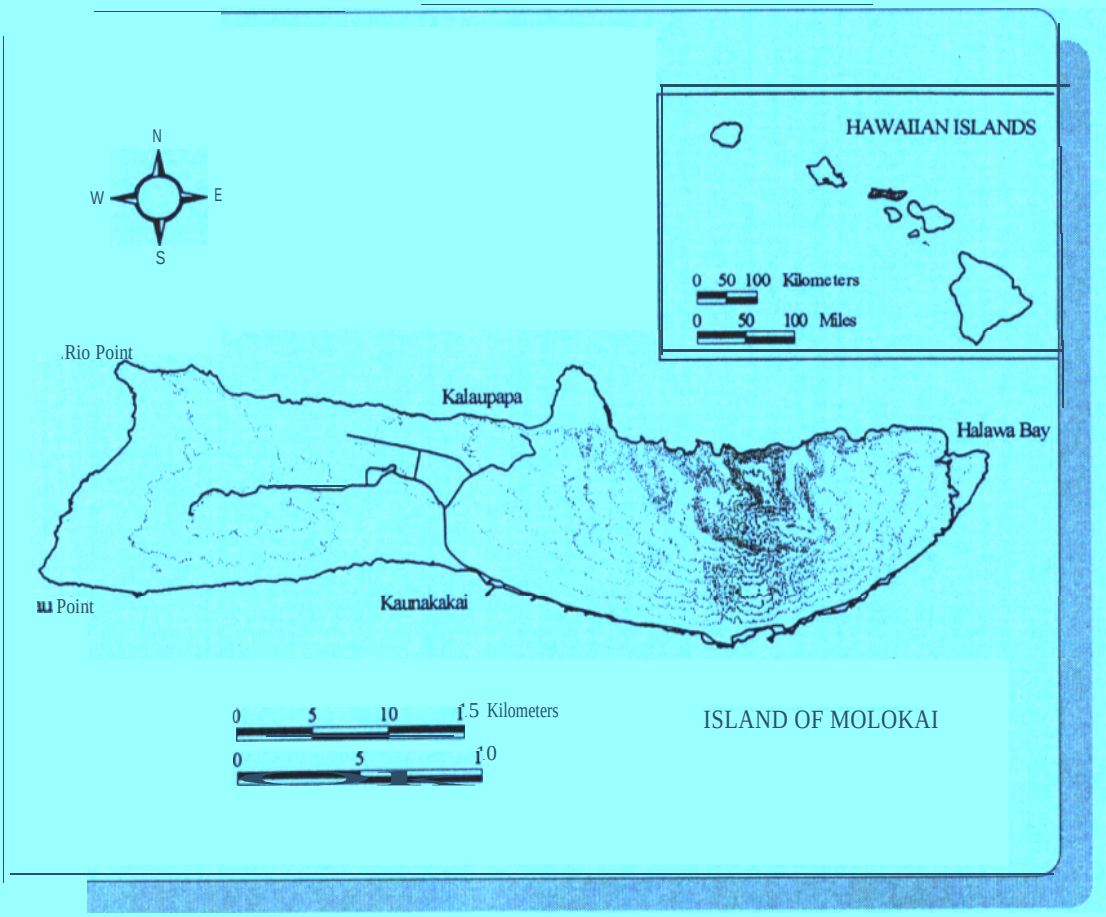
# RECOVERY PLAN FOR
# MOLOKAI PLANT CLUSTER

SEPTEMBER, 1996




U.S. Fish and Wildlife Service, Pacific Region

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# RECOVERY PLAN FOR THE MOLOKAI PLANT CLUSTER

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# EXECUTIVE SUMMARY

Current Species Status: The Recovery Plan for the Molokai Plant Cluster covers 16 plant taxa, 15 of which are listed as endangered and 1 as threatened, with numbers of known remaining individuals as follows (number of populations, number of individuals): *Bidens wiebkei* (kookoolau) (4, more than 100), *Brighamia rockii* (pua ala) (5, fewer than 200), *Canavalia molokaiensis* (awikiwiki) (7, fewer than 1,000), *Clermontia oblongifolia* ssp. *brevipes* (oha wai) (1, fewer than 20), *Cyanea mannii* (haha) (9, fewer than 1,000), *Cyanea procera* (haha) (3, 8), *Hedyotis mannii* (pilo) (4, 50-65), *Hibiscus arnottianus* ssp. *immaculatus* (kokio keokeo) (3, fewer than 100), *Melicope reflexa* (alani) (3, fewer than 1,000), *Phyllostegia mannii* (no common name (NCN)) (2, 4), *Pritchardia munroi* (loulu) (1, 1), *Schiedea lydgatei* (NCN) (4, more than 8,000), *Silene alexandri* (NCN) (2, 35), *Silene lanceolata* (NCN) (5, fewer than 1,500), *Stenogyne bifida* (NCN) (1, 12), and *Tetramolopium rockii* (NCN) (4, 174,000). Thirteen of these taxa are endemic to the island of Molokai. *Hedyotis mannii* is found on Maui and Lanai as well as Molokai. *Silene lanceolata* is found on Oahu, Hawaii, and Molokai, and is known to have occurred formerly on the islands of Kauai and Lanai. *Brighamia rockii*, which is now found only on Molokai, possibly occurred formerly on the islands of Maui and Lanai.

Habitat Requirements and Limiting Factors: The 16 taxa included in this plan grow in a variety of vegetative communities (grassland, shrubland, and forests), elevational zones (coastal to montane), and moisture regimes (dry to wet). These taxa and their habitats have been variously affected or are currently threatened by one or more of the following: habitat degradation by feral or domestic animals (goats, pigs, axis deer, cattle, and sheep); competition for space, light, water, and nutrients by introduced vegetation; erosion of substrate produced by human- or animal-caused disturbance; recreational and agricultural activities; habitat loss from fires; disease; loss of pollinators; and predation by animals (goats, axis deer, and rats). In addition, due to the small number of existing individuals and their very narrow distributions, these taxa and most of their populations are subject to an increased likelihood of extinction and/or reduced reproductive vigor from random naturally occurring events.

Recovery Objectives: Delist all taxa. Interim, downlisting, and delisting objectives are provided. Recovery of the Molokai plant cluster taxa should be pursued via the establishment of management units in order to make the most efficient use of available resources in an effort to conserve not only these taxa, but their habitats as well.

Recovery Criteria:

Interim Objectives:
The interim objective is to stabilize all existing populations of the Molokai 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 Molokai, and if possible, at least one other island where they now occur or occurred historically. 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 (*Brighamia rockii*, *Hibiscus arnottianus* ssp. *immaculatus*, *Melicope reflexa*, *Pritchardia munroi*), and a minimum of 50 mature individuals per population for short-lived perennials (*Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *Cyanea procera*, *Hedyotis mannii*, *Phyllostegia mannii*, *Schiedea lydgatei*, *Silene alexandri*, *Silene lanceolata*, *Stenogyne bifida*, and *Tetramolopium rockii*).

Downlisting Criteria:
A total of five to seven populations of each taxon should be documented on Molokai and at least one other 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 and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered.

Delisting Criteria:
For taxa other than *Tetramolopium rockii*, the following delisting criteria are recommended: A total of 8 to 10 populations of each taxon should be documented on Molokai and at least 1other 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 and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years.

Delisting Criteria for *Tetramolopium rockii*:
Due to this taxon's limited historic distribution and relatively large population size, delisting criteria for the threatened *Tetramolopium rockii* differ from the general criteria given above. The three existing populations of *Tetramolopium rockii* must be protected from all threats and the total number of individuals must

remain at current levels or increase. These levels must be sustained or exceeded for a period of 5 consecutive years. Species-specific recovery actions must no longer be required.

Actions Needed:

1. Protect habitat and control threats.
2. Expand existing wild populations.
3. Conduct essential research.
4. Develop and implement detailed monitoring plans for all species.
5. Establish new populations as needed to reach recovery objectives.
6. Validate and revise recovery criteria.

Total Estimated Cost of Recovery ($1,000's); some costs are yet to be determined:

| Year | Need 1 | Need 2 | Need 3 | Need 4 | Need 5 | Need 6 | Total |
|---|---|---|---|---|---|---|---|
| 1997 | 1071 | 0 | 224 | 35 | 0 | 0 | 1280 |
| 1998 | 1191 | 0 | 224 | 35 | 0 | 0 | 1400 |
| 1999 | 1191 | 0 | 224 | 35 | 0 | 0 | 1400 |
| 2000 | 1182 | 6 | 224 | 35 | 0 | 0 | 1397 |
| 2001 | 1172 | 6 | 224 | 35 | 0 | 0 | 1387 |
| 2002 | 1082 | 0 | 13 | 35 | 15 | 15 | 1110 |
| 2003 | 1082 | 0 | 13 | 35 | 15 | 15 | 1110 |
| 2004 | 1082 | 0 | 13 | 35 | 0 | 15 | 1095 |
| 2005 | 1082 | 0 | 13 | 35 | 0 | 15 | 1095 |
| 2006 | 1082 | 0 | 13 | 35 | 0 | 0 | 1080 |
| 2007 | 1082 | 0 | 13 | 35 | 0 | 0 | 1080 |
| 2008 | 1032 | 0 | 13 | 35 | 0 | 0 | 1080 |
| 2009 | 1032 | 0 | 13 | 35 | 0 | 0 | 1080 |
| 2010 | 1032 | 0 | 13 | 35 | 0 | 0 | 1080 |
| 2011 | 1032 | 0 | 13 | 35 | 0 | 0 | 1080 |
| 2012 | 1032 | 0 | 13 | 35 | 0 | 0 | 1080 |
| 2013 | 1032 | 0 | 13 | 35 | 0 | 0 | 1080 |
| 2014 | 1032 | 0 | 13 | 35 | 0 | 0 | 1080 |
| 2015 | 1032 | 0 | 13 | 35 | 0 | 0 | 1080 |
| 2016 | 1032 | 0 | 13 | 35 | 0 | 0 | 1080 |
| 2017 | 1032 | 0 | 13 | 35 | 0 | 0 | 1080 |
| Total | 22,619 | 12 | 1,328 | 735 | 30 | 60 | 24,784 |

Date of Recovery: Downlisting to Threatened could initiate in 2016, if recovery criteria are met. Delisting of *Tetramolopium rockii* could initiate in 2014, if recovery criteria are met.

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# INTRODUCTION

## 1. Brief Overview

Much of this section was taken directly from the listing package covering these taxa (USFWS 1992), with minor modifications by the author.

