species of the genus by its branching habit, large leaves, and very large, squarish capsules (Rock 1913, Stone 1969, Stone et al. 1990). Based on a specimen he collected in 1911 in Kipuka Puaulu, on the island of Hawaii, Rock (1913) described *Pelea zahlbruckneri*, in honor of Dr. A. Zahlbruckner, director of the Botanical Museum in Vienna. *Pelea* has since been submerged into *Melicope*, creating the combination *Melicope zahlbruckneri* (Stone et al. 1990).

#### Historic and Current Ranges and Population Status (Appendix J-6)

Historically, *Melicope zahlbruckneri* was known from three populations — near Glenwood, in Kipuka Puaulu, and at Moaula in Kau (Degener 1930; HHP 1991c1–1991c3; HPCC 1991d; Rock 1913; Stone 1969; Stone et al. 1990). It is currently known from two sites — in Kipuka Puaulu within HVNP, and a recently located population on State land in Laupahoehoe NAR (HHP 1991c2; HPCC 1991d; L. Pratt, pers. comm., 1994; K. Wood, NTBG, pers. comm. 1997). The Laupahoehoe population was first seen in 1991 by W. L. Wagner (K. Wood, pers. comm. 1997). The number of individual plants is not known. The Kipuka Puaulu population is reproducing and juvenile plants are present (L. Pratt, pers. comm., 1994). About 30 to 35 plants are known from this location.

#### Life History

No life history information is currently available for this species.

#### Habitat Description

This species is found in koa- and ohia-dominated Montane Mesic Forest at elevations between 1,195 and 1,300 meters (3,920 and 4,265 feet) (HHP 1991c2; HPCC 1991d; Stone et al. 1990). Associated taxa include pilo, ae, mamaki, kopiko, olopua, naio, *Pisonia* sp. (papala), several species of *Melicope* (alani), hoio, aalii, and three introduced grasses: meadow ricegrass, Hilo grass, and Dallis grass (HHP 1991c2; HPCC 1991d; M. Brueggemann, in litt., 1994; L. Pratt, pers. comm., 1994).

### Reasons for Decline

The major threats to *Melicope zahlbruckneri* are the two-spotted leafhopper; competition from introduced grasses (meadow ricegrass, Hilo grass, and Dallis grass); habitat change due to volcanic activity; potential fruit damage by rats; and a risk of extinction from naturally occurring events and/or reduced reproductive vigor due to the small number of individuals in the two remaining populations (HPCC 1991d; M. Bruegmann, in litt., 1994; L. Pratt, pers. comm., 1994).

### Conservation Efforts

HVNP has fenced Kipuka Puaulu and weed control efforts have been undertaken (see *Hibiscadelphus giffardianus* for details) (L. Pratt, pers. comm. 1997). There has been some effort at rodent trapping (L. Pratt, pers. comm. 1997). No additional species-specific conservation efforts have been undertaken. HDOA is researching potential biocontrol agents for the two-spotted leaf hopper (M. Isherwood, Jr., pers. comm. 1997). General conservation efforts for the Big Island II Plant Cluster taxa can be found in the Overall Conservation Efforts section of this addendum.

### Needed Recovery Actions

- 1) Survey and construct protective fencing around the new population at Laupahoehoe.

A survey of the plants at Laupahoehoe to determine the number of individuals and extent of this population should be conducted. A fenced enclosure should be constructed to protect the newly discovered population from potential impacts from ungulates. Once fenced, efforts should be made to remove ungulates, rats, and alien plants.

- 2) Control of insect damage.

Efforts should be made to control damage of the two-spotted leafhopper via manual spraying and treatment and research on more suitable control methods.

- 3) Reduce threats from rodent predation.

Steps should be taken to control rats within and surrounding the fenced areas. This should include the use of the currently approved Diphacinone bait blocks and ultimately a more broad-scale method such as aerial dispersal of rodenticide.

4) Outplant new populations in areas of reduced threat.

Attempts should be made to establish this species in Management Units 2 (Laupahoehoe/ Hakalau) and 5 (Kau Forest Reserve) (Figure 2) in sites free from impacts of ungulates and rats. Prior to outplantings, sites should be fenced and ungulates and alien plants removed.

Additional recovery actions, as discussed in the Stepdown Narrative of the Recovery Plan, beginning on page 134, are also appropriate for this species.

***Neraudia ovata* (no common name)(NCN) – Recovery Priority # 5**

Description and Taxonomy

Appendix I contains a line drawing of this taxon.

*Neraudia ovata*, of the nettle family (Urticaceae), is a sprawling or rarely erect shrub to a small tree, with stems 1 to 3 meters (3 to 10 feet) long, and branches bearing short, somewhat erect hairs. The alternate, thin, stalked leaves are smooth-margined, grayish on the undersurface, 5 to 14 centimeters (2 to 5.5 inches) long and 2 to 6.5 centimeters (0.8 to 2.6 inches) wide, and have spreading, curved, nearly translucent hairs. Male and female flowers are found on separate plants. Male flowers have extremely short stalks and a densely hairy calyx. Female flowers have no stalks and a densely hairy, boat-shaped calyx. The fruit is an achene (a dry, one-seeded fruit that does not open at maturity). This species is distinguished from others in this endemic Hawaiian genus by the density, length, and posture of the hairs on the lower leaf surface; smooth leaf margin; and the boat-shaped calyx of the female flower (Cowan 1949; Wagner et al. 1990).

The first name applied to this plant was *Neraudia pyrifolia*, by Charles Gaudichaud-Beaupré, based on material he collected in the early 1800's on the island of Hawaii (Cowan 1949). This name was later determined to have been invalidly published, lacking an adequate description. Gaudichaud-Beaupré applied the name *Neraudia ovata* to another specimen of what is now considered to be the same species, and this name is used in the current taxonomic treatment. H.A. Weddell considered this taxon a variety of *Neraudia melastomifolia*, but this has not been upheld by other taxonomists. S.L. Endlicher and E.G. Steudel placed this species in the genus *Boehmeria*, but the current taxonomic treatment maintains *Neraudia* as an endemic Hawaiian genus. Harold St. John named a new

species, *Neraudia cookii*, from a collection by David Nelson on Cook's 1779 voyage to Hawaii (St. John 1976). That specimen is considered to belong to *Neraudia ovata* in the current taxonomic treatment (Cowan 1949; Wagner et al. 1990).

#### Historic and Current Ranges and Population Status (Appendix J-7)

Historically, *Neraudia ovata* was found from North Kona all the way to Kau (Cowan 1949; HHP 1991d1-1991d3, 1993d1-1993d7; Hillebrand 1888; St. John 1976 and 1981; Skottsberg 1944).. There are currently three extant known populations. One population of three individuals is known from privately owned land in Kaloko, North Kona (Nishida 1993; Warshauer and Gerrish 1993; M. Bruegmann, in litt., 1994; Winona Char, Char and Associates, in litt., 1995). The second population of 8 individuals was surveyed in late 1995 and again in 1997 by Colorado State University personnel. This population is located at the boundary of the U.S. Army's Pohakuloa Training Area (PTA) and Puu Anahulu, owned by the State (Shaw et. al. 1997; HHP 1993d4, 1993d5; M. Bruegmann, in litt. 1996, 1997, pers. comm. 1997). The third population, which is located within PTA, has not been surveyed since 1980. It is unknown how many plants occur at this site.

#### Life History

No life history information is currently available for this species.

#### Habitat Description

*Neraudia ovata* grows in open ohia- and mamane-dominated Lowland and Montane Dry Forests at elevations of 115 meters (380 feet) at Kaloko and 1,325 and 1,520 meters (4,350 to 5,000 feet) at Pohakuloa Training Area (HHP 1993d4, 1993d5; Nishida 1993; M. Bruegmann, in litt., 1994, 1996; R. Shaw, in litt. 1996). Associated taxa include *Reynoldsia sandwicensis* (ohe makai), naio, *Cocculus trilobus* (huehue), *Myrsine* sp. (kolea), and *Schinus terebinthifolius* (Christmas berry), as well as the federally endangered *Nothocestrum breviflorum* (aiea) and *Pleomele hawaiiensis* (hala pepe), and other species of concern, including *Capparis sandwichiana* (pua pilo), *Fimbristylis hawaiiensis*, and *Bidens micrantha* ssp. *ctenophylla* (kookoolau) (Nishida 1993; Warshauer and Gerrish 1993; M. Bruegmann, in litt., 1994, 1996).

### Reasons for Decline and Current Threats

The major threats to *Neraudia ovata* are heavy browsing and habitat modification by feral sheep and goats (*Capra hircus*); competition from alien plants such as Christmas berry, *Leucaena leucocephala* (koa haole), and *Pennisetum setaceum* (fountain grass); habitat change due to volcanic activity; residential development; insect damage by the non-native spiraling whitefly (*Aleurodicus dispersus*); and a risk of extinction from naturally occurring events and/or reduced reproductive vigor due to the small number of existing individuals in the three remaining populations (Nishida 1993; M. Bruegmann, in litt., 1994, 1996).

### Conservation Efforts

VRPF has 2 plants in their nursery. NTBG has 6 plants. The Army is currently developing an Endangered Species Management Plan for PTA. This plan proposes management actions for the protection of federally listed species on their property. These proposed actions include fencing, ungulate control, and alien plant removal. No additional species-specific conservation efforts have been undertaken. HDOA has conducted a very successful biocontrol program for the spiraling whitefly which has significantly reduced damage caused by this insect (M. Isherwood, Jr., pers. comm. 1997). The spiraling whitefly remains a problem on certain preferred host plants, particularly in the summer, or on windy coastal areas where biocontrol efforts are not effective. General conservation efforts for the Big Island II Plant Cluster taxa can be found in the Overall Conservation Efforts section of this addendum.

### Needed Recovery Actions

- 1) Construct protective fences around the known populations, and initiate removal of sheep and goats and alien plants from its habitat.

Enclosures should be constructed to reduce impacts from domestic and feral ungulates. Once fencing is erected, those areas should undergo management to remove sheep, goats, and alien plant species. Because some of the land is privately owned, a commitment should be developed for long-term stewardship and conservation of these areas once they have been enclosed.

- 2) Control of insect damage.

Efforts should be made to control damage of the spiraling whitefly via manual spraying where appropriate, and research on other control methods.

3) Outplant new populations in areas of reduced threat.

Attempts should be made to establish this species in Management Units 4 (Hawaii Volcanoes National Park), 8 (Pohakuloa Training Area), and 10 (Kaloko Dry Forest) (Figure 2) in sites free from impacts of feral ungulates and future residential development. Prior to and following outplanting, alien plants should be removed from the site.

Additional recovery actions, as discussed in the Stepdown Narrative of the Recovery Plan, beginning on page 134, are also appropriate for this species.

### ***Phyllostegia racemosa* (kiponapona) – Recovery Priority # 2**

#### Description and Taxonomy

Appendix I contains a line drawing of this taxon.

*Phyllostegia racemosa*, of the mint family (Lamiaceae), is a climbing vine with many-branched, square stems and spicy-smelling leaves. Leaves are opposite, moderately covered with short, soft hairs, dotted with small glands, 3.4 to 6 centimeters (1.3 to 2.4 inches) long, and 1.4 to 4.3 centimeters (0.6 to 1.7 inches) wide, with shallow, rounded teeth. The leaf stalks are densely covered with short hairs. Flower clusters, densely covered with short, soft hairs, are comprised of 6 to 12 flowers with individual flower stalks 1 to 3 millimeters (0.04 to 0.12 inch) long and leaflike bracts. The green bell-shaped calyx is about 3.5 to 5 millimeters (0.1 to 0.2 inch) long, covered with glands, and has triangular lobes. The white corolla is two-lipped, with a tube about 7 to 10 millimeters (0.3 to 0.4 inch) long, upper lip 2 to 2.5 millimeters (0.08 to 0.1 inch) long, and lower lip 4 to 5 millimeters (0.16 to 0.2 inch) long. Fruits are divided into four nutlets about 1.5 to 2 millimeters (0.06 to 0.08 inch) long. This species is distinguished from others in this genus by its leaf shape, lack of a main stalk to the flower clusters, and calyx teeth that are rounded and shallow (Hillebrand 1888; Sherff 1935; Wagner et al. 1990). Bentham named *Phyllostegia racemosa* from a specimen collected by James Macrae on Mauna Kea, on the island of Hawaii, in 1830 (Sherff 1935).

#### Historic and Current Ranges and Population Status (Appendix J-8)

Historically, *Phyllostegia racemosa* was found in the Hakalau and Saddle Road



areas of Mauna Kea and the Kulani/Keauhou and Kipuka Ahiu areas of Mauna Loa (Clarke et al. 1983; HHP 1990a1, 1991a2, 1991e1–1991e4; Pratt and Cuddihy 1990; Sherff 1935, 1951; Jack Jeffrey, USFWS, in litt., 1993; Jaan Lepson, University of Hawaii [UH], in litt., 1990). Today, three populations of the species are known to occur on private and State lands in the Kulani/Keauhou area (3 individuals), on Federal land managed as the Hakalau Forest National Wildlife Refuge (32–42 individuals), and in Hawaii Volcanoes National Park (where the number of plants is unknown).

### Life History

No life history information for this species is currently available.

### Habitat Description

*Phyllostegia racemosa* is typically found epiphytically in disturbed koa, ohia, and hapuu dominated Montane Mesic or Wet Forests at elevations between 1,400 and 1,850 meters (4,650 to 6,070 feet). Associated taxa include *Vaccinium calycinum* (ohelo), *Rubus hawaiiensis* (akala), and *Dryopteris wallichiana* (Clarke et al. 1983; HHP 1991e1, 1991e4; HPCC 1991e; Wagner et al. 1990; J. Jeffrey, in litt., 1993).

### Reasons for Decline

The major threats to *Phyllostegia racemosa* are habitat disturbance by feral pigs and cattle; logging; competition from alien plant taxa, such as *Passiflora mollisma* (banana poka), kikuyu grass, *Anthoxanthum odoratum* (sweet vernalgrass), and *Paspalum urvillei* (Vasey grass); habitat change due to volcanic activity; and a risk of extinction from naturally occurring events and/or reduced reproductive vigor due to the small number of existing populations and individuals (Clarke et al. 1983; HHP 1991e1, 1991e4; HPCC 1991e; Pratt and Cuddihy 1990).

### Conservation Efforts

VRPF has 16 plants. NTBG has 2 plants and 300 seeds. Lyon Arboretum is currently propagating plants from tissue culture. Efforts are being made to fence the populations within the Kulani/Keauhou area through the Olaa-Kilauea Partnership. This partnership is comprised of personnel from the Hawaii State prison system, the National Park Service, BRD-USGS, the Service, DOFAW, and participating private landowners. IPIF, HDOA, and CPSU are working together,

developing a biocontrol program for banana poka. No additional species-specific conservation efforts have been undertaken. General conservation efforts for the Big Island II Plant Cluster taxa can be found in the Overall Conservation Efforts section of this addendum.

### Needed Recovery Actions

- 1) Construct fenced exclosures around the known populations, and initiate removal of feral ungulates and alien plant taxa.

Exclosures should be constructed to reduce impacts from feral pigs and cattle. Once they are fenced, ungulates and alien plants should be removed.

- 2) Outplant new populations in areas of reduced threat.

Attempts should be made to establish this species in Management Units 2 (Laupahoehoe/ Hakalau), 4 (Hawaii Volcanoes National Park) and, 5 (Kau Forest Reserve) (Figure 2), in sites free from impacts of ungulates and logging. Prior to and following outplanting, the sites' alien plants should be removed.

Additional recovery actions, as discussed in the Stepdown Narrative of the Recovery Plan for the Big Island Cluster, beginning on page 134, are also appropriate for this species.

### ***Phyllostegia velutina* (NCN) – Recovery Priority # 2**

#### Description and Taxonomy

Appendix I contains a line drawing of this taxon.

*Phyllostegia velutina*, of the mint family, is a climbing vine with dense, backward-pointing hairs on the leaves and square stems. The hairs are silky on the opposite, narrow, toothed leaves, which are 9.2 to 17.5 centimeters (3.6 to 6.9 inches) long and 2.5 to 5 centimeters (1 to 2 inches) wide. Six to 10 flowers are borne in an unbranched inflorescence with conspicuous leaflike bracts. The green bell-shaped calyx is 6 to 7 millimeters (0.2 to 0.3 inch) long, densely covered with upward-pointing hairs, and has triangular lobes. The white corolla is densely covered with upward-pointing hairs and is two-lipped, with a slightly curved tube about 12 millimeters (0.4 inch) long, upper lip 5 to 7 millimeters (0.2 to 0.3 inch) long, and lower lip 4 to 5 millimeters (0.1 to 0.2 inch) long. Fruits are divided

into four nutlets about 4 to 5 millimeters (0.1 to 0.2 inch) long. This species is distinguished from others in this genus by its silky hairs, lack of a main stalk to the flower clusters, and calyx teeth that are narrow and sharply pointed (Sherff 1935; Wagner et al. 1990). Based on a specimen collected on Mauna Kea by the U.S. Exploring Expedition in 1840, Sherff described a new variety of *Phyllostegia macrophylla*, variety *velutina*, named for its velvety leaves and stems (Sherff 1935). St. John (1987b) determined that this entity was sufficiently different to constitute a separate species, *Phyllostegia velutina*, which has been maintained in the current treatment of the genus (Wagner et al. 1990).

#### Historic and Current Ranges and Population Status (Appendix J-9)

Historically, *Phyllostegia velutina* was found on the southern slopes of Hualalai and the eastern, western, and southern slopes of Mauna Loa (Clarke et al. 1983; HHP 1991f1–1991f4; Sherff 1935; Wagner et al. 1990).

It is currently known from five locations. One extant population is known to occur on privately owned land near another population on State-owned Kulani Correctional Facility lands (Clarke et al. 1983; HHP 1991f1; HPCC 1990b, 1991f, 1992b; S. Bergfeld, in litt., 1995; M. Bruegmann, in litt., 1994; Jon Giffin, DOFAW, pers. comm., 1994). Approximately 3–6 plants are known from the population on private land. The population at Kulani Correctional Facility contains 5–10 small groups of plants with approximately 50–100 individuals (T. Rubenstein, BRD, pers. comm. 1997). A third population has been reported from the general area of Waiea Tract on State-owned land in South Kona, but the exact location and current status of this population are unknown (HHP 1991f2). The fourth location is in Puu Waawaa (S. Bergfeld, pers. comm. 1997). It is unknown how many plants occur at this location (S. Bergfeld, pers. comm. 1997). The fifth location is in a gully within the Honuaula Forest Reserve at about 1706 meters (5600 feet) elevation (C. Corn, DOFAW, pers. comm. 1998). There are fewer than 10 plants and the area is not fenced.

#### Life History

No life history information is currently available for this species.

### Habitat Description

*Phyllostegia velutina* typically grows in ohia- and koa-dominated Montane Mesic and Wet Forests at elevations between 1,490 and 1,800 meters (4,900 and 6,000 feet). Associated taxa include hapuus, *Cheirodendron trigynum* (olapa), ohelo, pilo, *Dryopteris wallichiana*, akala, mamaki, hoio, *Myrsine* sp. (kolea), and *Ilex anomala* (kawau) (Clarke et al. 1983; HHP 1991f1; HPCC 1990b, 1991f, 1992b; Wagner et al. 1990).

### Reasons for Decline

Threats to *Phyllostegia velutina* are habitat damage by cattle, feral pigs and sheep; prison facility expansion, road clearing, and logging; competition from alien plants, such as kikuyu grass, *Rubus ellipticus* (yellow Himalayan raspberry), Vasey grass, and fountain grass; fire; habitat change due to volcanic activity; and a risk of extinction from naturally occurring events and/or reduced reproductive vigor due to the small number of existing populations and individuals (HHP 1991f1; HPCC 1990b, 1991f, 1992b; M. Bruegmann, in litt., 1994).

### Conservation Efforts

VRPF has 282 plants. NTBG has 2 plants and 251 seeds. The Puu Waawaa population is fenced to exclude ungulates. Kulani Correctional Facility, through the Olaa-Kilauea Partnership, is fencing individual plants for short-term protection. Plans are being developed for larger fenced areas along with alien plant management. No additional species-specific conservation efforts have been undertaken. CPSU has made preliminary contacts for researchers to search for natural enemies of yellow Himalayan raspberry (M. Isherwood, Jr., pers. comm. 1997). General conservation efforts for the Big Island II Plant Cluster taxa can be found in the Overall Conservation Efforts section of this addendum.

### Needed Recovery Actions

- 1) Construct fenced exclosures around the known population on private property, and initiate removal of feral ungulates and alien plants. Without this protection, these plants will continue to decline due to degradation of habitat by feral ungulates. Once enclosed, removal of alien plant species like kikuyu grass, Himalayan raspberry, Vasey grass, and fountain grass should be initiated and a commitment should be developed for long-term stewardship and conservation of these areas.

2) Outplant new populations in area of reduced threat.

Attempts should be made to establish this species in Management Unit 9 (Puu Waawaa; Figure 2), in sites free from impacts of ungulates, road clearing, logging, and fire. Prior to and following outplanting, the site's alien plants should be removed.

3) Construct fenced enclosure around a small group of ~20 individuals at Kulani and remove feral pigs and cattle within the enclosure.

These plants are imminently threatened with extirpation due to habitat degradation and trampling by feral ungulates.

Additional recovery actions, as discussed in the Stepdown Narrative of the Recovery Plan for the Big Island Plant Cluster, beginning on page 134, are also appropriate for this species.

***Phyllostegia warshaueri* (NCN) – Recovery Priority # 5**

#### Description and Taxonomy

No line drawing is available for this taxon.

*Phyllostegia warshaueri*, of the mint family, is either a sprawling or climbing vine with end branches turning up, covered with upward-pointing fine, short hairs on the square stems which are about 1 to 3 meters (3.3 to 10 feet) long. The opposite, nearly hairless, toothed leaves are 9.5 to 20 centimeters (3.7 to 7.9 inches) long and 2 to 6.6 centimeters (0.8 to 2.6 inches) wide. Six to 14 flowers are borne in an unbranched inflorescence up to 20 centimeters (7.9 inches) long with a main stalk 25 to 40 millimeters (1.0 to 1.6 inches) long and conspicuous leaflike bracts. The green, hairless, cone-shaped calyx is 6 to 8 millimeters (0.2 to 0.3 inch) long and has triangular lobes. The corolla is white with a dark rose upper lip, sparsely hairy, and has a tube about 18 to 20 millimeters (0.7 to 0.8 inch) long, upper lip about 6 millimeters (0.2 inch) long, and lower lip 12 to 15 millimeters (0.5 to 0.6 inch) long. Fruits are divided into four nutlets about 6 to 7 millimeters (0.2 to 0.3 inch) long. This species is distinguished from others in this genus by its long main stalk to the flower clusters, toothed leaves, and the distribution of hairs (Sherff 1935, Wagner et al. 1990). *Phyllostegia ambigua* var.

*longipes* was first collected by J.M. Lydgate and named by Hillebrand (1888). The type locality was suggested to be “probably East Maui,” but this is assumed to be in error since Rock’s field notes indicate that he and Lydgate were in the Kohala Mountains at the time of that collection (Cuddihy 1982, Wagner et al. 1990). E.E. Sherff (1935) did not consider *Phyllostegia ambigua* different from *Phyllostegia brevidens*, and created the combination *Phyllostegia brevidens* var. *longipes*. Based on newly collected material, St. John considered this variety sufficiently different to warrant designation as the species *Phyllostegia warshaueri* (St John 1987b). The current treatment has maintained this species (Wagner et al. 1990).

#### Historic and Current Ranges and Population Status (Appendix J–10)

Historically, *Phyllostegia warshaueri* was found in the Hamakua region on the northern slopes of Mauna Kea and in the Kohala Mountains (Clarke et al. 1981; Cuddihy et al. 1982; HHP 1991g1–1991g3, 1993e). The only known individuals occur in four populations in the same regions— in Laupahoehoe; at the Waipunalei boundary and the NAR; at the Ookala Trail and near the Hamakua Ditch Trail in the Kohala Mountains. They occur on a combination of privately owned and State-owned land (HPCC 1992c; M. Bruegmann, in litt., 1994; D. Ragone and K. Wood, in litt., 1995). The total number of individuals is 5 to 10 (D. Ragone and K. Wood, in litt., 1995).

#### Life History

No life history information is currently available for this species.

#### Habitat Description

This species grows in ohia and hapuu Montane Wet Forest in which koa or olapa may codominate, at elevations between 730 and 1,150 meters (2,400 and 3,770 feet) (Clarke et al. 1981; Cuddihy et al. 1982; HHP 1991g1, 1991g2; HPCC 1992c; Wagner et al. 1990). Associated taxa include *Sadleria* sp. (amau), hapuu, *Broussaisia arguta* (kanawao), mamaki, *Dubautia plantaginea* (naenae), oha wai, hoio, *Machaerina angustifolia* (ukiuki), *Cyanea pilosa* (haha), and other species of *Cyanea* (HPCC 1992c).

### Reasons for Decline

The major threats to *Phyllostegia warshaueri* are habitat destruction by pigs; competition from alien plant taxa, such as thimbleberry, strawberry guava, *Setaria palmifolia* (palmgrass), *Juncus planifolius*, and *Tibouchina herbacea* (glorybush); ditch improvements and road clearing; and a risk of extinction from naturally occurring events and/or reduced reproductive vigor due to the small number of existing populations and individuals (HPCC 1992c; M. Bruegmann, in litt., 1994).

### Conservation Efforts

VRPF has 11 plants in their nursery. NTBG has 1 plant and 346 seeds. The Lyon Arboretum has 2 plants in their greenhouse. No additional species-specific conservation efforts have been undertaken. IPIF, HDOA, and CPSU are working together to develop a biocontrol program for glorybush. Also, IPIF is cooperating with CPSU to develop a biocontrol program for strawberry guava (M. Isherwood, Jr., pers. comm. 1997). General conservation efforts for the Big Island II Plant Cluster taxa can be found in the Overall Conservation Efforts section of this addendum.

### Needed Recovery Actions

- 1) Construct fenced exclosures on State lands in the Kohala Mountains and Laupahoehoe around the known populations, and initiate removal of feral ungulates and alien plants from its habitat.

Without this protection, this species will continue to decline due to habitat degradation by feral pigs. Once fencing is erected, those areas should undergo management to remove feral ungulates and alien plant species like thimbleberry, strawberry guava, palmgrass, *Juncus planifolius*, and glory bush.

- 2) Outplant new populations in areas of reduced threat.

Attempts should be made to establish this species in Management Units 1 (Kohala Mountains), and 2 (Laupahoehoe/ Hakalau) (Figure 2) in sites free from impacts of feral ungulates and construction activities like road clearing and ditch maintenance. The site's alien plants should be removed before and again after outplanting.

Additional recovery actions, as discussed in the Stepdown Narrative of the Recovery Plan for the Big Island Plant Cluster, beginning on page 134, are also appropriate for this species.

***Pleomele hawaiiensis* (hala pepe) – Recovery Priority # 2**

Description and Taxonomy

No line drawing is available for this taxon.

*Pleomele hawaiiensis*, of the agave family (Agavaceae), is a branching tree, 5 to 6 meters (16 to 20 feet) tall, with leaves spirally clustered at the tips of branches, leaving large brown leaf scars as they fall off. The leaves measure 23 to 38 centimeters (9 to 15 inches) long and 1.4 to 2.7 centimeters (0.6 to 1 inch) wide. Flowers are numerous in terminal clusters with a main stalk 6 to 13 centimeters (2 to 5 inches) long and individual flower stalks 5 to 12 millimeters (0.2 to 0.5 inch) long. The three sepals and three petals of the flower are similar and pale yellow, 33 to 43 millimeters (1.3 to 1.7 inches) long, with a constricted base. The fruit is a red berry about 10 to 13 millimeters (0.4 to 0.5 inch) long. This species differs from other Hawaiian species in this genus by its pale yellow flowers, the size of the flowers, the length of the constricted base of the flower, and the width of the leaves (Degener and Degener 1930; St. John 1985; Wagner et al. 1990). Otto and Isabelle Degener (1980) named *Pleomele hawaiiensis* from a specimen collected in 1977. Some experts considered this genus to be part of the larger genus *Dracaena*, but this combination is no longer used. St. John distinguished two separate species, *Pleomele haupukehuensis* and *P. konaensis*; however, the current treatment includes both in *Pleomele hawaiiensis* (Wagner et al. 1990).

Historic and Current Ranges and Population Status (Appendix J–11)

Historically, *Pleomele hawaiiensis* was found ranging from the Kohala mountains to Kau (Degener and Degener 1980; HHP 1991h1–1991h8, 1993f1–1993f4; HPCC 1991g, 1992d, 1993b; St. John 1985; Tunison et al. 1991; Wagner et al. 1990). Nine populations are currently known on Federal, State, and privately owned land: one in the Kohala mountains at Puu Kamoia (2 individuals); four from the Hualalai area with two populations in Puu Waawaa (200 individuals and 50–100 individuals), one population in Kaupulehu (no information available), and one population in Kaloko (11 individuals); two populations in the South Kona



area at Manuka (no information available) and Kahuku (11 individuals); and two populations in HVNP (no information on number of individuals for either population). These populations total 274–324 individuals (Char 1987; HHP 1991h1, 1991h2, 1991h4, 1991h5, 1993f3, 1993f4; HPCC 1991g, 1992d, 1993b; Nagata 1984; Nishida 1993; Tunison et al. 1991; M. Bruegmann, in litt., 1994, 1996; W. Char, in litt., 1995; Samuel Gon III, HHP, in litt., 1992; J. Lau, in litts., 1990, 1993; L. Pratt, in litt., 1994; W. Char, pers. comm., 1994; Clyde Imada, Bishop Museum, pers. comm., 1994). The only populations that are successfully reproducing are at Kaloko and Holei Pali in HVNP (M. Bruegmann, in litt., 1994). An additional population may exist along the western boundary of HVNP, but it has not been revisited recently (L. Pratt, in litt., 1995).

### Life History

No life history information is currently available for this species.

### Habitat Description

*Pleomele hawaiiensis* typically grows on open aa lava in diverse Lowland Dry Forests at elevations between 300 and 800 meters (1,000 and 2,700 feet) (HHP 1991h1, 1991h2, 1991h4, 1991h5, 1993f3, 1993f4; HPCC 1991g, 1992d, 1993b; Wagner et al. 1990; S. Gon, in litt., 1992; J. Lau, in litts., 1990, 1993). Associated taxa include ohia, lama, mamane, *Psydrax odorata* (alahee), huehue, naio, olopua, *Nototrichium sandwicense* (kului), *Sida fallax* (ilima), *Erythrina sandwicensis* (wiliwili), *Santalum* sp. (iliahi), *Osteomeles anthyllidifolia* (ulei), and fountain grass as a dominant ground cover, as well as four federally endangered species: *Caesalpinia kavaiensis* (uhiuhi), *Colubrina oppositifolia* (kauila), *Nothocestrum breviflorum* (aiea), *Neraudia ovata*, and other species of concern, including *Capparis sandwichiana* (pua pilo) and *Bidens micrantha* ssp. *ctenophylla* (kookoolau) (Char 1987; HHP 1991h2, 1991h4–1991h6; HPCC 1991g, 1992d, 1993b; M. Bruegmann, in litt., 1994; S. Gon, in litt., 1992; J. Lau, in litts., 1990 and 1993).

### Reasons for Decline and Current Threats

The major threats to *Pleomele hawaiiensis* are habitat conversion associated with residential and recreational development; habitat destruction by cattle, pigs, sheep, and goats; fire; competition from alien plant taxa, such as fountain grass, koa haole, Christmas berry, and lantana; habitat change due to volcanic activity; and

the lack of reproduction in all but two populations (Char 1987; HHP 1991h2, 1991h4, 1991h5; HPCC 1991g, 1992d, 1993b; Nagata 1984; M. Bruegmann, in litt., 1994; J. Lau, in litt., 1990; C. Imada, pers. comm., 1994).

### Conservation Efforts

In 1978, HVNP outplanted eight cuttings in two groups of four. The source for these cuttings is not known and none survived the outplanting (L. Pratt, pers. comm. 1997). HVNP has 28 plants in their facility and several seedlings. VRPF has 38 plants in their nursery. NTBAG has 1 plant and 829 seeds. The Lyon Arboretum is currently propagating individuals of this species from tissue culture and they have 3 plants. DOFAW has planted four additional plants within the Puu Waawaa Cabin enclosure and another five at the *Delissea* enclosure in Puu Waawaa on November 25, 1997 (L. Perry, pers. comm. 1997). No additional species-specific conservation efforts have been undertaken. General conservation efforts for the Big Island II Plant Cluster taxa can be found in the Overall Conservation Efforts section of this addendum.