This recovery plan covers 16 plant taxa that were added to the federal list of endangered and threatened species in October of 1992. The plants listed as endangered are *Bidens wiebkei* (kookoolau), *Brighamia rockii* (pua ala), *Canavalia molokaiensis* (awikiwiki), *Clermontia oblongifolia* ssp. *brevipes* (oha wai), *Cyanea mannii* (haha), *Cyanea procera* (haha), *Hedyotis mannii* (pilo), *Hibiscus arnottianus* ssp. *immaculatus* (kokio keokeo), *Melicope reflexa* (alani), *Phyllostegia mannii*, *Pritchardia munroi* (loulu), *Schiedea lydgatei*, *Silene alexandri*, *Silene lanceolata*, and *Stenogyne bifida*. The Service also determined threatened status for one plant, *Tetramolopium rockii*, the two varieties of which are covered by this plan.

Thirteen of these taxa are endemic to the island of Molokai. *Hedyotis mannii* is found on Maui and Lanai as well as Molokai. *Silene lanceolata* is found on Oahu, Hawaii, and Molokai, and occurred formerly on the islands of Kauai and Lanai. *Brighamia rockii*, which is now found only on Molokai, possibly occurred formerly on the islands of Maui and Lanai. Fifteen of these taxa are known from East Molokai and one is known from West Molokai. The 16 plant taxa and their habitats have been variously affected and are threatened by 1 or more of the following: habitat degradation and/or predation by feral or domestic animals (axis deer, goats, pigs, sheep, and cattle); competition for space, light, water, and nutrients by naturalized, alien vegetation; habitat loss from fires; predation by rats; human recreational activities; and military training exercises. Because of the low numbers of individuals and their severely restricted distributions, populations of these taxa are subject to an increased likelihood of extinction from random naturally occuring events.

Part I of this plan 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 plant taxa addressed in this plan are all endemic to the eight "main Hawaiian Islands" (Figure 1), which include Niihau, Kauai, Oahu, Maui, Molokai, Lanai, Kahoolawe and Hawaii (also known as "the Big Island"). The Hawaiian Islands are located over 3,200 kilometers (2,000 miles) from the nearest continent, making them the most isolated high islands on earth (USFWS 1992). This isolation has allowed the few plants and animals that arrived here to evolve into many varied and highly endemic species. Many of these species have lost their defenses against threats such as mammalian predation and competition with aggressive, weedy plant species that are typical of mainland environments (USFWS 1992).

The objective of this plan is to provide a framework for the recovery of these 16 taxa so that their protection by the Endangered Species Act (ESA) is no longer necessary. This plan 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 pursued via the establishment of management units in order to make the most efficient use of available resources in an effort to conserve not only these taxa, but their habitats as well.

Immediate actions necessary for the prevention of extinction of these taxa include fencing for exclusion of ungulates; alien plant control; protection from fire; population and plant community monitoring and management; *ex situ* propagation; and augmentation of populations, as appropriate. Long-term activities necessary for the perpetuation of these taxa in their natural habitats additionally include baseline and long-term research; public education; maintenance of fenced areas, fire breaks and fuel breaks; long-term monitoring and management of populations and communities; and re-establishment of populations within the historic ranges of some taxa. Further research regarding current range, reproduction and reproductive status, pollinators, life history, limiting factors, habitat requirements, and minimum viable population sizes is needed to facilitate appropriate management decisions regarding the long-term perpetuation of each of these taxa.

Appendix B contains line drawings of some of the species covered by this

plan. Appendix C contains illustrations of historic and current distributions, and Appendix D provides a summary of land ownership/management for the Molokai cluster taxa. Appendix E explains the Recovery Priority System and Appendix F is a summary of comments received.

## 2. General Description of Habitat

The island of Molokai (Figure 2), the fifth largest in the Hawaiian Islands chain, is approximately 61 kilometers (38 miles) long, up to 17 kilometers (10 miles) wide, and encompasses an area of about 688 square kilometers (266 square miles) (USFWS 1992). Three shield volcanoes make up most of the land mass of Molokai: West Molokai Mountain, East Molokai Mountain, and a volcano that formed Kalaupapa Peninsula (USFWS 1992). Molokai also can be divided into three major sections: the West Molokai section, comprising West Molokai Mountain; the central Molokai section or Hoolehua Plain formed between the two large mountain masses; and the East Molokai section, incorporating East Molokai Mountain and Kalaupapa Peninsula (USFWS 1992).

The taller and larger East Molokai Mountain rises 1,813 meters (4,970 feet) above sea level (USFWS 1992) and comprises roughly 50 percent of the island's land area. Topographically, the windward side of East Molokai differs from the leeward side. Precipitous cliffs line the northern windward coast with deep inaccessible valleys dissecting the coastal area. The annual rainfall on the windward side is 200 to over 375 centimeters (75 to over 150 inches), distributed throughout the year. The soils are poorly drained and high in organic matter. The gulches and valleys are usually very steep, but sometimes gently sloping (USFWS 1992). Much of the native vegetation on the northern part of East Molokai is intact because of its relative inaccessibility to humans and animals (USFWS 1992), although destructive ungulates have begun to enter the coastline in recent years (USFWS 1992). Table 1 summarizes the habitat types and associated plant species of the Molokai cluster plants. *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, and *Stenogyne bifida* extend through various windward vegetation communities, from Coastal Dry Communities along the northern coast to the Montane Mesic Communities found inland on that side of the island. Halawa, on Molokai's extreme eastern end, has the same soil types as the windward side of the island. *Bidens wiebkei* is the only plant taxon of the

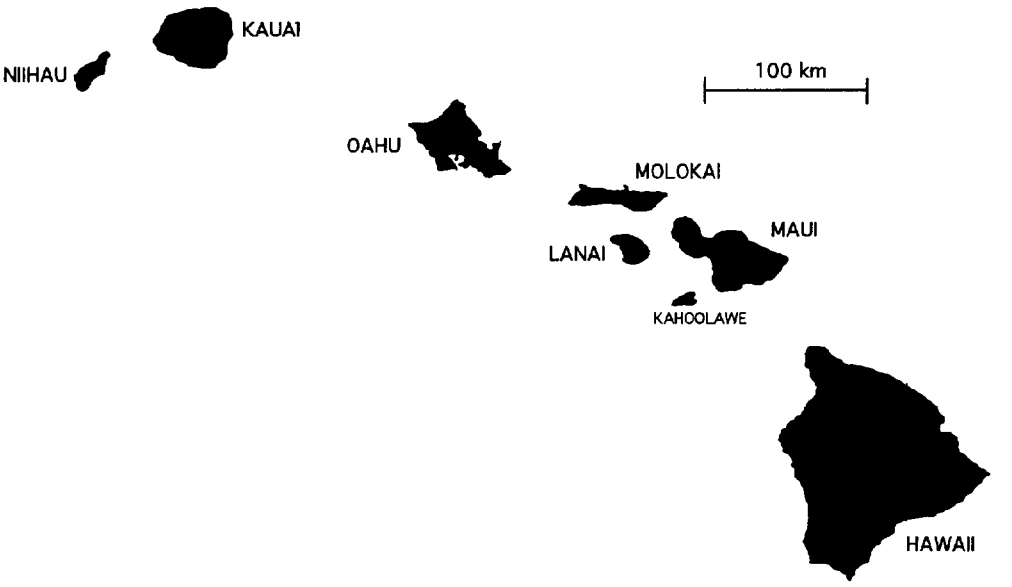


Figure 1. Map of the Main Hawaiian Islands.

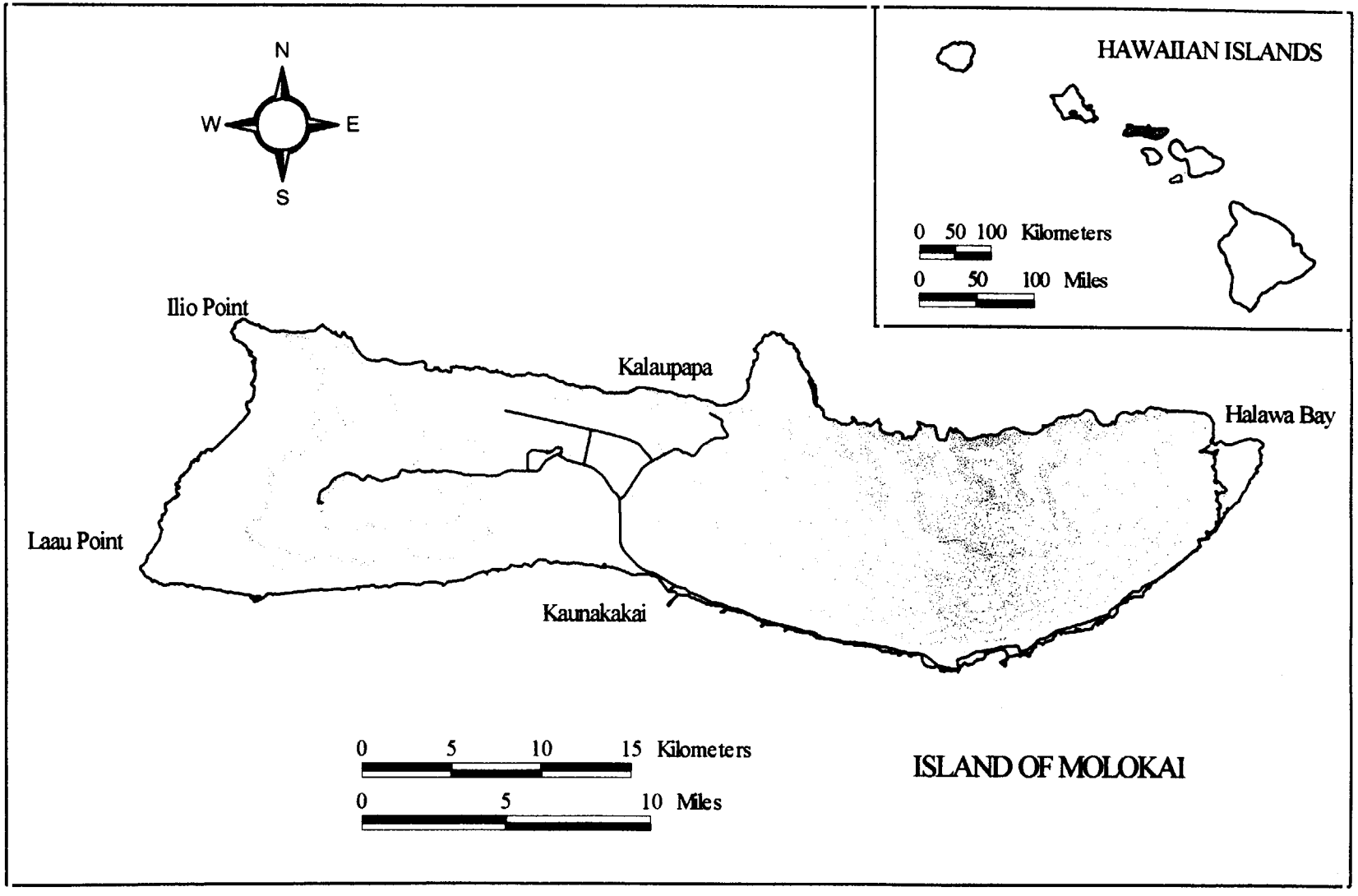


Figure 2. Map of the island of Molokai.