### Needed Recovery Actions

- 1) Construct protective fencing around known populations and initiate removal of ungulates and alien plants.

Without this protection, this species will continue to decline due to degradation of habitat by ungulates. Once fencing is erected, those areas should undergo management to remove alien plant species. Because some of the populations are on privately owned land, a commitment should be developed for long-term stewardship and conservation of these areas once they have been enclosed.

- 2) Outplant new populations in areas of reduced threat.

Attempts should be made to establish this species in Management Units 1 (Kohala Mountains), 4 (Hawaii Volcanoes National Park), 6 (Manuka NAR), 9 (Puu Waawaa), and 10 (Kaloko Dry Forest) (Figure 2), in sites free from ungulates and the threat of fire. Prior to and following outplanting, the site's alien plants should be removed.

Additional recovery actions, as discussed in the Stepdown Narrative of the Recovery Plan for the Big Island Cluster, beginning on page 134, are also appropriate for this species.

## ***Pritchardia schattaueri* (loulu) – Recovery Priority # 5**

### Description and Taxonomy

No line drawing is available for this taxon.

*Pritchardia schattaueri*, of the palm family (Arecaceae), is a large palm 30 to 40 meters (100 to 130 feet) tall with a gray, longitudinally grooved trunk 30 centimeters (12 inches) in diameter. Leaves form a spherical crown and are sometimes persistent after death. Leaves are fan-shaped, glossy green with small brown scales on the lower surface, up to 3.6 meters (11.8 feet) long and 1.7 meters (5.6 feet) wide. Flowers are on two- to four-branched inflorescences with a main stalk 1.2 to 1.75 meters (3.9 to 5.7 feet) long and individual branches 1 to 1.4 meters (3.2 to 4.6 feet) long. The five inflorescence bracts are lance-shaped, the lowest one 60 centimeters (2 feet) long, and the uppermost one 20 to 30 centimeters (9 to 12 inches) long. The calyx is green, shading to yellow-green at the tip, three-toothed, 6 millimeters (0.2 inch) long, and 4 millimeters (0.1 inch) wide. Fruits are round or pear-shaped, black with brown spots when mature, 3 to 5 centimeters (1.2 to 2 inch) long, and 3 to 4 centimeters (1.2 to 1.6 inches) wide. This species differs from its closest relative, *Pritchardia beccariana*, by its slender inflorescence branches, more deeply divided leaves, and pendulous rather than stiff tips of the leaf blade segments (Hodel 1985, Read and Hodel 1990). Donald Hodel described *Pritchardia schattaueri* in 1985 based on a specimen collected from plants discovered by George Schattauer in 1957.

### Historic and Current Ranges and Population Status (Appendix J-12)

*Pritchardia schattaueri* is known from 12 individuals in three locations in South Kona, all on privately owned land. Ten individuals are known from a forest partially cleared for pasture in Hoomau. Two other individuals are found singly at the edge of a macadamia nut farm and in an area owned by a development company (HHP 1991i1–1991i3; HPCC 1992e1, 1992e2; Hodel 1980, 1985; M. Bruegmann, in litt., 1994; Donald Hodel, University of California, Los Angeles, in litt., 1995).

### Life History

No life history information is currently available for this species.

### Habitat Description

*Pritchardia schattaueri* grows in ohia-dominated Lowland Mesic Forest, at elevations between 600 and 800 meters (1,970 to 2,600 feet) (HHP 1991i1–1991i3; HPCC 1992e1, 1992e2; Hodel 1985; Read and Hodel 1990). Associated taxa include ohia, olopua, papala, hapuu, kolea, and *Pittosporum* sp. (hoawa) (HHP 1991i2; HPCC 1992e1; M. Bruegmann, in litt., 1994).

### Reasons for Decline and Current Threats

The major threats to *Pritchardia schattaueri* are grazing and trampling by cattle and feral pigs; competition from alien plant taxa, such as strawberry guava, common guava, kikuyu grass, Christmas berry, and thimbleberry; seed predation by rats; residential and commercial development; habitat change due to volcanic activity; and a risk of extinction from naturally occurring events and/or reduced reproductive vigor due to the small number of existing populations and individuals and the lack of successful regeneration (HHP 1991i1–1991i3; HPCC 1992e1, 1992e2; Hodel 1980, 1985; M. Bruegmann, in litt., 1994). Lethal yellowing, a disease particular to palms, represents a potential threat if the disease ever reaches Hawaii. *Pritchardia* palms cultivated outside of Hawaii have proven highly vulnerable to this disease.

### Conservation Efforts

VRPF has 5 plants, with 2 of them in their greenhouse. The NTBG has 1 plant. The Lyon Arboretum has 2 plants. WFP has 6 plants at their facility. Approximately 66 seedlings were planted by DOFAW near the macadamia farm in Honomalino in June of 1993 (S. Bergfeld, pers. comm. 1997). DOFAW maintains nine exclosures that contain a total of over 50 individuals from the 1993 outplanting. There is another exclosure at the Kiolakaa Forestry Cabin on State land near South Point that currently contains six individuals (L. Perry, pers. comm. 1997). No additional species-specific conservation efforts have been undertaken. IPIF is cooperating with CPSU to develop a biocontrol program for strawberry guava (M. Isherwood, Jr., pers. comm. 1997). General conservation efforts for the Big Island II Plant Cluster taxa can be found in the Overall Conservation Efforts section of this addendum.

### Needed Recovery Actions

- 1) Construct protective fencing around known populations, and initiate removal of ungulates and alien plants from its habitat.

Without this protection, this species will continue to decline due to degradation of habitat by cattle and feral pigs. Once fencing is erected, those areas should undergo management to remove alien plant species and a commitment should be developed for long-term stewardship and conservation.

- 2) Reduce threats from rodent predation.

A management plan to control rats should be developed. This should include the use of the currently approved Diphacinone bait blocks and ultimately a more broad-scale method such as aerial dispersal of rodenticide.

- 3) Outplant new populations in areas of reduced threat.

Attempts should be made to establish this species in Management Unit 7 (Kipahoe/ South Kona, Figure 2) in sites free from impacts of ungulates, rats, and future residential and commercial development. Prior to and following outplanting, the site's alien plants should be removed.

Additional recovery actions, as discussed in the Stepdown Narrative of the Recovery Plan, beginning on page 134, are also appropriate for this species.

### ***Sicyos alba* (anunu) – Recovery Priority # 2**

#### Description and Taxonomy

Appendix I contains a line drawing of this taxon.

*Sicyos alba*, of the gourd family (Cucurbitaceae), is an annual vine up to 20 meters (65 feet) long, minutely hairy, and black-spotted. Leaves are pale, broadly heart-shaped, shallowly to deeply three- to five-lobed, 7 to 11 centimeters (2.8 to 4.3 inches) long, and 9 to 12 centimeters (3.5 to 4.7 inches) wide. Male and female flowers are borne in separate flower clusters on the same plant. Male flower clusters have main stalks 2.5 to 3.7 centimeters (1 to 1.5 inch) long and individual flower stalks 2 to 4 millimeters (0.08 to 0.1 inch) long. The male flowers are white, five-lobed, dotted with glands, and 2 to 2.5 millimeters (0.08 to 0.09 inch) long. The female flower clusters have two to eight flowers, a main

stalk 1 to 3.5 centimeters (0.4 to 1.4 inches) long, and no stalks on the individual flowers. The flowers are white and four-lobed, with the lobes 1.7 to 2 millimeters (0.07 to 0.08 inch) long. The fruit is white, fleshy, oblong, 29 to 32 millimeters (1.1 to 1.3 inches) long, and 10 to 11 millimeters (about 0.4 inch) wide. This species can be distinguished from its nearest relative, *Sicyos cucumerinus*, by its white fruit without bristles and ten or fewer female flowers per cluster (St. John 1978; Telford 1990). First collected by the U.S. Exploring Expedition of 1840 and 1841, and considered a new but unnamed variety of *Sicyos cucumerinus* by Gray in 1854, *Sarx alba* was named by St. John in 1978, creating *Sarx* as a new genus (St. John 1978). Ian Telford (1989) returned this entity to the genus *Sicyos*, as *Sicyos alba*.

#### Historic and Current Ranges and Population Status (Appendix J-13)

Historically, *Sicyos alba* was found in the Kilauea area (HHP 1991j1–1991j4; St. John 1978). Today, the two known populations are restricted to Puu Makaala NAR and Olaa Forest Reserve, both on State-owned land in the Puna District (HHP 1991ji; HPPC 1991h, 1993c). The number of individuals fluctuates from year to year because this species is an annual. At last report, only one individual was growing at Puu Makaala NAR, but about 20 individuals are known from the Olaa population (HPCC 1993c; M. Brueggemann, in litt., 1994; Steve Perlman, NTBG, pers. comm. 1994). A *Sicyos* collected in HVNP's Olaa Tract may also be this species, but the identification is unconfirmed at this time (L. Pratt, in litt., 1995).

#### Life History

No life history information is currently available for this species.

#### Habitat Description

*Sicyos alba* typically grows in ohia- and hapuu-dominated Montane Wet Forests, at elevations between 975 and 1,130 meters (3,200 to 3,720 feet). Associated taxa include hapuu, kawau, kanawao, haiwale, *Stenogyne* sp., kopiko, *Perrottetia sandwicensis* (olomea), olapa, hoio, and *Cyanea tritomantha* (haha) (HHP 1991j1; HPCC 1991h, 1993c; Telford 1990; M. Brueggemann, in litt., 1994).

### Reasons for Decline

The major threats to *Sicyos alba* are habitat damage by feral pigs; trail clearing; competition from alien plant taxa, such as banana poka, palmgrass, strawberry guava, and yellow Himalayan raspberry; habitat change due to volcanic activity; and a risk of extinction from naturally occurring events and/or reduced reproductive vigor due to the small number of existing individuals (HHP 1991j1; HPCC 1991h, 1993c).

### Conservation Efforts

NTBG has 9 seeds. No additional species-specific conservation efforts have been undertaken. IPIF, HDOA, and CPSU are working together to develop a biocontrol program for glorybush. Also, IPIF is cooperating with CPSU to develop a biocontrol program for strawberry guava. CPSU has made preliminary contacts for researchers to search for natural enemies of yellow Himalayan raspberry (M. Isherwood, Jr., pers. comm. 1997). General conservation efforts for the Big Island II Plant Cluster taxa can be found in the Overall Conservation Efforts section of this addendum.

### Needed Recovery Actions

- 1) Construct protective fencing around known populations, and initiate removal of ungulates and alien plants from its habitat.

Without this protection, this species will continue to decline due to degradation of habitat by feral pigs. Once fencing is erected, those areas should undergo management to remove alien plant species.

- 2) Outplant new populations in areas of reduced threat.

Attempts should be made to establish this species in Management Unit 3 (Puu Makaala NAR, Figure 2) in sites free from impacts of ungulates and trail clearing. Prior to and following outplanting, the site's alien plants should be removed.

Additional recovery actions, as discussed in the Stepdown Narrative of the Recovery Plan, beginning on page 134, are also appropriate for this species.

*Zanthoxylum dipetalum* var. *tomentosum* (ae) – Recovery Priority # 6

Description and Taxonomy

No line drawing is available for this taxon.

*Zanthoxylum dipetalum* var. *tomentosum*, of the citrus family, is a thornless tree 4 to 15 meters (13 to 50 feet) tall with a trunk up to 30 centimeters (12 inches) in diameter. It has alternate leaves comprised of three to seven leathery, elliptical, gland-dotted, smooth-edged leaflets usually 6 to 36 centimeters (2.4 to 12 inches) long and 2.5 to 13.5 centimeters (1 to 5.3 inches) wide. The undersurface of the leaflets is densely covered with fine, short hairs, and the lowest pair of leaflets is often strongly reduced. The stalks of the side leaflets have one joint each, and the stalk of the terminal leaflet has two joints.

Flowers are usually either male or female, and usually only one sex is found on a single tree. Clusters of 5 to 15 flowers, 9 to 18 millimeters (0.4 to 0.7 inch) long, have a main flower stalk 10 to 40 millimeters (0.4 to 1.6 inches) long and individual flower stalks 3 to 8 millimeters (0.1 to 0.3 inch) long. Each flower has four broadly triangular sepals about 1 to 1.5 millimeters (0.04 to 0.06 inch) long and two or four yellowish-white petals, sometimes tinged with red, 6 to 10 millimeters (0.2 to 0.4 inch) long. The fruit is an oval follicle (dry fruit that opens along one side) 15 to 33 millimeters (0.6 to 1.3 inches) long, containing one black seed about 10 to 26 millimeters (0.4 to 1 inch) long. This variety is distinguished from *Zanthoxylum dipetalum* var. *dipetalum* by the hairs on the undersurface of the leaflets. It is distinguished from other Hawaiian species of the genus by its reduced lower leaflets, the presence of only one joint on some of the leaflet stalks, and the large seeds (Rock 1913, Stone et al. 1990).

Horace Mann described *Zanthoxylum dipetalum* in 1867, and Rock named a new variety *Zanthoxylum dipetalum* var. *tomentosum*, based on a specimen he collected at Puu Waawaa on Hualalai in 1909 (Rock 1913). The specific epithet refers to the dense covering of soft hairs on the undersurface of the leaflets. Some authors have placed Hawaiian taxa in the genus *Fagara*, resulting in the name *Fagara dipetala* var. *tomentosa*. However, *Zanthoxylum dipetalum* var. *tomentosum* is maintained in the current treatment of the Hawaiian species (Stone et al. 1990).



### Historic and Current Ranges and Population Status (Appendix J-14)

Only one population of *Zanthoxylum dipetalum* var. *tomentosum* has ever been known, located at Puu Waawaa on Hualalai, on State-owned land. Approximately 24 individuals are now known, scattered through this area (Rock 1913; Stone et al. 1990; HHP 1993g; HPCC 1991i, 1993d; M. Bruegmann, in litt., 1994; J. Giffin, in litt., 1992; J. Lau, in litt., 1992).

### Life History

No life history information is currently available for this species.

### Habitat Description

*Zanthoxylum dipetalum* var. *tomentosum* grows in degraded ohia-dominated Montane Mesic Forest, often on aa lava, at elevations between 915 and 1,040 meters (3,000 and 3,400 feet) (M. Bruegmann, in litt., 1994). Associated species include mamane, lama, alaa, iliahi, ohe, kolea, and kopiko (HHP 1993g; HPCC 1993d).

### Reasons for Decline

Threats to *Zanthoxylum dipetalum* var. *tomentosum* include browsing, trampling, and habitat disturbance by cattle, feral pigs, and feral sheep; competition from alien plant species, such as kikuyu grass, fountain grass, lantana, koa haole, and *Grevillea robusta* (silk oak); habitat change due to volcanic activity; and fire (HHP 1993g; HPCC 1993d; M. Bruegmann, in litt., 1994; J. Lau, in litt., 1992). The species is also at risk of extinction from naturally occurring events and/or reduced reproductive vigor due to the small number of existing individuals in only one population.

### Conservation Efforts

DOFAW has outplanted approximately 20 individuals onto State-owned land in the Puu Waawaa area (J.Giffin, DOFAW, pers. comm. 1997). It is not known when this outplanting occurred. The plants are not fenced and this land is currently under a pasture lease. No other species-specific conservation efforts have been undertaken. General conservation efforts for the Big Island II Plant Cluster taxa can be found in the Overall Conservation Efforts section of this addendum.

### Needed Recovery Actions

- 1) Construct protective fencing around known populations, and initiate removal of ungulates and alien plants from its habitat.

Fencing should be focused on the vulnerable outplanted population first. Without this protection, this population will decline due to trampling and browsing by ungulates. Once fencing is erected, the areas should undergo management to remove alien plant species.

- 2) Outplant new populations in areas of reduced threat.

Attempts should be made to establish this species in Management Unit 9 (Puu Waawaa; Figure 2), in sites free from the impacts of ungulates and fire. Prior to and following outplanting, the site's alien plants should be removed.

Additional recovery actions, as discussed in the Stepdown Narrative of the Recovery Plan, beginning on page 134, are also appropriate for this species.

### 6. Overall Recovery Strategy

See pages 114–116 of the Recovery Plan for the Big Island Plant Cluster (Service 1996b). To ultimately recover the listed plant taxa in Hawaii, habitat must be protected and managed for natural expansion of the current populations, as well as reintroduction of these taxa into portions of former range. Habitats essential for the recovery of listed species in Hawaii will be published by the Service in the Recovery Plan for Multi-Island Plants. Maps showing these habitat areas may be used by land owners and managers to identify priority areas for management and restoration and for wide-range planning purposes.

## II. RECOVERY

### **1. Objectives**

See pages 117–118 of the Recovery Plan for the Big Island Plant Cluster (Service 1996b) for a general overview of the recovery objectives for these taxa and definitions of endangered and threatened species and populations.

The interim objective is to stabilize all existing populations of the Big Island II taxa. To be considered stable, each taxon must be managed to control threats (e.g., fenced) and be represented in an *ex situ* (such as a nursery or arboretum) collection. In addition, a minimum total of three populations of each taxon should be documented on the Big Island. Each of these populations must be naturally reproducing and increasing in number, with a minimum of 25 mature individuals per population for long-lived perennials (*Hibiscadelphus giffardianus*, *Hibiscadelphus hualalaiensis*, *Melicope zahlbruckneri*, *Pritchardia schattaueri*, and *Zanthoxylum dipetalum* var. *tomentosum*), a minimum of 50 mature individuals per population for short-lived perennials (*Clermontia drepanomorpha*, *Cyanea platyphylla*, *Neraudia ovata*, *Phyllostegia racemosa*, *Phyllostegia velutina*, *Phyllostegia warshaueri*, and *Pleomele hawaiiensis*), and a minimum of 100 mature individuals per population for *Sicyos alba*, an annual (Table 16).

For downlisting, a total of five to seven populations of each taxon should be documented on the Big Island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats for 5 years, with a minimum of 100 mature individuals per population for long-lived perennials, a minimum of 300 mature individuals per population for short-lived perennials, and a minimum of 500 mature individuals for the annual taxon.

For delisting, a total of 8 to 10 populations of each taxon should be documented on the Big Island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, a minimum of 300 mature individuals per population for short-lived perennials, and a minimum of 500 mature individuals for the annual

taxon. Each population should persist at this level for a minimum of 5 consecutive years.

Because we have no knowledge of the life history of these taxa with respect to specific requirements for their short-term and long-term survival, only tentative criteria for stabilizing, downlisting and delisting are established here. These criteria were formulated based on recommendations by the Hawaii and Pacific Plants Recovery Coordinating Committee, as well as the International Union for Conservation of Nature and Natural Resources' (IUCN's) draft red list categories (Version 2.2) and the advice and recommendations of various biologists and knowledgeable individuals.

Additional information is needed about each of the Big Island II Plant Cluster species so that more meaningful recovery criteria can be quantified.

TABLE 4. Current status, recovery objectives, and needed actions for the Big Island II Plant Cluster

Species/Status	Interim	Downlisting	Delisting
<p><i>Clermontia drepanomorpha</i></p> <p><u>Current status</u> 6 populations ~237-292 plants</p>	<p>Objective</p> <p>3 populations 50 mature plants each 150 total mature plants</p> <p>Needed Increases</p> <p>Increase total plants in existing populations</p>	<p>Objective</p> <p>5-7 populations At least 300 mature plants each Sustained for 5 years</p> <p>Needed Increases</p> <p>Increase total plants in existing populations</p>	<p>Objective</p> <p>8-10 populations At least 300 mature plants each Sustained for 5 years</p> <p>Needed Increases</p> <p>Establish 2-4 populations Increase total plants</p>
<p><i>Cyanea platyphylla</i></p> <p><u>Current status</u> 2 natural populations 1 outplanted population ~ 21 plants</p>	<p>Objective</p> <p>3 populations 50 mature plants each 150 total mature plants</p> <p>Needed Increases</p> <p>Increase total plants</p>	<p>Objective</p> <p>5-7 populations At least 300 mature plants each Sustained for 5 years</p> <p>Needed Increases</p> <p>Establish 2-4 populations Increase total plants</p>	<p>Objective</p> <p>8-10 populations At least 300 mature plants each Sustained for 5 years</p> <p>Needed Increases</p> <p>Establish 5-7 populations Increase total plants</p>
<p><i>Hibiscadelphus giffardianus</i></p> <p><u>Current status</u> 1 outplanted population 9 individuals</p>	<p>Objective</p> <p>3 populations 25 mature plants each 75 total mature plants</p> <p>Needed Increases</p> <p>Establish 2 populations Increase total plants</p>	<p>Objective</p> <p>5-7 populations At least 100 mature plants each Sustained for 5 years</p> <p>Needed Increases</p> <p>Establish 4-6 populations Increase total plants</p>	<p>Objective</p> <p>8-10 populations At least 100 mature plants each Sustained for 5 years</p> <p>Needed Increases</p> <p>Establish 7-9 populations Increase total plants</p>

Species/Status	Interim	Downlisting	Delisting
<p><i>Hibiscadelphus hualalaiensis</i>  <u>Current status</u>            3 outplanted populations            30 plants</p>	<p>Objectives            3 populations            25 mature plants each            75 total mature plants            Needed Increases            Increase total plants</p>	<p>Objectives            5-7 populations            At least 100 mature plants each            Sustained for 5 years            Needed Increases            Establish 2-4 populations            Increase total plants</p>	<p>Objectives            8-10 populations            At least 100 mature plants each            Sustained for 5 years            Needed Increases            Establish 5-7 populations            Increase total plants</p>
<p><i>Melicope zahlbruckneri</i>  <u>Current status</u>            2 populations            ~30-35 plants</p>	<p>Objectives            3 populations            25 mature plants each            75 total mature plants            Needed Increases            Establish 1 population            Increase total plants</p>	<p>Objectives            5-7 populations            At least 100 mature plants each            Sustained for 5 years            Needed Increases            Establish 3-5 populations            Increase total plants</p>	<p>Objectives            8-10 populations            At least 100 mature plants each            Sustained for 5 years            Needed Increases            Establish 6-8 populations            Increase total plants</p>
<p><i>Neraudia ovata</i>  <u>Current status</u>            3 populations            ~11 plants</p>	<p>Objectives            3 populations            50 mature plants each            150 total mature plants            Needed Increases            Increase total plants</p>	<p>Objectives            5-7 populations            At least 300 mature plants each            Sustained for 5 years            Needed Increases            Establish 2-4 populations            Increase total plants</p>	<p>Objectives            8-10 populations            At least 300 mature plants each            Sustained for 5 years            Needed Increases            Establish 5-7 populations            Increase total plants</p>

Species/Status	Interim	Downlisting	Delisting
<p><i>Phyllostegia racemosa</i></p> <p><u>Current status</u> 3 populations ~32-42 plants</p>	<p>Objectives 3 populations 50 mature plants each 150 total mature plants</p> <p>Needed Increases Increase total plants</p>	<p>Objectives 5-7 populations At least 300 mature plants each Sustained for 5 years</p> <p>Needed Increases Establish 2-4 populations Increase total plants</p>	<p>Objectives 8-10 populations At least 300 mature plants each Sustained for 5 years</p> <p>Needed Increases Establish 5-7 populations Increase total plants</p>
<p><i>Phyllostegia velutina</i></p> <p><u>Current status</u> 5 populations 63-116 plants</p>	<p>Objectives 3 populations 50 mature plants each 150 total mature plants</p> <p>Needed Increases Increase total plants</p>	<p>Objectives 5-7 populations At least 300 mature plants each Sustained for 5 years</p> <p>Needed Increases Establish 0-2 populations Increase total plants</p>	<p>Objectives 8-10 populations At least 300 mature plants each Sustained for 5 years</p> <p>Needed Increases Establish 3-5 populations Increase total plants</p>
<p><i>Phyllostegia warshaueri</i></p> <p><u>Current status</u> 4 populations 5-10 plants</p>	<p>Objectives 3 populations 50 mature plants each 150 total mature plants</p> <p>Needed Increases Increase total plants</p>	<p>Objectives 5-7 populations At least 300 mature plants each Sustained for 5 years</p> <p>Needed Increases Establish 1-3 populations Increase total plants</p>	<p>Objectives 8-10 populations At least 300 mature plants each Sustained for 5 years</p> <p>Needed Increases Establish 4-6 populations Increase total plants</p>

<b>Species/Status</b>	<b>Interim</b>	<b>Downlisting</b>	<b>Delisting</b>
<i>Pleomele hawaiiensis</i> <u>Current status</u> 9 populations 274-324 plants	Objectives 3 populations 50 mature plants each 150 total mature plants Needed Increases Increase total plants	Objectives 5-7 populations At least 300 mature plants each Sustained for 5 years Needed Increases Increase total plants	Objectives 8-10 populations At least 300 mature plants each Sustained for 5 years Needed Increases Increase total plants
<i>Pritchardia schattaueri</i> <u>Current status</u> 3 natural populations 2 outplanted populations 68 plants	Objectives 3 populations 25 mature plants each 75 total mature plants Needed Increases Maintain current number of plants	Objectives 5-7 populations At least 100 mature plants each Sustained for 5 years Needed Increases Establish 0-2 populations Increase total plants	Objectives 8-10 populations At least 100 mature plants each Sustained for 5 years Needed Increases Establish 3-5 populations Increase total plants
<i>Sicyos alba</i> <u>Current status</u> 2 populations ~ 21 plants	Objectives 3 populations 100 mature plants each 300 total mature plants Needed Increases Establish 1 population Increase total plants	Objectives 5-7 populations At least 500 mature plants each Sustained for 5 years Needed Increases Establish 3-5 populations Increase total plants	Objectives 8-10 populations At least 500 mature plants each Sustained for 5 years Needed Increases Establish 6-8 populations Increase total plants



Species/Status	Interim	Downlisting	Delisting
<p><i>Zanthoxylum dipetalum</i> var. <i>tomentosum</i></p> <p><u>Current status</u> 1 natural population 1 outplanted population 44 plants</p>	<p>Objectives 3 populations 25 mature plants each 75 total mature plants</p> <p>Needed Increases Establish 1 population Increase total plants</p>	<p>Objectives 5-7 populations At least 100 mature plants each Sustained for 5 years</p> <p>Needed Increases Establish 1-3 populations Increase total plants</p>	<p>Objectives 8-10 populations At least 100 mature plants each Sustained for 5 years</p> <p>Needed Increases Establish 6-8 populations Increase total plants</p>

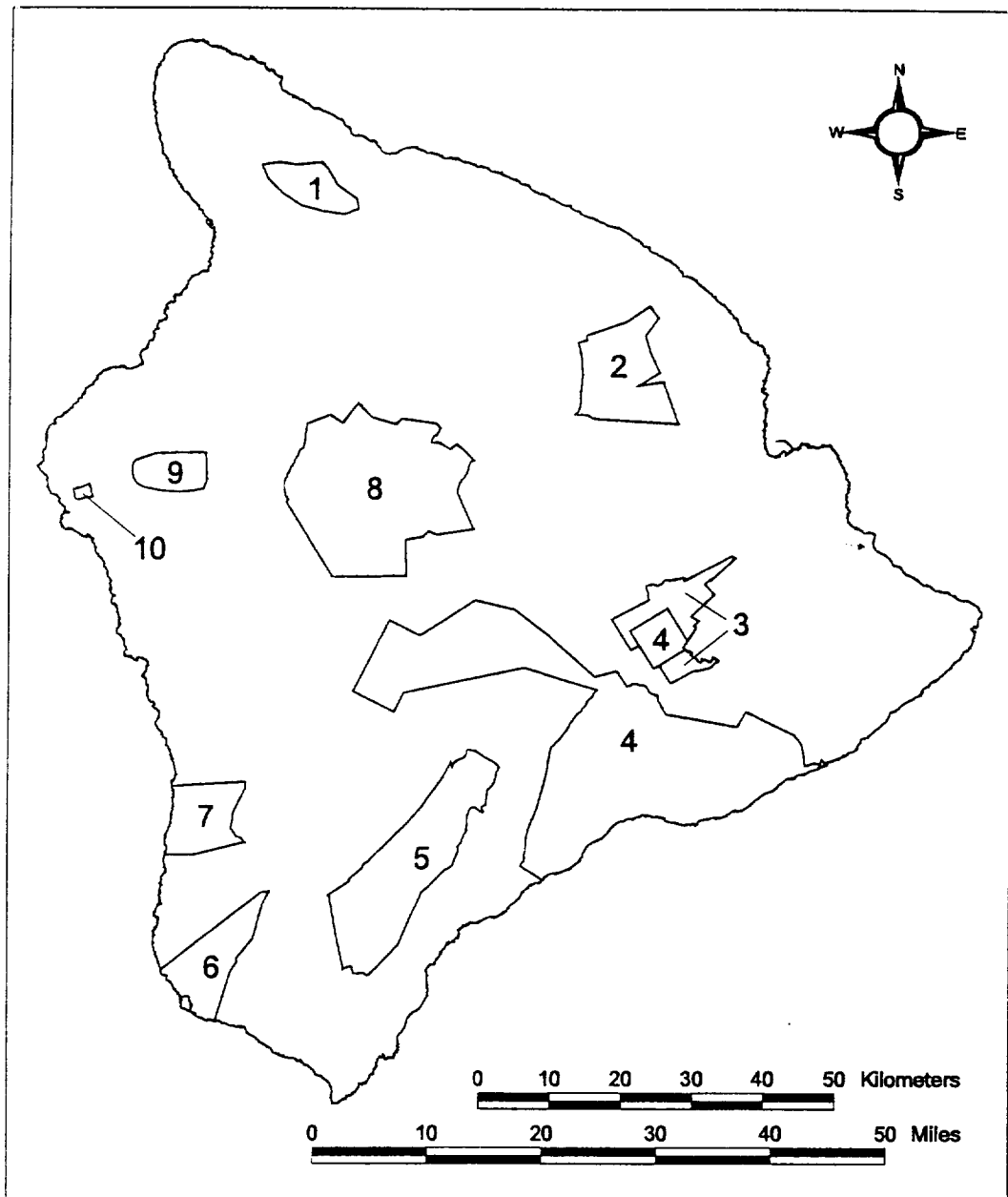


Figure 2: Location of potential areas on the island of Hawaii for consideration as management units for the Hawaii Plant Cluster recovery plan: 1) Kohala Mountains; 2) Laupahoehoe Natural Area Reserve/Hakalau National Wildlife Refuge; 3) Puu Makaala Natural Area Reserve; 4) Hawaii Volcanoes National Park; 5) Kau Forest Reserve; 6) Manuka Natural Area Reserve; 7) Kipahoehoe Natural Area Reserve/South Kona Forest Reserve; 8) Pohakula Training Area; 9) Puu Waawaa Wildlife Sanctuary/Hualalai; and 10) Kaloko Dry Forest

## **2. Stepdown Outline**

See pages 131-133 of the Recovery Plan for the Big Island Plant Cluster.

## **3. Stepdown Narrative**

The Stepdown Narrative beginning on page 134 of the Recovery Plan for the Big Island Plant Cluster is applicable to the Big Island II Plant Cluster taxa.

The Big Island II Plant Cluster taxa should be added to the following management units. These management units are described in detail on pages 135-137 of the Recovery Plan.

### **1. Kohala Mountains**

Although the Recovery Plan for the Big Island Plant Cluster has this management unit listed as the Kohala Mountain Bogs, it should be widened to include much of the Kohala Forest Reserve. The following taxa from the Big Island II Plant Cluster occur or have occurred in this area: *Clermontia drepanomorpha*, *Cyanea platyphylla*, *Phyllostegia warshaueri*, and *Pleomele hawaiiensis*.

### **2. Laupahoehoe Natural Area Reserve/ Hakalau National Wildlife Refuge.**

The following taxa from the Big Island II Plant Cluster occur or have occurred in these areas: *Cyanea platyphylla*, *Melicope zahlbruckneri*, *Phyllostegia racemosa*, and *Phyllostegia warshaueri*.

### **3. Puu Makaala Natural Area Reserve.**

The following taxon from the Big Island II Plant Cluster occurs or has occurred in this area: *Sicyos alba*.

### **4. Hawaii Volcanoes National Park (HVNP).**

The following taxa from the Big Island II Plant Cluster occur or have occurred in this area: *Hibiscadelphus giffardianus*, *Neraudia ovata*, *Phyllostegia racemosa*, and *Pleomele hawaiiensis*.