| Habitat Type | Molokai Recovery Plan Species | Associated Native Species | Associated Alien Species |
|---|---|---|---|
| **Lowland Grassland Forest**<br>elevation:<br><br>15-2,000 meters<br>(50-6,500 feet)<br><br>rainfall:<br><br>fewer than120 centimeters<br>(48 inches) per year | *Schiedea lydgatei*<br>*Silene alexandri*<br>*Silene lanceolata* | *Chamaesyce* sp. (akoko)<br>*Chenopodium oahuense* (aheahea)<br>*Dodonaea viscosa* (aalii)<br>*Metrosideros polymorpha* (ohia)<br>*Sophora chrysophylla* (mamane)<br>*Styphelia tameiameiae*(pukiawe) | *Melinis minutiflora*<br>*Pennisetum setaceum*<br>(fountain grass) |
| **Lowland Dry Forest**<br>elevation:<br><br>15-2,000 meters<br>(50-6,500 feet)<br><br>rainfall:<br><br>fewer than120 centimeters<br>(48 inches) per year | *Schiedea lydgatei* | *Diospyros sandwicensis*<br>*Dodonaea viscosa* (aalii)<br>*Metrosideros polymorpha* (ohia)<br>*Styphelia tameiameiae*(pukiawe) | *Melinis minutiflora*<br>*Schinus terebinthifolius* |

Table 1. Summary of Molokai cluster taxa habitat types and associated species.

| Habitat Type | Molokai Recovery Plan Species | Associated Native Species | Associated Alien Species |
|---|---|---|---|
| **Lowland Mesic Forest**<br>elevation:<br><br>15-2,000 meters<br>(50-6,500 feet)<br><br>rainfall:<br><br>120-200 centimeters<br>(48-100 inches) per year | *Bidens wiebkei*<br>*Brighamia rockii*<br>*Canavalia molokaiensis*<br>*Cyanea mannii*<br>*Hedyotis mannii*<br>*Hibiscus arnottianus* ssp. *immaculatus*<br>*Schiedea lydgatei* | *Antidesma* sp. (hame)<br>*Canthium odoratum* (alahee)<br>*Chamaesyce* sp. (akoko)<br>*Cheirodendron trigynum* (olapa)<br>*Cibotium* sp. (hapuu)<br>*Cyanea* sp. (haha)<br>*Dicranopteris linearis* (uluhe)<br>*Diospyros sandwicensis* (lama)<br>*Dodonaea viscosa* (aalii)<br>*Metrosideros polymorpha* (ohia)<br>Nestegis sandwicensis (olopua)<br>*Osteomeles anthyllidifolia* (ulei)<br>*Pipturus albidus* (mamaki)<br>*Pisonia* sp. (papala kepau)<br>*Psychotria* sp. (kopiko)<br>*Scaevola gaudichaudii* (naupaka kuahiwi)<br>*Styphelia tameiameiae*(pukiawe)<br>*Vaccinium* sp. (ohelo)<br>*Wikstromia* sp. (akia) | *Fraxinus uhdei*<br>*Melinis minutiflora*<br>*Pinus* spp.<br>*Psidium cattleianum* (strawberry guava)<br>*Schinus terebinthifolius* |

Table 1. Continued.

| Habitat Type | Molokai Recovery Plan Species | Associated Native Species | Associated Alien Species |
|---|---|---|---|
| **Montane Mesic Forest**<br>elevation:<br><br>500-2,700 meters<br>(1,600-8,800 feet)<br><br>rainfall:<br><br>120-250 centimeters<br>(48-100 inches) per year | *Cyanea mannii*<br>*Hedyotis mannii*<br>*Schiedea lydgatei*<br>*Stenogyne bifida* | *Broussaisia arguta* (kanawao)<br>*Cheirodendron trigynum* (olapa)<br>*Cibotium* sp. (hapuu)<br>*Cyanea* sp. (haha)<br>*Dicranopteris linearis* (uluhe)<br>*Dodonaea viscosa* (aalii)<br>*Hedyotis hillebrandii* (manono)<br>*Metrosideros polymorpha* (ohia)<br>*Pipturus albidus* (mamaki)<br>*Pouteria* sp. (alaa)<br>*Psychotria* (kopiko)<br>*Styphelia tameiameiae*(pukiawe)<br>*Vaccinium* sp. (ohelo)<br>*Wikstromia* sp. (akia) | *Fraxinus uhdei*<br>*Melinis minutiflora*<br>*Pinus* spp.<br>*Psidium cattleianum* (strawberry guava)<br>*Rubus argutus* |

Table 1. Continued

| Habitat Type | Molokai Recovery Plan Species | Associated Native Species | Associated Alien Species |
|---|---|---|---|
| **Lowland Wet Forest**<br>elevation:<br><br>15-2,000 meters<br>(50-6,500 feet)<br><br>rainfall:<br><br>more than 250 centimeters<br>(100 inches) per year | *Clermontia oblongifolia* ssp. *brevipes*<br>*Cyanea mannii*<br>*Cyanea procera*<br>*Hedyotis mannii*<br>*Melicope reflexa*<br>*Phyllostegia mannii* | *Asplenium*<br>*Cheirodendron trigynum* (olapa)<br>*Cibotium* sp. (hapuu)<br>*Coprosma ochracea* (pilo)<br>*Cyanea* sp. (haha)<br>*Dicranopteris linearis* (uluhe)<br>*Metrosideros polymorpha* (ohia)<br>*Pipturus albidus* (mamaki)<br>*Psychotria* sp. (kopiko)<br>*Touchardia latifolia* (olona)<br>*Vaccinium* sp. (ohelo)<br>*Wikstromia* sp. (akia) | *Clidemia hirta* (Koster's curse)<br>*Psidium cattleianum* (strawberry guava) |

Table 1. Continued.

| Habitat Type | Molokai Recovery Plan Species | Associated Native Species | Associated Alien Species |
|---|---|---|---|
| **Montane Wet Forest**<br>elevation:<br><br>500-2,700 meters<br>(1,600-8,800 feet)<br><br>rainfall:<br><br>more than 250 centimeters<br>(100 inches) per year | *Clermontia oblongifolia* ssp. *brevipes*<br>*Cyanea mannii*<br>*Cyanea procera*<br>*Hedyotis mannii*<br>*Melicope reflexa*<br>*Phyllostegia mannii*<br>*Stenogyne bifida* | *Asplenium*<br>*Broussaisia arguta* (kanawao)<br>*Cheirodendron trigynum* (olapa)<br>*Cibotium* sp. (hapuu)<br>*Coprosma ochracea* (pilo)<br>*Cyanea* sp. (haha)<br>*Dicranopteris linearis* (uluhe)<br>*Hedyotis hillebrandii* (manono)<br>*Metrosideros polymorpha* (ohia)<br>*Pipturus albidus* (mamaki)<br>*Pouteria* sp. (alaa)<br>*Psychotria* sp. (kopiko)<br>*Touchardia latifolia* (olona)<br>*Vaccinium* (ohelo)<br>*Wikstromia* sp. (akia) | *Clidemia hirta* (Koster's curse)<br>*Psidium cattleianum* (strawberry guava) |

Table 1. Continued.

| Habitat Type | Molokai Recovery Plan Species | Associated Native Species | Associated Alien Species |
|---|---|---|---|
| **Coastal Shrub Forest**<br>elevation:<br><br>0-300 meters<br>(0-1,000 feet)<br><br>rainfall:<br><br>fewer than 120 centimeters<br>(48 inches) per year | *Brighamia rockii*<br>*Tetramolopium rockii* | *Canthium odoratum* (alahee)<br>*Diospyros sandwicensis* (lama)<br>*Fimbristylis cymosa*<br>*Heliotropium anomalum* (hinahina)<br>*Lipochaeta integrifolia* (nehe)<br>*Metrosideros polymorpha* (ohia)<br>*Osteomeles anthyllidifolia* (ulei)<br>*Scaevola* (naupaka)<br>*Sida fallax* (ilima)<br>*Sporobolus virginicus* (akiaki) | *Cenchrus ciliatus*<br>*Lantana camara*<br>*Prosopis pallida*<br>*Schinus terebinthifolius* |

Table 1. Continued.

16 covered by this recovery plan that grows in the Lowland to Montane Mesic Shrublands and Forests found on this section of the island.

Although Molokai's windward side receives most of the island's rainfall, some falls onto the upper slopes of the leeward (southern) side, decreasing as elevation decreases, and resulting in diverse leeward communities ranging from wet forests to dry shrub and grasslands. The average annual rainfall on the leeward side of East Molokai is between 80 and 130 centimeters (30 and 50 inches), mostly falling between November and April. The gently sloping to very steep topography of upland regions has predominantly well drained and medium-textured soils. *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *Cyanea procera*, *Hedyotis mannii*, *Melicope reflexa*, *Phyllostegia mannii*, *Pritchardia munroi*, *Schiedea lydgatei*, *Silene alexandri*, and *Silene lanceolata* are found in one or more of these habitats that extend from upper elevation Montane Wet Forests down to the Lowland Dry Communities on the leeward side of the island.

With the advent of cattle ranching and later pineapple cultivation, most of Molokai, particularly West Molokai and East Molokai's southern section, was converted to pasture land. The only remaining large tracts of native vegetation are found within the Molokai Forest Reserve on the upper elevation portions of East Molokai; most of the plant taxa in this plan are restricted to this forest reserve. *Tetramolopium rockii*, the only taxon of the 16 found on West Molokai, is restricted to coastal calcareous sand dunes on the island's northwestern corner, where the impacts of ranching activities and development have been quite limited. This Coastal Dry Community extends from sea level to 300 meters (1,000 feet) in elevation and has an annual rainfall of 250 to 1,000 millimeters (10 to 40 inches).