### **5. Kau Forest Reserve.**

The following taxa from the Big Island II Plant Cluster occur or have occurred in this area: *Melicope zahlbruckneri* and *Phyllostegia racemosa*.

**6. Manuka Natural Area Reserve.**

The following taxon from the Big Island II Plant Cluster occurs or has occurred in this area: *Pleomele hawaiiensis*.

**7. Kipahoe Natural Area Reserve/ South Kona Forest Reserve.**

The following taxon from the Big Island II Plant Cluster occur or has occurred in this area: *Pritchardia schattaueri*.

**8. Pohakuloa Training Area (PTA).**

The following taxon from the Big Island II Plant Cluster occurs or has occurred in this area: *Neraudia ovata*.

**9. Puu Waawaa Wildlife Sanctuary/ Hualalai.**

The following taxa from the Big Island II Plant Cluster occur or have occurred in these areas: *Hibiscadelphus hualalaiensis*, *Phyllostegia velutina*, *Pleomele hawaiiensis*, and *Zanthoxylum dipetalum* var. *tomentosum*.

**10. Kaloko Dry Forest**

Though less than 300 acres in size and at very low elevation and rainfall, the Kaloko dry forest (Figure 2) represents some of the best remaining dry forest outside of Pohakuloa Training Area. This management unit was added because it is one of the few remaining parcels of dry forest that has not been overrun by fountain grass and it appears to have escaped from any ungulate pressures, due to the rough nature of the aa substrate. These conditions may allow for successful outplanting for some taxa found in the Big Island II Plant Cluster. The following taxa in the Big Island II Plant Cluster are found within this area: *Neraudia ovata*, and *Pleomele hawaiiensis*.

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### III. IMPLEMENTATION SCHEDULE

All agencies, landowners and land managers with responsibilities for plant species in the Big Island II Addendum were identified in the implementation schedule for the Big Island Plant Cluster Recovery Plan. Many of these taxa occur in the same general areas, they suffer from the same threats, and require the same recovery efforts.

The Implementation Schedule that follows outlines actions and estimated cost for the recovery program for the Big Island Plant Cluster and the Big Island II Plant Cluster, as set forth in the recovery plan and this addendum. It is a guide for meeting the objectives discussed in Part II of the Recovery Plan for the Big Island Plant Cluster. This schedule indicates task priority, task numbers, task descriptions, duration of tasks, the entities responsible for committing funds, and lastly, estimated costs. The entities responsible for committing funds are not, necessarily, the entities that will actually carry out the tasks. When more than one entity is listed as the responsible party, an asterisk is used to identify the lead entity.

The actions identified in the implementation schedule, when accomplished, should protect habitat for the species, stabilize the existing populations and increase the population sizes and numbers. Monetary needs for all parties involved are identified to reach this point, wherever feasible.

Priorities in Column 1 of the following implementation schedule are assigned as follows:

- Priority 1 — An action that must be taken to prevent extinction to prevent the species from declining irreversibly.
- Priority 2 — An action that must be taken to prevent a significant decline in species population or habitat quality, or some other significant negative impact short of extinction.
- Priority 3 — All other actions necessary to provide for full recovery of the species.

## Key to Acronyms Used in Implementation Schedule

BOT	—	Various Botanical Gardens (e.g., National Tropical Botanical Garden, Lyon Arboretum, Waimea Botanical Garden, etc.)
BRD	—	Biological Resources Division, U.S. Geological Survey
DLNR	—	Hawaii Department of Land and Natural Resources
DOD	—	U.S. Department of Defense
HDOA	—	Hawaii Department of Agriculture
LE	—	Law Enforcement
NPS	—	National Park Service
O	—	Task is ongoing
PIE	—	U.S. Fish & Wildlife Service, Pacific Islands Ecoregion, Honolulu, Hawaii
PL	—	Various private landowners
TBD	—	Funding or timing of the task has not been determined
TNCH	—	The Nature Conservancy of Hawaii

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**TNC Preserves**

Ms. Heather Cole  
The Nature Conservancy of Hawaii  
P.O. Box 2188  
Kamuela, HI 96743

**Appropriate Landowners/Managers**

Trustees  
Kamehameha Schools Bishop Estate  
P.O. Box 3466  
Honolulu, HI 96801

Department of Hawaiian Home Lands  
P.O. Box 1879  
Honolulu, HI 96805

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(\*) Persons and Agencies who provided information necessary for the development of the Plan.

(\*\*) Persons and Agencies who provided comments on the Draft Plan.

## APPENDIX I - LINE DRAWINGS OF PLANTS

No line drawings were available for the following species:

*Cyanea platyphylla*

*Hibiscadelphus giffardianus*

*Melicope zahlbruckneri*

*Phyllostegia warshaueri*

*Pleomele hawaiiensis*

*Pritchardia schattaueri*

*Zanthoxylum dipetalum* var. *tomentosum*



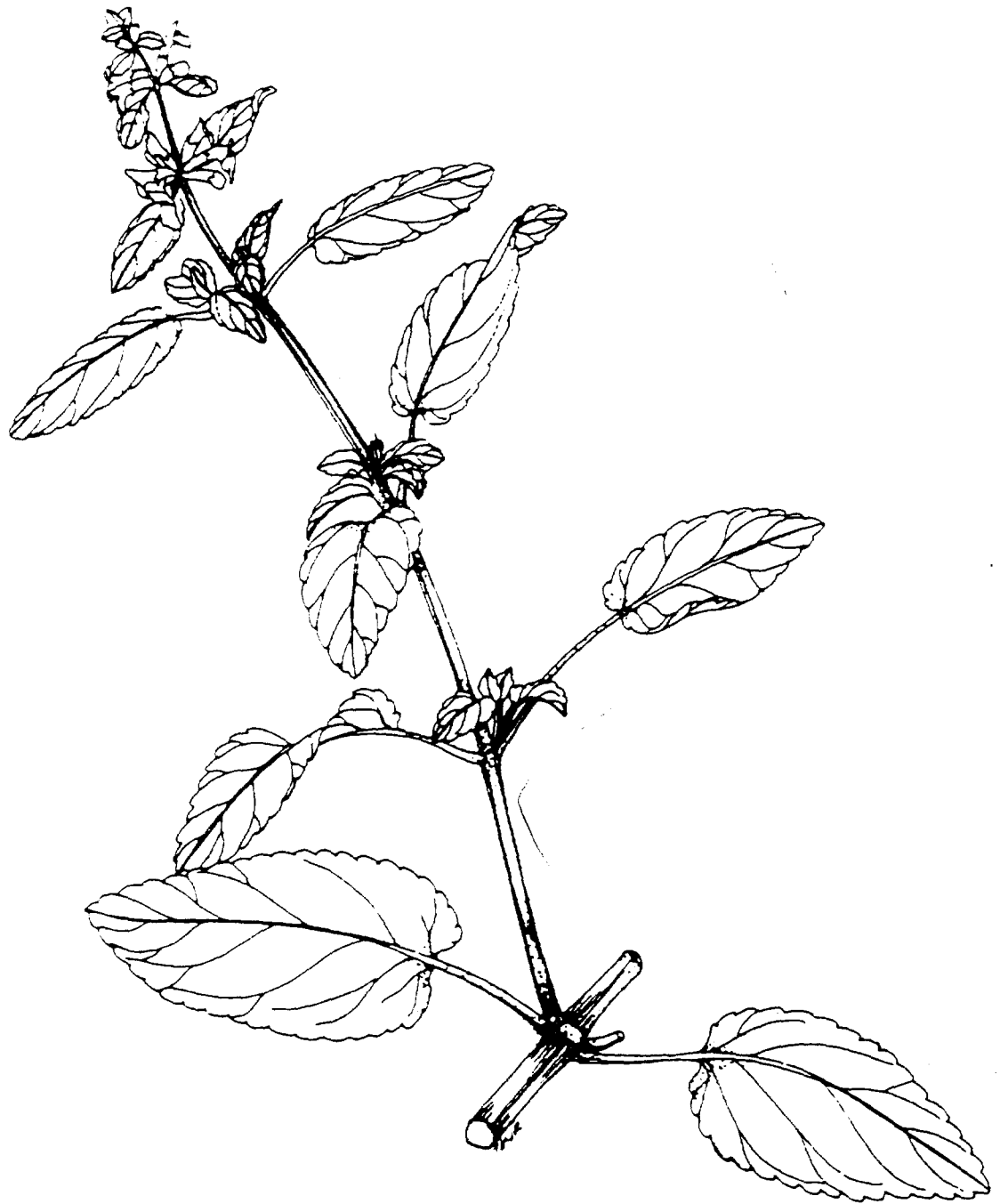
Line drawing of *Clermontia drepanomorpha* from Wagner *et al.* (1990).



Line drawing of *Hibiscadelphus hualalaiensis* from Wagner *et al.* (1990).



Line drawing of *Neraudia ovata* from Wagner *et al.* (1990).



Line drawing of *Phyllostegia racemosa* from Wagner *et al.* (1990).



Line drawing of *Phyllostegia velutina* from Wagner *et al.* (1990).

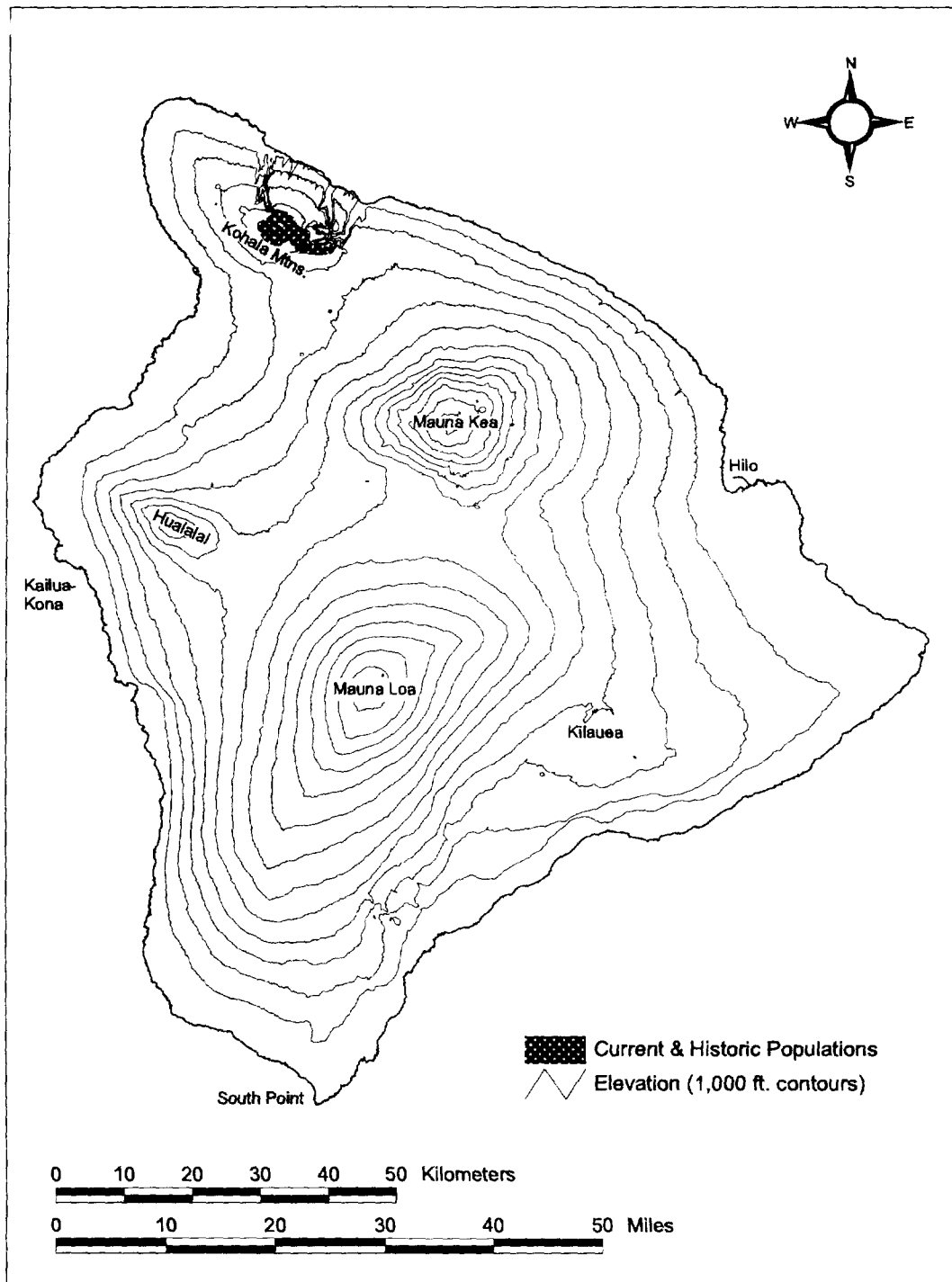


Line drawing of *Sicyos alba* from Wagner *et al.* (1990).

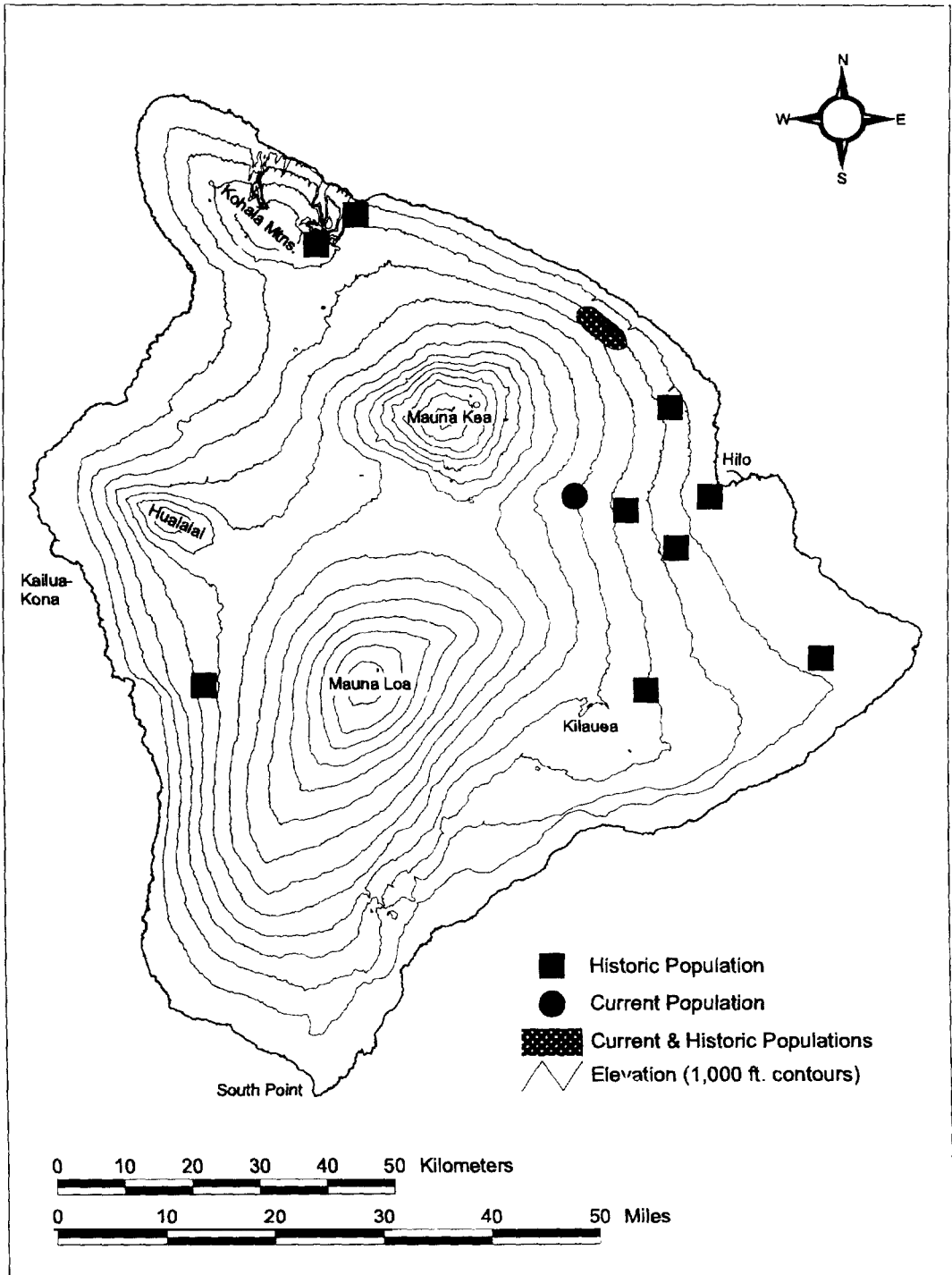


## **APPENDIX J - MAPS DEPICTING DISTRIBUTION OF TAXA**

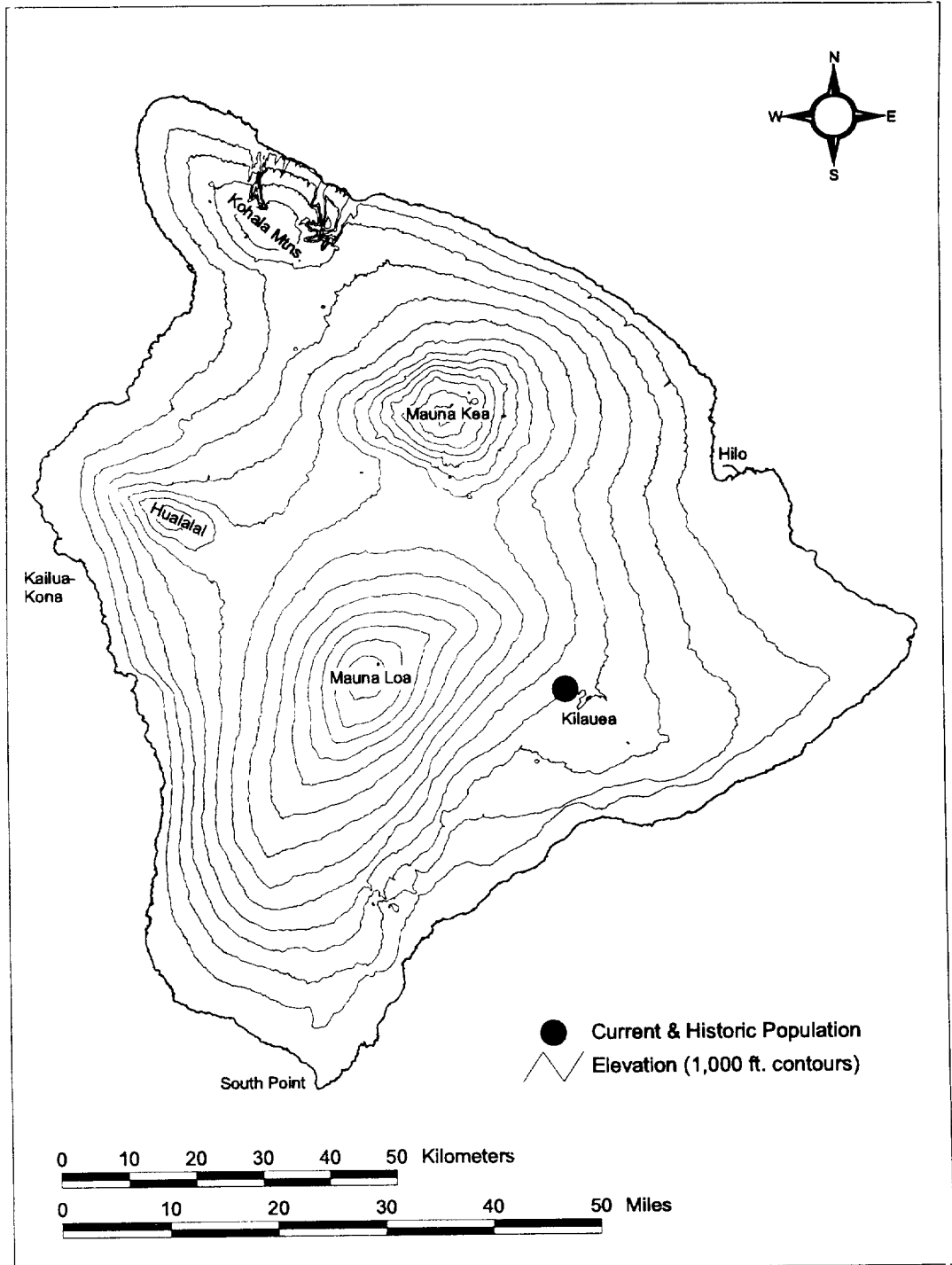
Historical distributions are estimates based on the best available information. For some species historical information is the same as current distribution.



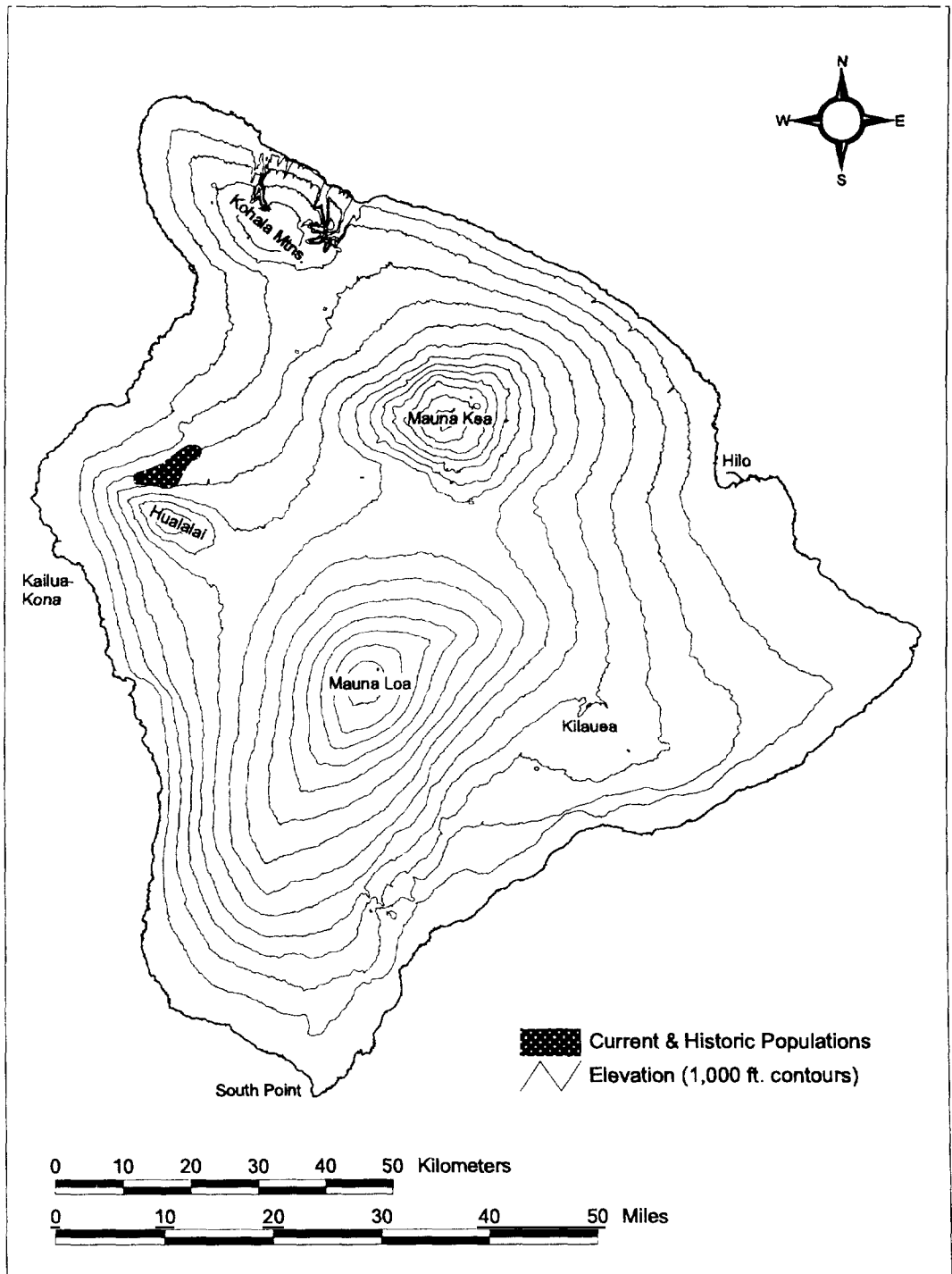
Distribution of *Clermontia drepanomorpha*



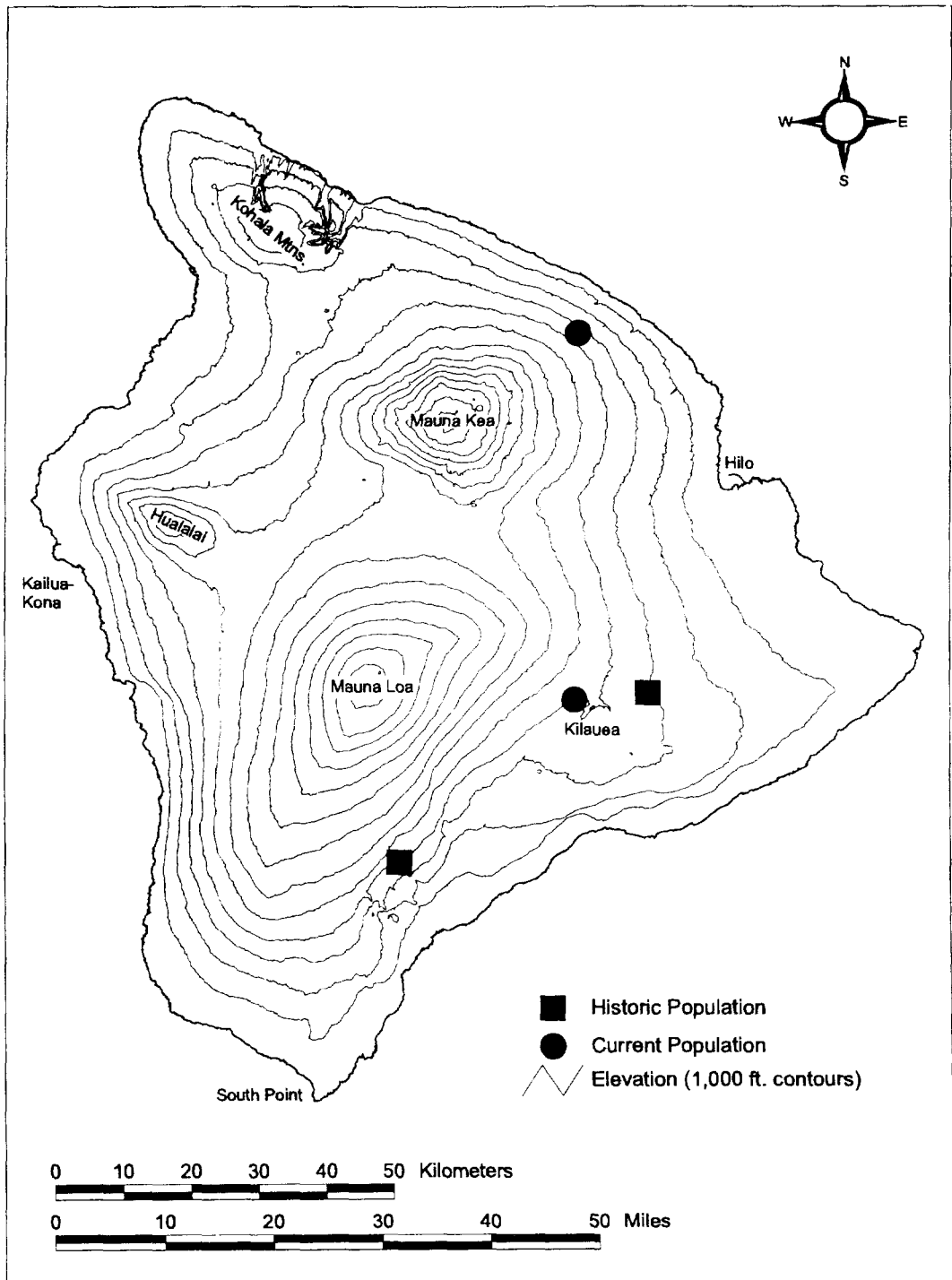
Distribution of *Cyanea platyphylla*



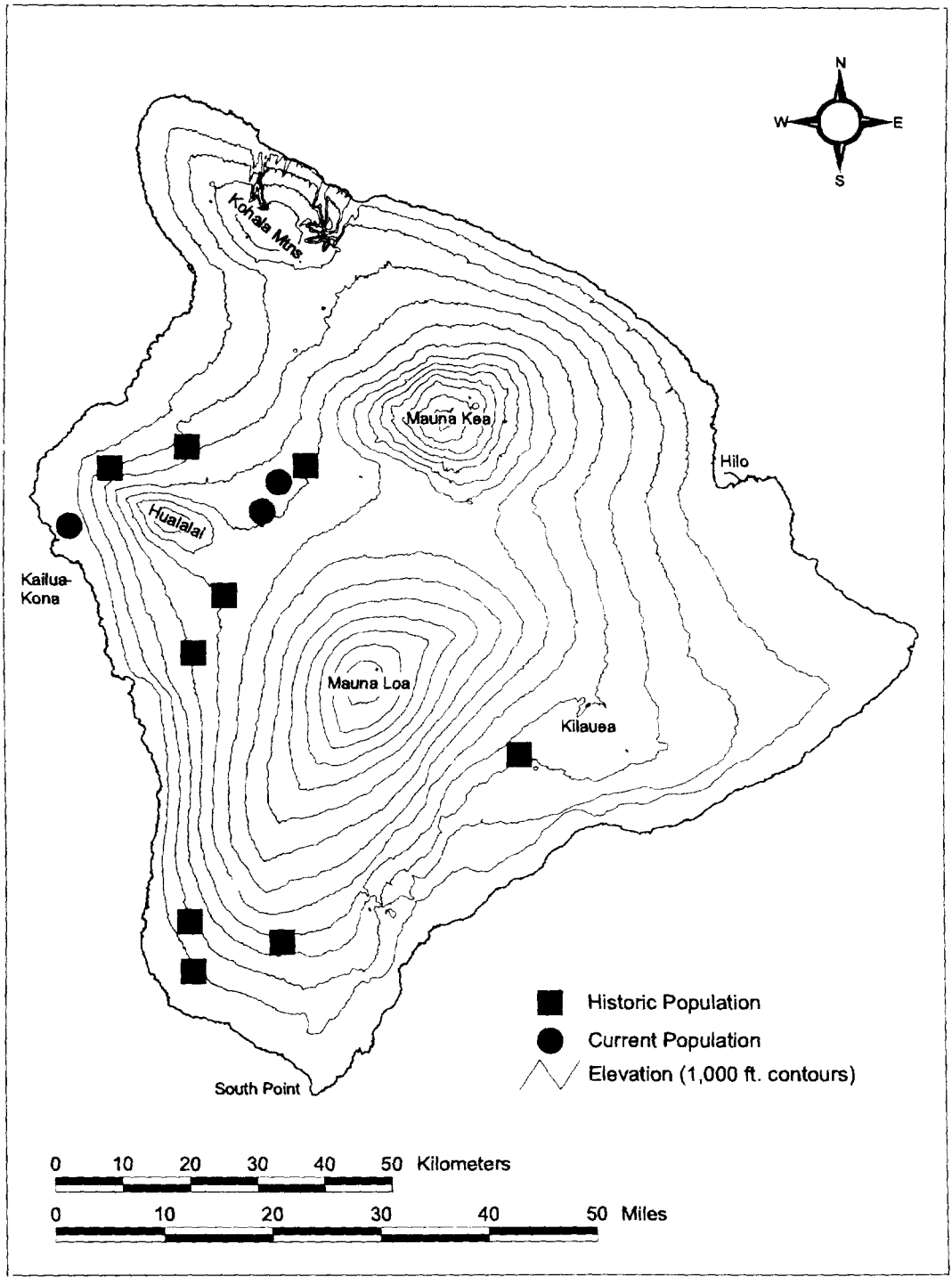
Distribution of *Hibiscadelphus giffardianus*