Of the 16 taxa covered by this plan, *Silene lanceolata* and *Hedyotis mannii* are the only species that are currently found on an island other than Molokai. Populations of *S. lanceolata* grow on the island of Hawaii in the saddle region between Mauna Kea and Mauna Loa Mountains, and on the island of Oahu at the Makua Military Reservation in the Waianae Mountains. The Montane Dry Shrub and Grassland communities to which this species belongs extend into the subalpine zone, from 500 to 2,900 meters (1,600 to 9,500 feet) in elevation with annual rainfall between 30 and 100 centimeters (12 and 40 inches) (USFWS 1992). The Lanai Island population of *Hedyotis mannii* grows in two gulches of Lanaihale. The vegetation communities of the area in which this species is found

range from Lowland Wet Shrubland to Lowland Wet Forest. These communities range in elevation from 100 to 1,200 meters (330 to 3,950 feet) with an annual rainfall between 150 to 600 centimeters (60 and 240 inches) (USFWS 1992).

The land that supports the Molokai cluster taxa is owned by the State of Hawaii, the Federal government, and private entities. The three State agencies are the Department of Land and Natural Resources (DLNR) (including the Natural Area Reserves System and Forest Reserves), the Department of Health, and the Department of Hawaiian Home Lands. The last two have cooperative management agreements with the National Park Service. Federally owned land consists of the Pohakuloa Training Area (PTA) on the island of Hawaii and Makua Military Reservation on the island of Oahu, both under the jurisdiction of the U.S. Army. Among various private owners are The Nature Conservancy of Hawaii (TNCH) and a private owner with a conservation easement with The Nature Conservancy of Hawaii. Current and historic island distributions as well as land stewardship of current populations of the Molokai plant cluster taxa can be found in Table 2.

Table 2. Current and historic island distributions, and land stewards of current populations of the Molokai plant cluster taxa.

| Taxon | Total Populations and Individuals | Populations by Land Steward | | | Number of Populations by Island (H = Historic) | | | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Federal | State | Private | K | O | Mo | L | Ma | Ha | |
| *Bidens wiebkei* | 4, more than 100 | | | 4 | | | 4 | | | | |
| *Brighamia rockii* | 5, fewer than 200 | | 1* | 4 | | | 5 | H? | H? | | * DLNR Huelo Is. |
| *Canavalia molokaiensis* | 7, fewer than 1,000 | 2 | 2 | 3 | | | 7 | | | | |
| *Clermontia oblongifolia* ssp. *brevipes* | 1, fewer than 20 | | | 1 | | | 1 | | | | |
| *Cyanea mannii* | 9, fewer than 1,000 | | 1 | 8 | | | 9 | | | | |
| *Cyanea procera* | 3, 8 | | | 3 | | | 3 | | | | |
| *Hedyotis mannii* | 4, 50-65 | | 1 | 3 | | | 1 | 2 | 1 | | |
| *Hibiscus arnottianus* ssp. *immaculatus* | 3, fewer than 100 | | 2 | 1 | | | 3 | | | | |
| *Melicope reflexa* | 3, fewer than 1,000 | | 1 | 2 | | | 3 | | | | |
| *Phyllostegia mannii* | 2, 4 | | | 2 | | | 2 | | H | | |
| *Pritchardia munroi* | 1, 1 | | | 1 | | | 1 | | | | |
| *Schiedea lydgatei* | 4, more than 8,000 | | 1 | 3 | | | 4 | | | | |
| *Silene alexandri* | 2, 35 | | | 2 | | | 2 | | | | |
| *Silene lanceolata* | 5, fewer than 1,500 | 3 | | 2 | H | 1 | 2 | H | | 2<br>*<br>** | * Makua Military Reservation (Oahu)<br>** Pohakuloa Training Area (Hawaii Island) |
| *Stenogyne bifida* | 1, 12 | | | 1 | | | 1 | | | | |
| *Tetramolopium rockii* | 4, 174,000 | 1* | 1 | 2 | | | 4 | | | | * Kalaupapa National Historical Park |

## 3. Overall Reasons for Decline and Current Threats

Below is a general discussion of threats to the native communities upon which the taxa covered in this plan depend. Information was taken directly from the listing package covering these taxa. Threats specific to each taxon are detailed in the species accounts and summarized in Table 3.

Native vegetation on the Hawaiian Islands has undergone extreme alteration because of past and present land management practices including ranching activities, deliberate animal and alien plant introductions, and agricultural development (USFWS 1992). Ongoing and threatened destruction and adverse modification of habitat by feral animals and competition with alien plants are the primary threats facing the 16 taxa covered by this plan.

### Feral Animals

Fifteen of the 16 taxa are variously threatened by feral animals. Direct predation by goats, deer, or cattle is a probable threat at sites where those animals have been reported, potentially affecting 11 of the taxa: *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Cyanea procera*, *Hibiscus arnottianus* ssp. *immaculatus*, *Melicope reflexa*, *Pritchardia munroi*, *Silene alexandri*, *Silene lanceolata*, *Stenogyne bifida*, and *Tetramolopium rockii*.

Of the ungulates that have become established on Molokai during the past 150 years, the axis deer (*Axis axis*) has probably had the greatest impact on the native vegetation. Eight axis deer, introduced to Molokai in 1868 (USFWS 1992), increased to thousands of animals by the 1960s (USFWS 1992). By the turn of the century, the deer occupied much of the dry to mesic lowland areas and the wet forests of East Molokai (USFWS 1992), where herds so damaged the vegetation that professional hunters were hired to control their numbers (USFWS 1992). The native vegetation suffered irreparable damage from overgrazing by these animals. Deer degrade the habitat by trampling, consuming, and overgrazing vegetation, which removes ground cover and exposes the soil to erosional actions (USFWS 1992). Alien plant species may then exploit the newly disturbed areas.

| Species | Alien Species | Fire | Natural Disasters | Human Impacts |
|---|---|---|---|---|
| *Bidens wiebkei* | D, G, Pl | X | | X |
| *Brighamia rockii* | D, G, Pl, (R) | | | |
| *Canavalia molokaiensis* | G, P, (Pl) | | | |
| *Clermontia oblongifolia* ssp. *brevipes* | P, (R) | X | | |
| *Cyanea mannii* | P, (R) | X | | |
| *Cyanea procera* | (G, R, P) | X | | |
| *Hedyotis mannii* | P, Pl | X | | |
| *Hibiscus arnottianus* ssp. *immaculatus* | G | X | | |
| *Melicope reflexa* | D, P, Pl | X | X | |
| *Phyllostegia mannii* | P | X | X | |
| *Pritchardia munroi* | D, G, P, R | X | X | |
| *Schiedea lydgatei* | Pl | X | | |
| *Silene alexandri* | G, (C) | X | | |
| *Silene lanceolata* | G, P, S, Pl | X | | |
| *Stenogyne bifida* | D, G, P | | | X |
| *Tetramolopium rockii* | D, C, Pl, (G) | X | | X |

Key: D - deer, G - goats, C - Cattle, S - Sheep, P - pigs, R - rats, Pl - plants, () - potential threat.

Table 3. Summary of threats to the Molokai cluster taxa

A large portion of the axis deer population on Molokai has been actively managed for recreational hunting by the Hawaii Division of Forestry and Wildlife (DOFAW) since 1959. The maximum allowable limit is only one male deer per hunting trip; the remainder are managed to provide a sustainable yield (USFWS 1992). Its future as a game species is assured because of its popularity among hunting organizations and its adaptability to the environment of Molokai (USFWS 1992). At present, five of the seven managed hunting areas on Molokai are within the Molokai Forest Reserve. Many areas lack maintained boundary fences that would prevent deer from entering more fragile habitats to the north (USFWS 1992) and non-game areas to the east. Recently axis deer have begun to enter the windward valleys and the northern coastline of East Molokai where they were not previously observed (USFWS 1992). At Moomomi, axis deer graze primarily on introduced plants inland of the dunes (USFWS 1992), but they are also likely to consume *Tetramolopium rockii* where it is the dominant ground cover. Axis deer are threatening the coastal habitats of *Brighamia rockii* and *Tetramolopium rockii* and the montane habitats of *Melicope reflexa*, *Pritchardia munroi*, and *Stenogyne bifida* (USFWS 1992). The lowland habitat of *Bidens wiebkei* is also threatened by axis deer (USFWS 1992).

Introduced to Molokai in the early 1800s, the goat (*Capra hircus*) population flourished despite losses in the goatskin trade that spanned most of that century (USFWS 1992). Currently, feral goats, unlike axis deer, degrade Molokai's higher elevation dry forests (USFWS 1992) and are now invading the wetter regions along the northern coast of East Molokai (USFWS 1992). The impact of feral goats on native vegetation is similar to that described for deer (USFWS 1992). Although northeastern Molokai is considered one of the most remote and inaccessible places in the main Hawaiian Islands, the vegetation there is predominantly exotic (USFWS 1992). The replacement of native vegetation is attributed to the large number of goats. Due to their agility, goats can reach vegetation not usually accessible to other animals (USFWS 1992). As a result, various native plants are confined to areas inaccessible to goats. For example, *Brighamia rockii* persists on steep ledges out of the reach of goats and is unlikely to reestablish in any place accessible to them (USFWS 1992). A goat exclosure experiment on the island of Hawaii demonstrated that *Canavalia hawaiiensis*, a relative of *Canavalia molokaiensis*, is consumed by goats (USFWS

1992). The sole populations of *Silene alexandri* and *Silene lanceolata* at Makolelau; the *Bidens wiebkei* population at Makakupaia; populations of *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, and *Stenogyne bifida* along the northern shore of East Molokai; *Cyanea procera* at the head of Waikolu Valley; and the only known wild *Pritchardia munroi* palm are threatened by goats (USFWS 1992). The Hawaii Island populations of *Silene lanceolata* located at the Pohakuloa Training Area are also threatened by feral goats found throughout the region. Like axis deer, goats are managed by the Division of Forestry and Wildlife as a game animal, assuring the persistence of goat populations on the island of Molokai.

Unlike axis deer and goats, pigs (*Sus scrofa*) are generally restricted to the wetter forested regions of Molokai, predominantly in the Molokai Forest Reserve where the majority of the plants covered by this plan are located. Well known as a major destroyer of these forest habitats, feral pigs root extensively, trample native vegetation cover, and generally degrade native habitat (USFWS 1992). Feral pigs are major disseminators of alien plant seeds by carrying them internally or on their bodies, and they often carry the seeds into more pristine forests, further degrading the native ecosystem. In East Molokai's wet upland forests, pigs are destroying the habitat of most populations of *Canavalia molokaiensis*, *Cyanea mannii*, and *Melicope reflexa*, both populations of *Clermontia oblongifolia* ssp. *brevipes*, the only known population of *Phyllostegia mannii*, and the remaining individuals of *Hedyotis mannii* (USFWS 1992). Pigs also threaten the Kawela Gulch population of *Stenogyne bifida* on Molokai and locally degrade the habitat of *Silene lanceolata* on the island of Hawaii (USFWS 1992). The only known surviving plant of *Pritchardia munroi* in the wild was recently fenced to protect it from pigs and other ungulates (USFWS 1992). They continue to degrade the habitat outside the fenced enclosure, making it unlikely that seedlings will become established there. Eradication efforts in The Nature Conservancy of Hawaii preserves include public hunting; many other areas of East Molokai also have public hunting programs (USFWS 1992). However, feral pigs are invasive animals and often inhabit gulches and areas not frequented by hunters or management personnel, hindering the control of those animals in remote sites.

Feral sheep (*Ovis aries*) have become firmly established on the island of Hawaii (USFWS 1992) since their introduction to that island in 1793 (Cuddihy

and Stone 1990). Like feral goats, sheep roam the upper elevation dry forests of Mauna Kea (above 1,000 meters (3,300 feet)), including the Pohakuloa Training Area, causing damage similar to that of goats (USFWS 1992). Sheep have decimated vast areas of native forest and shrubland on Mauna Kea and continue to do so as a managed game species. Sheep threaten the habitat of *Silene lanceolata.*

Rats (*Rattus* spp.) eat the fruits of *Pritchardia munroi* (USFWS 1992). Although the incidence of rats in the vicinity of the last remaining wild plant appears to be low, the fence that was erected to protect that plant from foraging animals does not prevent rats from continuing to feed on the fruit (USFWS 1992). A more important threat is foraging by goats and other ungulates in the area, which has resulted in a lack of successful regeneration of the palm (USFWS 1992). There is no direct evidence that rats feed on *Brighamia rockii*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, or *Cyanea procera.* However, such evidence does exist for related *Clermontia* and *Cyanea* species in similar habitat on other islands (USFWS 1992). Because rats are found in remote areas on Molokai, it is likely that predation occurs on these four taxa as well (USFWS 1992).

Ranching, Agriculture and Development

Although not a direct threat, cattle (*Bos taurus*) ranching on Molokai has played a significant role over most of the past 150 years in reducing areas of native vegetation to vast pastures of alien grasses (USFWS 1992). In 1960, approximately 61 percent of Molokai's land area was devoted to grazing, primarily the lower elevation dry to mesic forests, shrublands, and grasslands of West and central Molokai (USFWS 1992). Cattle degraded the habitat by trampling and feeding on vegetation, eventually opening up the ground cover, exposing the soil, and increasing its vulnerability to erosion (USFWS 1992). Red erosional scars resulting from decades of cattle disturbance, and exacerbated by other feral ungulate activities, are still evident on West Molokai and upper elevation ridges of East Molokai. Cattle also have facilitated the spread of alien grasses and other plants (USFWS 1992). Because of this alteration of vegetation, natural areas became limited to the upper elevation mesic to wet forests of East Molokai, where the State designated a single protected area: the Molokai Forest Reserve. Most of the taxa covered by this plan are restricted to this forest reserve,

which occupies about 30 percent of Molokai's land area (USFWS 1992). As the fences separating cattle ranches from the forest reserve began to deteriorate over time, cattle from low elevation pastures were free to enter the forest reserve, further degrading the native forest (USFWS 1992).

In the early 1970s, in an effort to keep bovine tuberculosis from entering domestic stock, a total of 375 wild cattle were eradicated from the forest reserve (USFWS 1992). Because this did not eliminate tuberculosis, domestic cattle were eradicated from the island between 1985 and 1986. After a mandatory 1-year hiatus, ranches were allowed to reintroduce non-breeding and later breeding animals, and the cattle population on Molokai is now growing (USFWS 1992). At present, cattle are limited to a large private ranch on West Molokai with over 1,800 animals and small private ranches on East Molokai (USFWS 1992). Cattle are not known to have entered the Molokai Forest Reserve since their reintroduction to the island in 1987 (USFWS 1992). However, on West Molokai there have been reports of cattle in Moomomi Preserve (USFWS 1992), where a protective fence was recently erected to protect *Tetramolopium rockii* and other unique native plants (USFWS 1992). Since part of the *T. rockii* population lies outside the fence, cattle continue to degrade habitat of this taxon. The future of cattle and their impact on the native vegetation of Molokai, including the 16 taxa covered by this plan, are uncertain. However, if cattle ranching becomes a more important economic activity on the island, the impact of cattle will likely be increasingly deleterious.

Cattle ranching was the island's primary industry until the 1920s, when pineapple cultivation was introduced to boost the then failing economy (USFWS 1992). Most of the land used for this form of agriculture had already been altered through decades of extensive ranching activities. Until the industry's decline in the 1970s, pineapple cultivation contributed significantly to the high degree of erosion on Molokai (USFWS 1992). More recently, economic growth has been based largely on tourism (USFWS 1992). Hotels are being proposed in conjunction with an anticipated increase in the tourist industry. Although development is limited at present to the primary tourist destination of Kaluakoi on Molokai's western end, it is likely that development will affect the native vegetation elsewhere on the island.

Alien Plants

Seven of the 16 taxa are threatened by competition with 1 or more alien plant species. Introduced to Hawaii before 1911, Christmas berry (*Schinus terebinthifolius*) has had particularly detrimental impacts (USFWS 1992). Its spread is facilitated by the opening of the ground cover and canopy by feral ungulates. This fast-growing tree is considered one of the major alien plant problems affecting the native vegetation of Molokai because it may form dense thickets that displace other plants (USFWS 1992). It is spreading in Kalaupapa, Waikolu, and throughout Halawa (USFWS 1992), where it presently threatens the habitat of four of the five populations of *Bidens wiebkei* and may threaten populations of *Brighamia rockii* (USFWS 1992).

With the introduction of cattle, goats, and deer and the development of organized ranching, the native forests in many parts of the State were converted to vast pastures of alien grasses. Of the alien grasses that have become established on Molokai, *Melinus minutiflora* (molasses grass) is probably the most disruptive to the native dry forests. First introduced as cattle fodder (USFWS 1992), then planted for erosion control (USFWS 1992), this alien species quickly spread to dry and mesic forests previously disturbed by ungulates. Molasses grass produces a dense mat that may smother plants (USFWS 1992), essentially preventing seedling growth and native plant reproduction (USFWS 1992). As a fuel for fire, molasses grass intensifies its heat and carries fire into areas with woody plants (USFWS 1992). It can spread prolifically after a fire and effectively compete with less fire-adapted native plant species, creating a dense stand of alien grass where forests once stood. Molasses grass is becoming a major problem in dry sites along the many leeward ridges of East Molokai. Also affected are the lower portions of Kamakou Preserve and outlying areas to the south (USFWS 1992). Here all five populations of *Schiedea lydgatei*, and populations of *Canavalia molokaiensis* and *Hedyotis mannii* are threatened by invading molasses grass (USFWS 1992). The southern section of Halawa, containing a population of *Bidens wiebkei*, is also infested (USFWS 1992). The other plant taxa covered by this plan that are found near molasses grass are not presently threatened, because they grow in gulches and wetter areas where the intact ground cover makes invasion by molasses grass difficult.

*Prosopis pallida* (kiawe), a common deciduous tree found in arid, low-

elevation, disturbed sites on Molokai (USFWS 1992), has invaded areas adjacent to the hardened sand dunes of Moomomi Preserve where *Tetramolopium rockii* grows (USFWS 1992). Kiawe shades the ground cover and its vast root system dries the substrate by utilizing all available water (USFWS 1992). It thus competes with *Tetramolopium rockii* (USFWS 1992) for light, space, and moisture.

Of the naturalized species in the melastome family, *Clidemia hirta* (Koster's curse) has become one of the most disruptive invaders of Hawaii's native ecosystems (USFWS 1992). First reported from the island of Oahu in 1941, Koster's curse quickly invaded the other Hawaiian Islands and now occupies more than 60 square kilometers (23 square miles) on East Molokai, primarily in Pelekunu and Wailau valleys (USFWS 1992). This noxious shrub forms a dense understory up to 2 meters (6 feet) tall, shading other plants and hindering plant regeneration (USFWS 1992). Koster's curse threatens to replace the Wailau-Mapulehu summit ridge population of *Melicope reflexa* (USFWS 1992).

*Pennisetum setaceum* (fountain grass) is a fire-adapted bunch grass that has spread rapidly over bare lava flows and open areas on the island of Hawaii since its introduction in the early 1900s. Fountain grass is particularly detrimental to Hawaii's dry forests because it can invade areas once dominated by native plants, where it interferes with plant regeneration, carries fires into areas not usually prone to fires, and increases the likelihood of fires (USFWS 1992). The *Chamaesyce olowaluana* (akoko) forests on the island of Hawaii, apparently former habitat of *Silene lanceolata*, have burned repeatedly and are now largely replaced by fountain grass (USFWS 1992). This alien plant is present in the habitat of one of the populations of *Silene lanceolata* on the island of Hawaii, where it is likely to become a more serious problem.

Fire

Fire is a major threat to the plant species found in dry to mesic habitats, especially in the lower portions of Kamakou Preserve and adjacent areas to the south, where populations of *Schiedea lydgatei, Silene alexandri*, and *Silene lanceolata* are located (USFWS 1992). Populations of *Bidens wiebkei* at Halawa and *Tetramolopium rockii* at Moomomi are also threatened by fire (USFWS 1992). For reasons previously discussed, the presence of molasses grass greatly

enhances the potential and destructiveness of fires. For example, in 1988 a human-caused fire consumed roughly 38 square kilometers (15 square miles) of shrubland and forest from the southern coastline of East Molokai to the southwest corner of Kamakou Preserve, about 5.5 kilometers (3.5 miles) inland (USFWS 1992). This fire burned two of the five populations of *Schiedea lydgatei*, and they may have been permanently destroyed. Molasses grass was the main carrier of that fire (USFWS 1992). Although fires are not frequent at Moomomi, a single fire could burn extensively through dry shrub and grassland and destroy portions of the *Tetramolopium rockii* populations that grow there (USFWS 1992). The dry to mesic habitat of *Pritchardia munroi* is also threatened by fire (USFWS 1992).