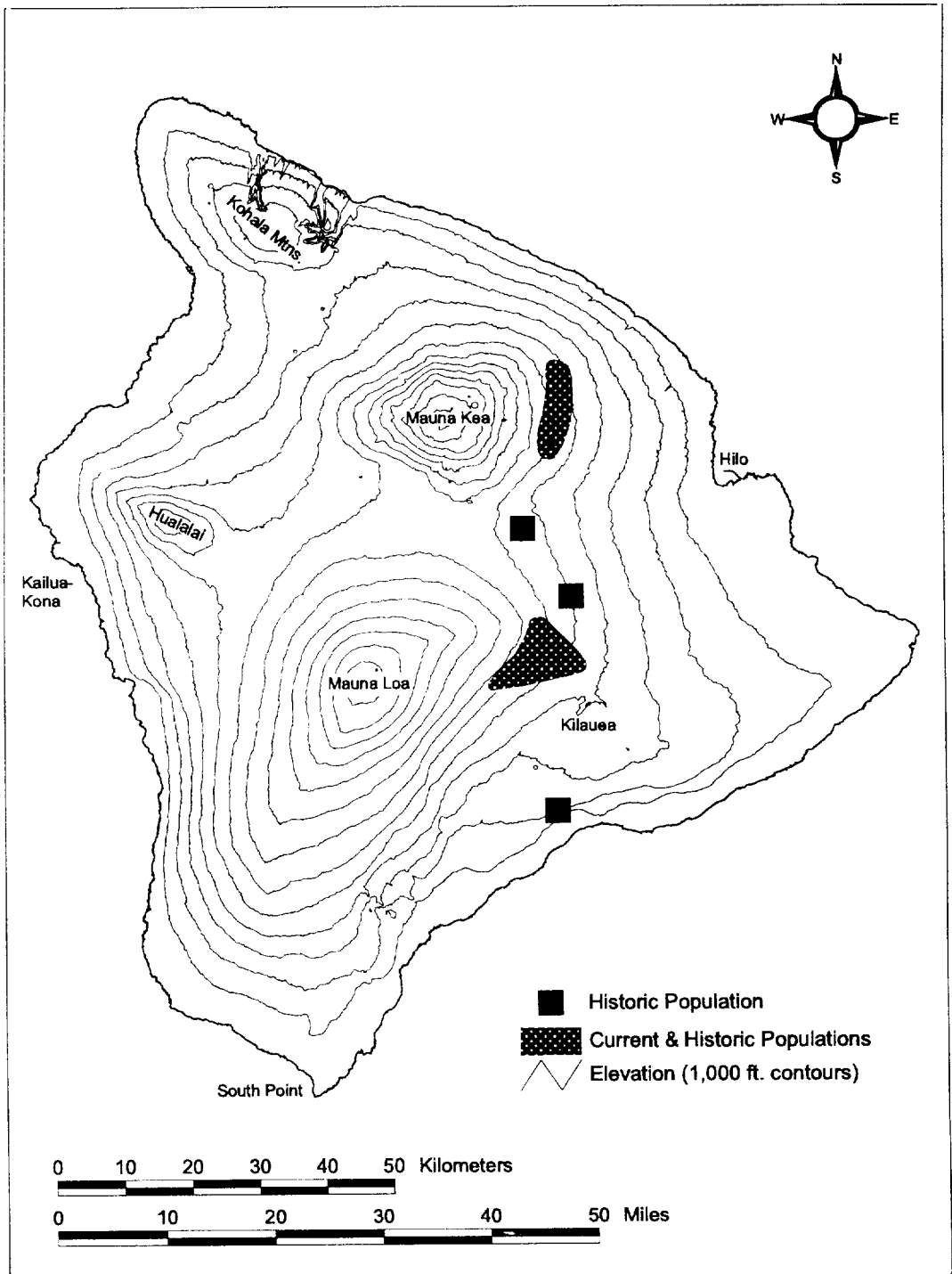
Distribution of *Hibiscadelphus hualalaiensis*