Natural or human-caused fires within the Pohakuloa Training Area on the island of Hawaii or Makua Military Reservation on the island of Oahu threaten native vegetation, including the habitat of four populations of *Silene lanceolata.* Although the habitat of Hawaii Island populations of *S. lanceolata* at Kipuka Alala and Kipuka Kalawamauna has apparently been burned repeatedly, those populations are still present (USFWS 1992). This suggests the possibility that this species may be tolerant to fire. However, fire-adapted grasses already at these sites can exploit newly burned areas more rapidly than woody species (USFWS 1992) (presumably including *S. lanceolata*), resulting in the conversion of native shrubland to land dominated by alien grasses. Fire is, therefore, at least an indirect and serious threat to this species. In order to protect the Kipuka Kalawamauna population from fires, the U.S. Army has installed firebreaks and now redirects ordnance firing away from that kipuka. The Army is also developing plans to protect the newly discovered Kipuka Alala population.

Human Impacts

Habitat disturbance caused by human activities threatens five of the taxa. Military exercises at the Pohakuloa Training Area on the island of Hawaii have threatened *Silene lanceolata* in the past. Planned military maneuvers are now being reevaluated in light of the recent discovery of the Kipuka Alala and Kipuka Kalawamauna populations of that species. Recreational activities such as fishing and camping have drawn people to Moomomi Preserve and the adjacent coastline. The population of *Tetramolopium rockii* on State-owned Hawaiian Home Lands east of Moomomi Preserve is subject to disturbance by vehicles passing along two

jeep roads that run through that population (USFWS 1992), which represents almost 25 percent of the individuals of that species. Although the human impact on the spray zone population of *T. rockii* on Kalaupapa Peninsula is now minimal, greater impacts may result from the expected increase in visitor use after the residents of Kalaupapa's Hansen's disease settlement live out their lives (USFWS 1992). A population of *Bidens wiebkei* at Makakupaia, representing approximately half of the total individuals of that species, grows along a jeep road. Off-road activity would damage a significant portion of that population. The one remaining population of *Stenogyne bifida* is located near a hiking trail at Kawela and has the potential of being trampled or collected (USFWS 1992).

Overutilization is not known to be a factor, but unrestricted collecting for scientific or horticultural purposes or excessive visits by individuals interested in seeing rare plants could result from increased publicity and would seriously impact the 11 taxa whose low numbers make them especially vulnerable to disturbances. Such disturbance could promote erosion and greater ingression of alien plant species.

Vulnerability Due to Low Numbers

The small number of populations and individual plants of many of these taxa increases the potential for extinction from random naturally occurring events. The limited gene pool may depress reproductive vigor, or a single human-caused or natural environmental disturbance could destroy a significant percentage of the individuals or the only extant population. For example, three of the taxa are known from a single population: *Clermontia oblongifolia* ssp. *brevipes* (< 20 plants), *Pritchardia munroi* (a single remaining plant in the wild), and *Stenogyne bifida* (12 plants). All of the 16 taxa are known from 9 or fewer populations; 12 of them from fewer than 5 populations. Eight of the taxa are estimated to number no more than 100 known individuals.

## 4. Overall Conservation Efforts

Federal and State

The taxa covered by this plan were added to the Federal list of endangered and threatened species on October 8, 1992; 15 as endangered and 1as threatened.

The Federal listing of the taxa in the Molokai cluster as endangered or threatened has afforded each the protection of the Endangered Species Act (ESA). 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 Endangered Species Act offers additional Federal protection to these taxa since it is a violation of the act for any person to remove, cut, dig up, or 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 ESA].

Critical habitat was not designated for any of the taxa in the Molokai 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 in local newspapers (USFWS 1992).

In 1994, the Hawaii Department of Agriculture released a leaf-eating insect, *Lius poseidon*, a member of the flat-headed wood-borer family (Buprestidae), as a biological control agent in an attempt to control the invasive alien plant, Koster's curse (*Clidemia hirta*) (Patrick Conant, Hawaii Department of Agriculture, personal communication 1996).

In March of 1989, the State of Hawaii erected a fence to protect the last remaining individual of *Pritchardia munroi* from the effects of feral ungulates. The State has also constructed a fence that divides Puu Alii Natural Area Reserve (NAR) into two manageable areas. Between 1992 and 1994, the State reduced the

numbers of feral pigs, goats and deer by using aerial hunting in the Molokai Forest Reserve, and by using snares at Puu Alii Natural Area Reserve. Currently, the State is working with The Nature Conservancy of Hawaii and local hunters to control feral ungulates through cooperative hunting efforts (Robert Hobdy, DOFAW, personal communication 1995).

Private

The Nature Conservancy of Hawaii operates three preserves on the island of Molokai that contain some of the species covered by this plan. These preserves are Kamakou, Moomomi, and Pelekunu. In the past (1991-1992), The Nature Conservancy of Hawaii has employed snaring to control feral ungulates in remote sections of Kamakou and Pelekunu, and it is working with the State and local hunters to control feral ungulates through cooperative hunting efforts. At Moomomi, The Nature Conservancy of Hawaii contributes to the maintenance of a boundary fence that excludes cattle from neighboring ranch lands. Exclosures have been erected to determine the effects of deer on coastal dunes. Until The Nature Conservancy of Hawaii has a better understanding of the effects of deer within Moomomi Preserve, no control efforts will be undertaken (Joan Yoshioka, TNCH, personal communication 1995). Alien plant control has been conducted around the population of *Stenogyne bifida* on Kamakou Preserve.

Seeds and/or plants of some of these taxa have been collected by the National Tropical Botanical Garden (NTBG) and the Hawaii Plant Conservation Center (HPCC), located on the island of Kauai, Hawaii. Many of these plants have also been successfully propagated in their facilities. Table 4 presents the National Tropical Botanical Garden's holdings and propagation success of the Molokai cluster taxa, as of January 1995 (Diane Ragone, NTBG, personal communication 1995). The National Tropical Garden's plans for these holdings include research into propagation methods and feasibility of long-term seed storage.

Waimea Arboretum, on the north shore of the island of Oahu, Hawaii, has also been involved in the collection and propagation of some of these species. Individuals of *Bidens wiebkei* and *Pritchardia munroi* are currently being grown

at Waimea Arboretum. The arboretum was unsuccessful at propagating and maintaining the following Molokai Plant Cluster taxa: *Canavalia molokaiensis*, *Brighamia rockii*, *Tetramolopium rockii* var. *calcisabulorum*, and *Tetramolopium rockii* var *rockii* (David Orr, Waimea Arboretum, personal communication 1995).

| Taxon | Seeds | Propagated? (Y/N) |
|---|---|---|
| *Bidens wiebkei* | 1,800 | Y |
| *Brighamia rockii* | 9,750 | Y |
| *Canavalia molokaiensis* | not counted | Y |
| *Clermontia oblongifolia* ssp. *brevipes* | 0 | N |
| *Cyanea mannii* | 100 | Y |
| *Cyanea procera* | 0 | N |
| *Hedyotis mannii* | 620 | Y |
| *Hibiscus arnottianus* ssp. *immaculatus* | 0 | Y |
| *Melicope reflexa* | 0 | N |
| *Phyllostegia mannii* | 760 | Y |
| *Pritchardia munroi* | 0 | Y |
| *Schiedea lydgatei* | 800 | N |
| *Silene alexandri* | 1,775 | Y |
| *Silene lanceolata* | 1,200 | N |
| *Stenogyne bifida* | 130 | Y |
| *Tetramolopium rockii* | | |
| var. *calcisabulorum* | 7,000 | Y |
| var. *rockii* | 11,960 | Y |

Table 4. Seeds and plants of the Molokai cluster taxa at the National Tropical Botanical Garden, Kauai (D. Ragone, personal communication 1995).

## 5. Species Accounts

The following are individual species accounts for the Molokai plant cluster taxa. The general strategy for the recovery of these species can be found in the Overall Recovery Strategy section, immediately following the Species Accounts section. Species-specific recovery actions can be found in the account for that species.

***Bidens wiebkei*** Recovery Priority 2
(on USFWS scale of 1-18 (USFWS 1983) - See Appendix E

Description and Taxonomy

Appendix B contains a line drawing of this taxon.

*Bidens wiebkei* was named by Earl Edward Sherff in honor of Henry Wiebke, a school principal on Molokai, who, with Otto Degener, discovered the plant in 1928 (USFWS 1992). Sherff (1928a) named *Bidens campylotheca* var. *nematocera* based on Wilhelm Hillebrand's (1888) description of an unnamed variety of *Campylotheca grandiflora* from Molokai; he later raised this taxon to specific status and published the combination *Bidens nematocera* (USFWS 1992). Hillebrand's type, the only specimen of *B. nematocera* collected, was deposited in Berlin and destroyed during World War II. In the current treatment of the genus, Fred R. Ganders and Kenneth M. Nagata (1990) tentatively consider *B. nematocera* to be synonymous with *B. wiebkei*. A line drawing of this species can be found in Appendix B.

*Bidens wiebkei*, a member of the aster family (Asteraceae), is a perennial herb which is somewhat woody at the base and grows from 0.5 to 1 meters (1.6 to 3.3 feet) tall. The opposite, pinnately (consisting of many small leaflets) compound leaves are 7 to 13 centimeters (2.8 to 5.1 inches) long and each has three to seven leaflets, 2.5 to 8 centimeters (1 to 3 inches) long and 1 to 2.5 centimeters (0.4 to 1 inch) wide. Flower heads are arranged on side branches in clusters of usually 10 to 30, each 1.6 to 2.5 centimeters (0.6 to 1 inch) in diameter and comprising 4 to 6 sterile, yellow ray florets (small flowers), about 10 to 12 millimeters (0.5 inch) long and 2 to 5 millimeters (0.08 to 0.2 inch) wide, and 9 to

18 bisexual, yellow disk florets. Fruits are brownish-black achenes (dry, one-seeded fruits), which are curved or twisted and winged and measure 6 to 9 millimeters (0.2 to 0.4 inch) long and 0.9 to 2 millimeters (0.04 to 0.08 inch) wide. This plant is distinguished from other *Bidens* species growing on Molokai by its erect habit and the curved or twisted, winged achenes (USFWS 1992).

Life History

This species was observed in flower during May 1982 (HHP 1990a). No additional life history information is currently available.