Distribution of *Melicope zahlbruckneri*

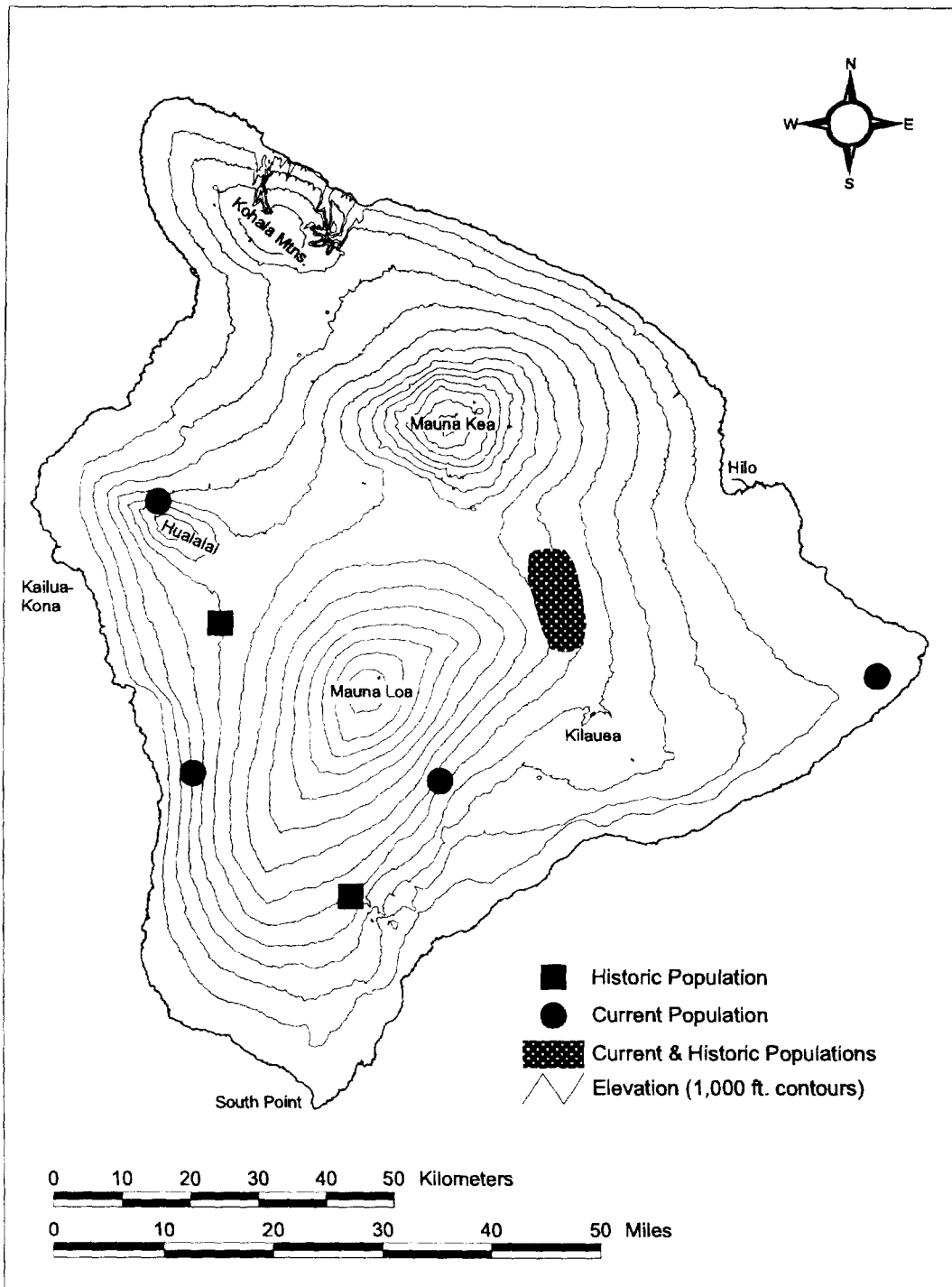


Distribution of *Neraudia ovata*

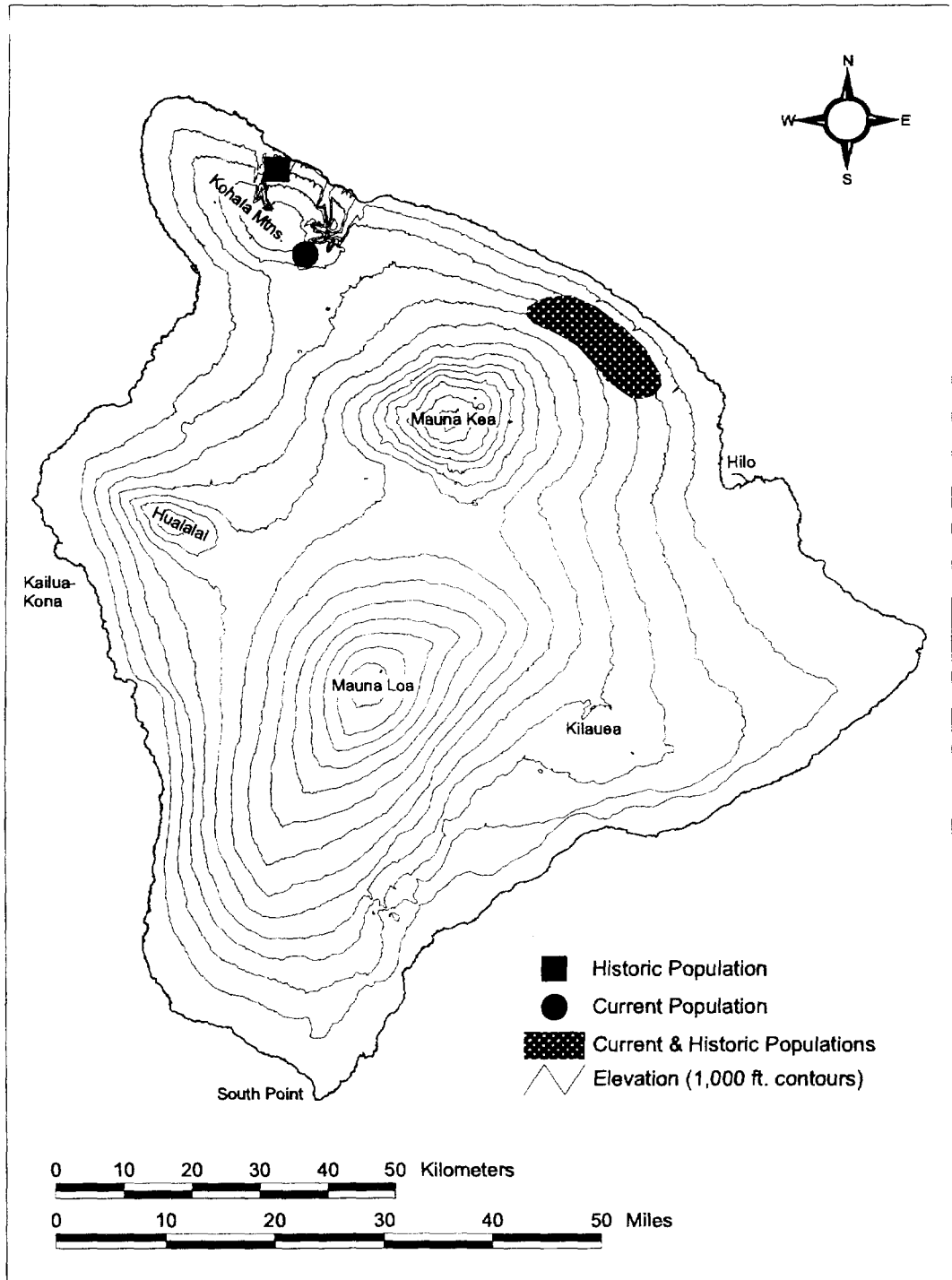


Distribution of *Phyllostegia racemosa*

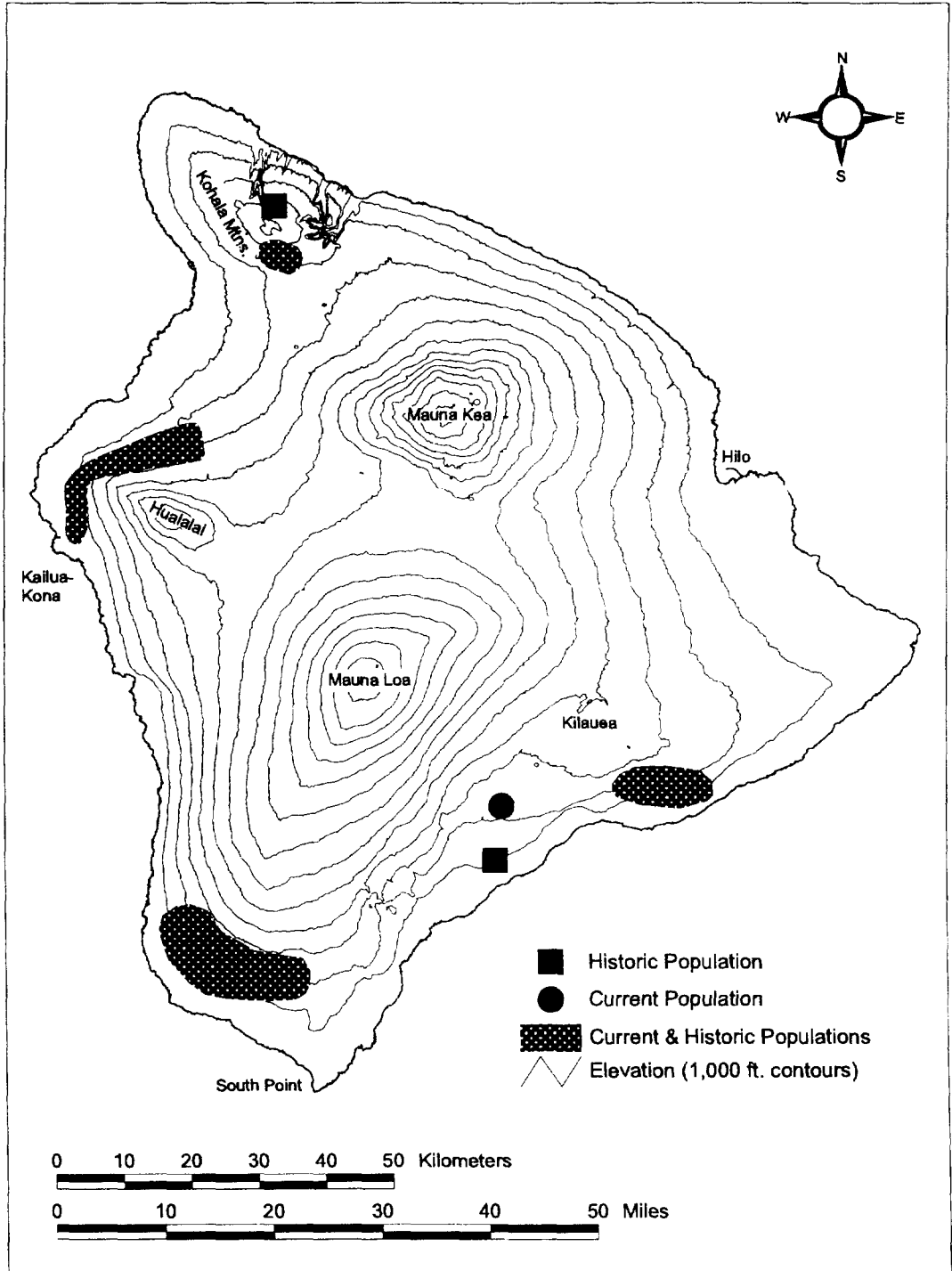




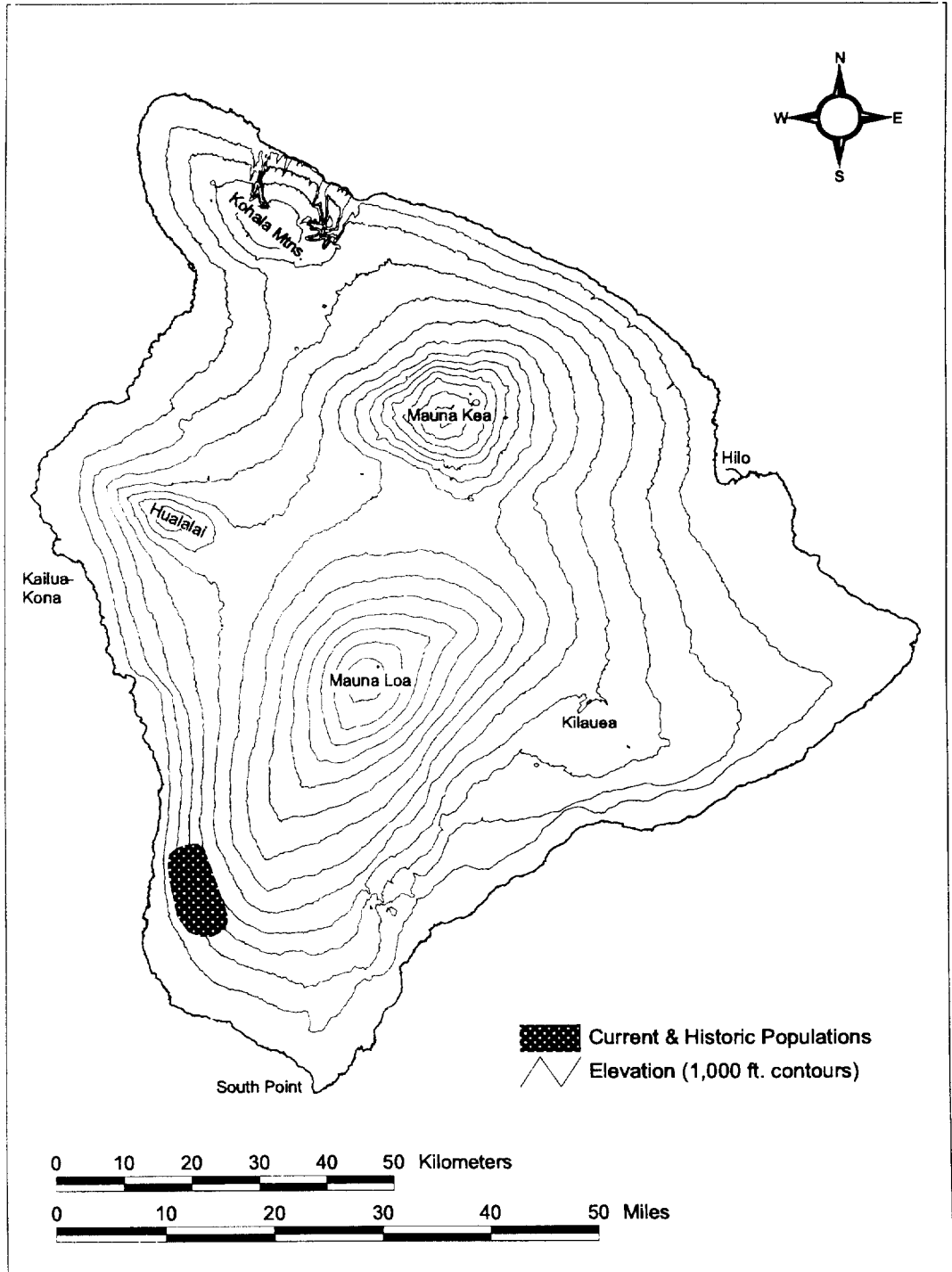
Distribution of *Phyllostegia velutina*



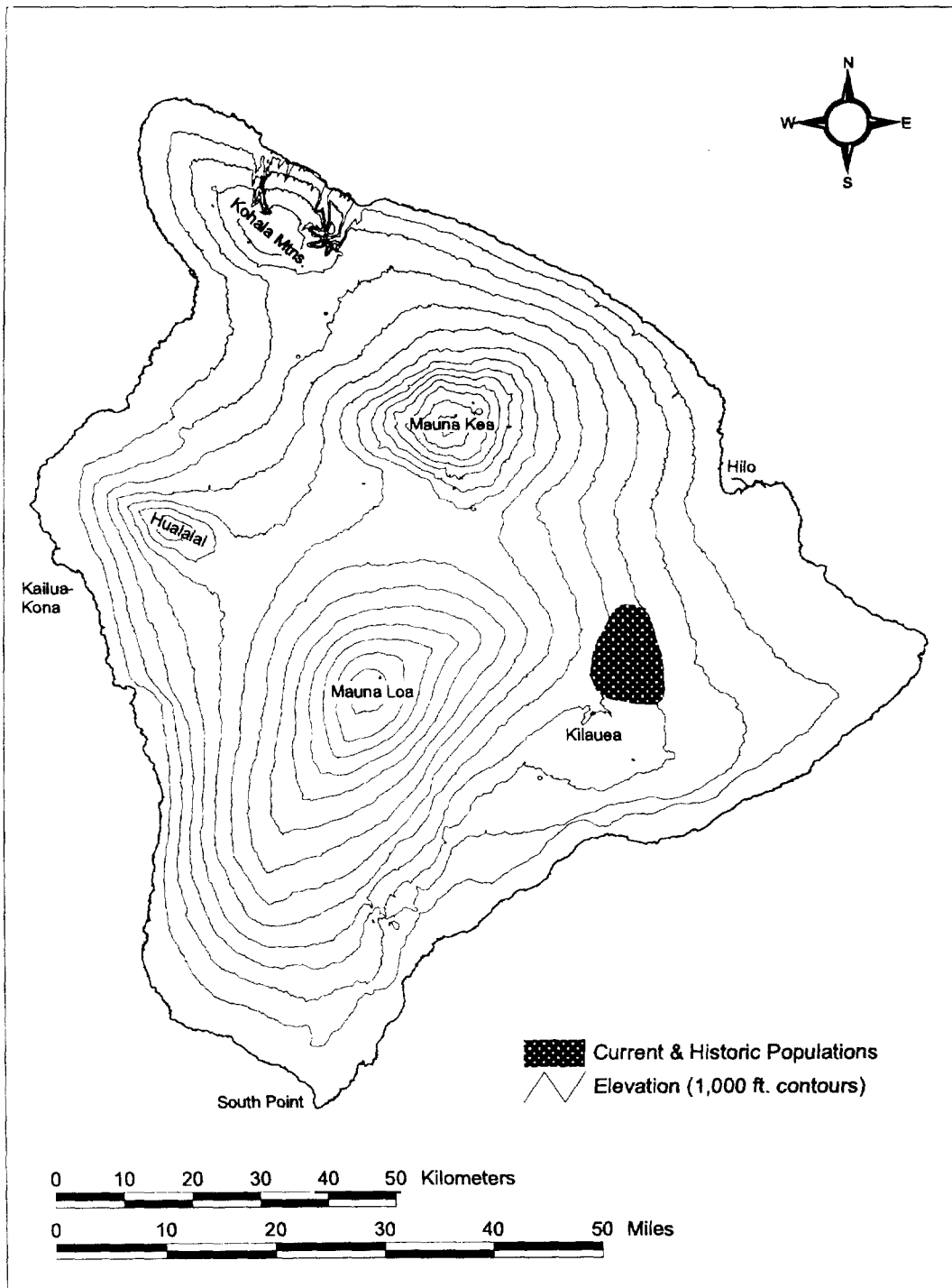
Distribution of *Phyllostegia warshaueri*



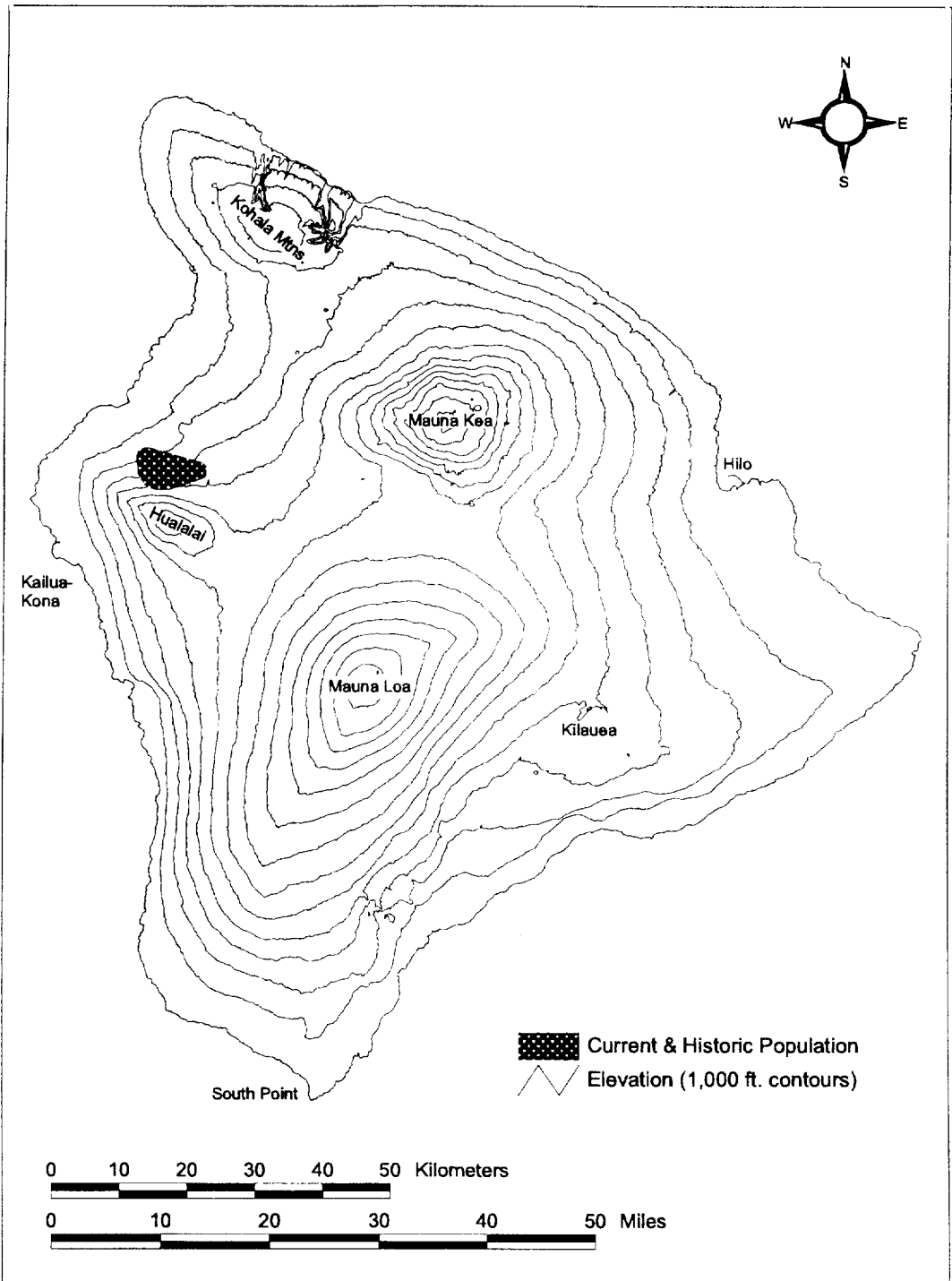
Distribution of *Pleomele hawaiiensis*



Distribution of *Pritchardia schattaueri*



Distribution of *Sicyos alba*



Distribution of *Zanthoxylum dipetalum* var. *tomentosum*

## APPENDIX K - SUMMARY OF LANDOWNERSHIP/ MANAGEMENT

Land stewards of current populations of the Big Island II Plant Cluster taxa.

Taxon	Total Populations and (Individuals)	Populations by Land Steward						
		NP	DOD	NWR	SL	NAR	FR	P
<i>Clermontia drepanomorpha</i>	6 (237-292)					✓	✓	✓
<i>Cyanea platyphylla</i>	3 (21)					✓	✓*	✓
<i>Hibiscadelphus giffardianus</i>	1 (9)	✓*						
<i>Hibiscadelphus hualalaiensis</i>	3 (30)				✓*			✓*
<i>Melicope zahlbruckneri</i>	2 (30-35)	✓				✓		
<i>Neraudia ovata</i>	3 (11)		✓		✓			✓
<i>Phyllostegia racemosa</i>	3 (35-45)	✓		✓	✓			✓
<i>Phyllostegia velutina</i>	5 (63-116)				✓		✓	✓
<i>Phyllostegia warshaueri</i>	4 (5-10)				✓	✓		✓
<i>Pleomele hawaiiensis</i>	9 (274-324)	✓			✓			✓
<i>Pritchardia schattaueri</i>	5 (84)				✓*			✓
<i>Sicyos alba</i>	2 (21)					✓	✓	
<i>Zanthoxylum dipetalum</i> var. <i>tomentosum</i>	2 (44)				✓			

Key: NP - National Park, DOD - Department of Defense, NWR - National Wildlife Refuge,  
SL - State Land (unspecified), NAR - Natural Area Reserve, FR - Forest Reserve, P - Private.

\* - includes outplanted populations

## APPENDIX L - SUMMARY OF COMMENTS

The U.S. Fish and Wildlife Service received comments on the Draft Big Island II: Addendum to the Recovery Plan for the Big Island Plant Cluster from the Division of Forestry and Wildlife, the Hawaii Department of Agriculture, National Tropical Botanical Garden, and Hawaii Island Landscape Association. Most of these comments provided additional information on numbers of populations/ individuals, distribution of certain taxa, changes to cost estimates for tasks in the Implementation Schedule, and editorial changes. These comments have been incorporated into the final plan. Additional comments are addressed specifically below. The following peer reviewers provided comments on the plan: Marie Bruegmann, Lyman Perry, and Carolyn Corn.

Comment 1: Costs shown for recovering Big Island Plant Cluster species average \$405,000 to \$427,000 per species, which is considerably less than that shown for Kauai species (2x higher), Molokai (3x higher), Lanai (6x higher), and Maui (10x higher). Yet, travel distances to manage the species and sizes of habitats to manage are greater on Hawaii.

Service Response: Costs given in Implementation Schedules are estimates. In many cases, costs are related to accessibility of the plants or accessibility of suitable habitat for outplanting. It may be possible to combine tasks for a number of species that occur in the same area, for example, thus minimizing overall costs. Additionally, many of the Recovery plans for endangered and threatened Hawaiian plants outline the need for research on the control of alien plants and insects. This research may be carried out simultaneously for a number of these plants.

Comment 2: It is useful to know land ownership and plant populations sizes on the various land parcels for management and recovery purposes. This information is lacking or hard to decipher for some of the taxa. Also it would be helpful to indicate the range of elevation and, when available, the rainfall regimes and soil



types for each species.

Service Response: Land ownership and plant population sizes are included in the Historic and Current Ranges and Population Status sections of the individual species accounts. General land ownership information can be found in Appendix K. The ranges of elevation and rainfall regimes have been included in Table 1 (Summary of Big Island II Plant Cluster habitat types and associated plant taxa). Soil type for each species is not known.

Comment 3: All 13 plant taxa under life history show no information is currently available. Both flowering and fruiting times can be included by reviewing Bishop Museum herbarium sheets. When little to nothing is known for a species, how does one manage the species effectively? For example, fruiting times let us know when to bait for rodents that eat the seeds. There is a real need to get research going on the life history, threats, and lack of reproduction. Yet this isn't mentioned under needed recovery actions or given priority.

Service Response: Herbarium specimens were examined in the preparation of this plan. However, phenological data from specimens does not reflect typical flowering and fruiting times since collectors often collect from any flowering or fruiting individual whether or not the majority of the population is flowering. Research on life history of the 13 taxa and research to determine and develop effective control methods for alien species that threaten these 13 taxa is included in the Conservation Efforts Section in the individual species accounts, in the Stepdown Outline and Narrative (Service 1996b), and in the Recovery Plan Implementation Schedule for the Big Island II Plant Clusters (Tasks 12232, 22, 23, 24, 251, 252, 253).

Comment 4: It is recommended that biocontrol methods be considered as an option for alien plant and insect control.

Service Response: Biocontrol will be considered as an option. Further research on determining impacts of alien plants and insects, and effective methods of their

control is outlined in the Conservation Efforts Section in the individual species accounts, in the Stepdown Outline and Narrative (Service 1996b), and in the Recovery Plan Implementation Schedule for the Big Island and Big Island II Plant Clusters (Tasks 12231 and 12232).

Comment 5: A responsible system for the propagation of certain plants, such as *Pritchardia* palms, etc. is strongly supported by the botanical garden or scientific community, commercial nurseries and landscapers, and the native Hawaiian community. We hope that agencies such as U.S. Fish and Wildlife Service will strongly urge the Hawaii Department of Land and Natural Resources to quickly and responsibly adopt rules that are not overly burdensome to the general public.

Service Response: The Service supports biologically sound propagation programs for native Hawaiian species that demonstrate no negative effects on their long-term survival, and will work in partnership with the Hawaii Department of Land and Natural Resources to this end.

**Region 1  
U.S. Fish and Wildlife Service  
Ecological Services  
911 N.E. 11th Avenue  
Portland, Oregon 97232-4181**



**April 1998**