Habitat Description

Four populations of this species are scattered along steep, exposed slopes (USFWS 1992) in *Metrosideros polymorpha* (ohia) dominated mesic shrublands and forests at 250 to 1,050 meters (820 to 3,450 feet) in elevation (USFWS 1992). Other associated plant taxa include *Antidesma* (hame), *Nestegis sandwicensis* (olopua), *Pisonia* (papala kepau), and *Scaevola gaudichaudii* (naupaka kuahiwi) (USFWS 1992).

Current and Historic Ranges and Population Status

Historically, *Bidens wiebkei* was known from Pelekunu and the easternmost section of Molokai at Halawa (USFWS 1992). It is still found near Halawa and was recently discovered on Puu Kolekole, just south of its historical range, on privately owned land (USFWS 1992). The four populations of this species are distributed over a distance of 4 by 1.6 kilometers (2.5 by 1 miles), and number at least 100 individuals (Loyal Mehrhoff, USFWS, personal communication 1995).

Reasons for Decline and Current Threats

The major threats to *Bidens wiebkei* include habitat degradation and possible predation by deer and feral goats, competition with alien plants (*Melinus minutiflora* (molasses grass) and *Schinus terebinthifolius* (Christmas berry)), and fire. Damage or vandalism by humans of those plants found along trails is also a serious threat.

Conservation Efforts

Seeds of this species have been collected and propagated by the National Tropical Botanical Garden and Waimea Arboretum. No additional species-specific conservation efforts have been undertaken. General conservation efforts for the Molokai plant cluster taxa can be found in the Overall Conservation Efforts section of this plan.

Needed Recovery Actions

The general strategies discussed in a later section, 6. Overall Recovery Strategy, are appropriate for this species.

***Brighamia rockii*** Recovery Priority 2

Description and Taxonomy

No line drawing is available for this taxon.

Asa Gray described *Brighamia insignis* based upon alcohol-preserved flowers and fruits collected by William Tufts Brigham on Molokai and a dried specimen collected on Kauai or Niihau by Ezechiel Jules Remy (USFWS 1992). Brigham's bottled material has since been lost. In his monograph, Harold St. John (1969) named plants collected on Molokai *B. rockii* and *B. rockii f. longiloba*, based, respectively, upon specimens collected by Frances Raymond Fosberg and Charles Noyes Forbes. The specific epithet was chosen to honor Joseph F. Rock. St. John (1969) also described *B. remyi*, based upon a specimen collected on Maui by Remy. In the current treatment of the genus, Thomas G. Lammers (1990) recognizes only two species: *Brighamia rockii* for plants presently found on Molokai and possibly for those formerly found on Lanai and Maui, and *Brighamia insignis* for the Kauai and Niihau plants.

*Brighamia rockii*, a member of the bellflower family (Campanulaceae), grows as an unbranched plant 1 to 5 meters (3.3 to 16 feet) tall with a thickened, succulent stem that tapers from the base. The fleshy, oval leaves are widest at their tips and are arranged in a rosette (circular cluster) at the top of the plant. They measure 6 to 22 centimeters (2.4 to 8.7 inches) long and 5 to 15 centimeters (2 to 6 inches) wide. The fragrant flowers are clustered in groups of three to eight

in the leaf axils (the point between the leaf and the stem). Each flower cluster is on a stalk 3.5 to 7.5 centimeters (1.4 to 3.0 inches) long, and each flower is on a stalk 6 to 12 millimeters (0.2 to 0.5 inch) long. The green basal portion of the flower (hypanthium) has 10 ribs and is topped by 5 calyx lobes 2.5 to 8 millimeters (0.01 to 0.3 inch) long. The petals are fused into a green to yellowish-green tube 8 to 13 centimeters (3.1 to 5.1 inches) long and 0.2 to 0.4 centimeters (0.1 to 0.2 inch) wide that flares into five white, elliptic lobes 1.7 to 3.7 centimeters (0.7 to 1.5 inches) long and 0.8 to 1.3 centimeters (0.3 to 0.5 inch) wide. The fruit is a capsule 13 to 20 millimeters (0.5 to 0.8 inch) long, 7 to 10 millimeters (0.3 to 0.4 inch) wide, and 3 to 4 millimeters (0.1 to 0.2 inch) thick containing numerous seeds about 1.1 to 1.2 millimeters (0.05 inch) long. This species is a member of a unique endemic Hawaiian genus with only one other species, found on Kauai, from which it differs by the color of its petals, its longer calyx (fused sepals) lobes, and its shorter flower stalks (USFWS 1992).

Life History

Recent observations of *Brighamia* by Gemmill et al. (In Prep.) has provided the following information: the reproductive system is protandrous, meaning there is a temporal separation between the production of male and female gametes, in this case a separation of several days; only 5 per cent of the flowers produce pollen; very few fruits are produced per inflorescence; there are 20-60 seeds per capsule; and plants in cultivation have flowers at an age of 9 months. This species was observed in flower during August 1987 (HHP 1994a).

Habitat Description

The plants are found in rock crevices on steep sea cliffs, often within the spray zone, in Coastal Dry to Mesic Forests or Shrublands at an elevational zone from sea level to 470 meters (1,540 feet) with such associated species as ohia, *Canthium odoratum* (alahee), *Diospyros sandwicensis* (lama), *Osteomeles anthyllidifolia* (ulei), and *Scaevola* (naupaka) (USFWS 1992).

Current and Historic Ranges and Population Status

*Brighamia rockii* once ranged along the northern coast of East Molokai from Kalaupapa to Halawa and may possibly have grown on Lanai and Maui

(USFWS 1992). Today its range has decreased to scattered populations on steep, inaccessible sea cliffs along East Molokai's northern coastline from Anapuhi Beach to Wailau Valley on private land, and on the relatively inaccessible State-owned sea stack of Huelo, east of Anapuhi Beach (USFWS 1992). The 5 known populations of *Brighamia rockii* that extend over this 10.5-kilometer (6.5-mile) long stretch total fewer than 200 individuals (Steve Perlman, NTBG, personal communication 1995).

Reasons for Decline and Current Threats

Habitat damage (and possibly predation) by deer and goats poses a serious threat to *Brighamia rockii*. Competition with alien plants is also a threat. Although there is no evidence that rats feed on the fruits, rats are also a potential threat, as evidenced by predation on related Hawaiian genera. Recent observations suggest that low reproductive rates in wild populations could be due to a combination of factors including low production of pollen, low establishment of seedlings and a lack of pollinators (Gemmill et al. In Prep.).

Conservation Efforts

Hand pollination of *Brighamia rockii* has been conducted, and seeds have been collected and propagated by the National Tropical Botanical Garden. No additional species-specific conservation efforts have been undertaken. General conservation efforts for the Molokai plant cluster taxa can be found in the Overall Conservation Efforts section of this plan.

Needed Recovery Actions

The general strategies discussed in a later section, 6. Overall Recovery Strategy, are appropriate for this species.

***Canavalia molokaiensis*** Recovery Priority 2

Description and Taxonomy

Appendix B contains a line drawing of this taxon.

Forbes first collected *Canavalia molokaiensis* on Molokai in 1912, and 50

years later Otto Degener, Isa Degener, and J. Sauer described the species (Degener *et al.* 1962). Fosberg (1966) reduced several Hawaiian species of the genus to varieties, resulting in the name *C. galeata* var. *molokaiensis* for this taxon. In his revision of the Hawaiian taxa of the genus, St. John (1970) accepted *C. molokaiensis* and published two additional names, *C. peninsularis* and *C. stenophylla*, for Molokai plants. In the current treatment (Wagner and Herbst 1990), however, only *C. molokaiensis* is recognized. A line drawing of this species can be found in Appendix B.

*Canavalia molokaiensis*, a member of the pea family (Fabaceae), is a perennial climbing herb with twining branches. Each leaf is made up of three lance-shaped or sometimes oval leaflets, which usually measure 3.5 to 8 centimeters (1.4 to 3 inches) long and 1.3 to 5.4 centimeters (0.5 to 2.1 inches) wide. Four to 15 flowers are arranged along a stalk 3 to 9 centimeters (1.2 to 3.5 inches) long. The calyx (fused sepals), which is 20 to 28 millimeters (0.8 to 1.1 inches) long, comprises a larger upper lip with two lobes and a smaller lower lip with three lobes. The five rose-purple petals vary from 36 to 47 millimeters (1.4 to 1.9 inches) in length. The flattened pods, 12 to 16 centimeters (4.7 to 6.3 inches) long and 2.3 to 3.5 centimeters (0.9 to 1.4 inches) wide, enclose flattened, dark reddish-brown, oblong-elliptic seeds, which are 17 to 22 millimeters (0.7 to 0.9 inch) long and about 12 to 14 millimeters (0.5 inch) wide. The only species of its genus found on Molokai, this plant can be distinguished from others in the genus by its narrower leaflets and its larger, rose-purple flowers (USFWS 1992).

Life History

This species has been observed in flower during May 1982 (HHP 1990b) and December 1989 (HHP 1990c). Fruits and flowers were observed in March 1989 (HHP 1990d). No additional life history information is currently available.

Habitat Description

This species typically grows in exposed dry sites on steep slopes in mesic shrublands and forests at 850 to 930 meters (2,790 to 3,050 feet) elevation (USFWS 1992). Associated plant species include ohia, *Chamaesyce* (akoko), *Dodonaea viscosa* (aalii), *Styphelia tameiameiae* (pukiawe), and *Wikstroemia* (akia) (USFWS 1992).

Current and Historic Ranges and Population Status

Historically, *Canavalia molokaiensis* was known from East Molokai, at Kalaupapa, Pelekunu, and farther south in Kahuaawi Gulch and the region of Manawai (USFWS 1992). It now has a more restricted range: from Kalaupapa to Waialeia, Kaunakakai, and Kamakou (USFWS 1992). The 7 known populations, with fewer than 1,000 individuals, are on State and private land, as well as land leased by the National Park Service from the Department of Hawaiian Home Lands, and are distributed over an 11- by 5.5-kilometer (7- by 3.5- mile) area (J. Lau, personal communication 1996). The largest population of roughly 20 plants lies within a 0.081-hectare (0.2-acre area) (USFWS 1992).

Reasons for Decline and Current Threats

Feral ungulates, particularly goats and pigs, degrade the habitat of *Canavalia molokaiensis* extensively and pose an immediate threat to this species. Predation on a related species of *Canavalia* suggests that goats may possibly consume this species. Competition with the alien plant, molasses grass, is also an immediate threat.

Conservation Efforts

Seeds of *Canavalia molokaiensis* have been collected and propagated by the National Tropical Botanical Garden. No additional species-specific conservation efforts have been undertaken. General conservation efforts for the Molokai plant cluster taxa can be found in the Overall Conservation Efforts section of this plan.

Needed Recovery Actions

The general strategies discussed in a later section, 6. Overall Recovery Strategy, are appropriate for this species.

***Clermontia oblongifolia ssp. brevipes*** Recovery Priority 6

Description and Taxonomy

Appendix B contains a line drawing of this taxon.

Franz Elfried Wimmer (1943) described *Clermontia oblongifolia* f. *brevipes* based upon a specimen collected by Forbes on Molokai in 1912. The name of the form refers to the plant's short leaves, leaf stalks, and flower stalks. Lammers (1988) raised this taxon to the subspecific level when he published the new combination *C. oblongifolia* ssp. *brevipes*. A line drawing of this species can be found in Appendix B.

*Clermontia oblongifolia* ssp. *brevipes*, a member of the bellflower family, is a shrub or tree, which reaches a height of 2 to 7 meters (6.6 to 23 feet). The leaves, on petioles (leaf stalks) 1.8 to 3 centimeters (0.7 to 1.2 inches) long, are lance-shaped; have thickened, rounded teeth; and reach a length of 7 to 11 centimeters (2.8 to 4.3 inches) and a width of 2 to 5 centimeters (0.8 to 2 inches). Two or sometimes three flowers are grouped together on a stalk 5 to 10 millimeters (0.2 to 0.4 inch) long, each flower having a stalk 1 to 4.5 centimeters (0.4 to 1.8 inches) long. The flower is 6 to 7.8 centimeters (2.4 to 3.1 inches) long; the calyx (fused sepals) and corolla (fused petals) are similar in size and appearance, and each forms an arched tube, which is greenish-white or purplish on the outside and white or cream colored on the inside. The nearly spherical, orange fruit is a berry, 17 to 30 millimeters (0.7 to 1.2 inches) long. This species is distinguished from others in the genus by the structure of its calyx and corolla as well as by the lengths of the flower, the floral lobes, and the green hypanthium. This subspecies differs from others of the species by the shape of its leaves and the lengths of its leaves, leaf stalks, and flower stalks (USFWS 1992).

Life History

No life history information for this species is currently available.

Habitat Description

This taxon typically grows in shallow soil on gulch slopes in wet ohia-dominated forests at elevations between 1,100 and 1,200 meters (3,500 and 3,900

feet) (USFWS 1992). Associated plant species include *Cheirodendron trigynum* (olapa) (USFWS 1992).

Current and Historic Ranges and Population Status

*Clermontia oblongifolia* ssp. *brevipes* is known from a single population located in the southeastern part of TNCH's Kamakou Preserve, East Molokai (USFWS 1992). This population was last seen in 1982, and is thought to contain fewer than 20 individuals. Another possible population, also from the Kamakou area, has not been seen for over 40 years and is believed to have been extirpated (USFWS 1992). Other than this population, the historical range is not known. If the species cannot be found, it may be considered for delisting due to extinction.

Reasons for Decline and Current Threats

Feral pigs are an immediate threat to the habitat of the single remaining population of *Clermontia oblongifolia* ssp. *brevipes*. Its limited number makes the taxon vulnerable to extinction by a single random naturally occurring event. Predation on related species suggests that rats may possibly feed on the fruit or plant parts of this taxon (USFWS 1992).

Conservation Efforts

No species-specific conservation efforts have been undertaken. General conservation efforts for the Molokai plant cluster taxa can be found in the Overall Conservation Efforts section of this plan.

Needed Recovery Actions

The general strategies discussed in a later section, 6. Overall Recovery Strategy, are appropriate for this species, but the following actions are felt to be particularly urgent.

In order to prevent this species from going extinct, the propagation and maintenance of *ex situ* (at other than its original site, such as in a nursery or arboretum) genetic stock should be immediately undertaken, as well as the protection of remaining wild individuals from the effects of pigs and rats. Following these immediate preservation measures, long-term recovery actions should be implemented.

## *Cyanea mannii* Recovery Priority 2

Description and Taxonomy

No line drawing is available for this taxon.

Brigham named *Delissea mannii* in honor of Horace Mann, Jr., with whom he collected the plant on Molokai in the 1860s and in whose "Enumeration" Brigham published the name (Mann 1867). Hillebrand (1888) transferred the taxon to the genus *Cyanea*, resulting in the name *Cyanea mannii*.

*Cyanea mannii*, a member of the bellflower family, is a branched shrub 1.5 to 3 meters (5 to 10 feet) tall. The leaves are narrowly elliptic or lance-shaped, 12 to 21 centimeters (4.7 to 8.3 inches) long and 2.5 to 5 centimeters (1 to 2 inches) wide, and have petioles 2.2 to 10 centimeters (0.9 to 3.9 inches) long and hardened teeth along the leaf margins. Each flower cluster, arising from the axil of a leaf on a stalk 20 to 35 millimeters (0.8 to 1.4 inches) long, comprises 6 to 12 flowers, each on a stalk 8 to 12 millimeters (0.3 to 0.5 inch) long. Each flower has a smooth, green hypanthium, which measures about 4 to 6 millimeters (0.2 inch) long and 3 to 5 millimeters (0.1 to 0.2 inch) wide and is topped by triangular calyx lobes 3 to 5 millimeters (0.1 to 0.2 inch) long and 2 to 3 millimeters (0.08 to 0.1 inch) wide. The purplish corolla forms a nearly upright tube 30 to 35 millimeters (1.2 to 1.4 inches) long and 3 to 4 millimeters (0.1 to 0.2 inch) wide, which ends in five spreading lobes. Berries have not been observed. This species is distinguished from the seven other species of the genus on Molokai by a combination of the following characters: a branched, woody habit; leaves with small, hardened, marginal teeth; and a purplish corolla (USFWS 1992).

Life History

*Cyanea mannii* was observed in flower during July 1984 (HHP 1990e). No additional life history information is currently available.

Habitat Description

This species typically grows on the sides of deep gulches in ohia-dominated mesic to wet forests at elevations of about 1,000 to 1,220 meters

(3,300 to 4,000 feet) (USFWS 1992). Associated plant taxa include akia, olapa, *Dicranopteris linearis* (uluhe), and *Vaccinium* (ohelo) (USFWS 1992).

Current and Historic Ranges and Population Status

Historically, *Cyanea mannii* was known only from Kalae on East Molokai (USFWS 1992). In 1984, a single plant was discovered by Joan Aidem west of Puu Kolekole on East Molokai on privately owned land (USFWS 1992). Since then, additional populations have been discovered in the east and west forks of Kawela Gulch within Kamakou Preserve on East Molokai. Currently, there are 9 known populations, with a total of fewer than 1,000 individuals (J. Lau, personal communication 1996).

Reasons for Decline and Current Threats

Feral pigs threaten the habitat of *Cyanea mannii*. Rats may feed on the fruit or other parts of the plant, as shown by predation on related species. Because of the small number of remaining individuals, one random naturally occurring event could extirpate a significant proportion of the populations (USFWS 1992).

Conservation Efforts

Seeds of this species have been collected and propagated by the National Tropical Botanical Garden. No additional species-specific conservation efforts have been undertaken. General conservation efforts for the Molokai plant cluster taxa can be found in the Overall Conservation Efforts section of this plan.

Needed Recovery Actions

The general strategies discussed in a later section, 6. Overall Recovery Strategy, are appropriate for this species.

***Cyanea procera*** Recovery Priority 5

Description and Taxonomy

No line drawing is available for this taxon.

Hillebrand discovered *Cyanea procera* on Molokai and formed the

specific epithet from a Latin word meaning "tall," in reference to the height of the plant (Hillebrand 1888). St. John (1987, St. John and Takeuchi 1987), believing there to be no generic distinction between *Cyanea* and *Delissea*, transferred the species to the genus *Delissea*, the older of the two generic names, creating *D. procera*. The current treatment, however, maintains the separation of the two genera (Lammers 1990).

*Cyanea procera*, a member of the bellflower family, is a palm-like tree 3 to 9 meters (10 to 30 feet) tall with stalkless, lance-shaped leaves 60 to 75 centimeters (24 to 30 inches) long and 10 to 17 centimeters (3.9 to 6.7 inches) wide with tiny hardened teeth along the margins. Each flower cluster has a stalk 25 to 40 millimeters (1.0 to 1.6 inches) long and comprises 10 to 20 flowers, each on a stalk 6 to 10 millimeters (0.2 to 0.4 inch) long. Each flower has a hypanthium, 15 to 20 millimeters (0.6 to 0.8 inch) in length and 8 to 13 millimeters (0.3 to 0.5 inch) in width, topped by shallow triangular calyx lobes 3 to 4 millimeters (0.1 to 0.2 inch) long and about 4 to 5 millimeters (0.2 inch) wide. The purplish corolla forms a nearly upright or slightly curved tube 60 to 80 millimeters (2.4 to 3.1 inches) long and 6 to 11 millimeters (0.2 to 0.4 inch) wide, which ends in five downwardly curving lobes that make the flower appear one-lipped. The ellipse- or egg-shaped berries are 3.0 to 4.5 centimeters (1.2 to 1.8 inches) long and 2.0 to 2.8 centimeters (0.8 to 1.1 inches) wide. This species can be distinguished from other species of the genus and from *C. mannii* by its growth habit, its sessile leaves, and the single-lipped appearance of the corolla (USFWS 1992).

## Life History

No life history information is currently available for this species.

## Habitat Description

Individuals have been found in a wet ohia-dominated forest at an elevation of 1,060 meters (3,480 feet), on a steep rock wall, with thin soil, on the southwest slope of a narrow gulch. Associated plant species include various species of *Asplenium, Coprosma ochracea* (pilo), *Pipturus albidus* (mamaki), and *Touchardia latifolia* (olona) (USFWS 1992).

Current and Historic Ranges and Population Status

Historically, *Cyanea procera* was known only from an unspecified site in the Kamalo region of East Molokai (HHP 1991a) until its discovery in 1987 at Puu O Kaeha, west of Kamalo on private land. There are currently three known populations of this species with a total of eight individuals (J. Lau, S. Perlman, personal communications 1995).

Reasons for Decline and Current Threats

Goats have been observed in the vicinity of this species. Only eight plants of *Cyanea procera* are known to exist, making this species vulnerable to extinction from random naturally occurring events, such as landslides. Like other *Cyanea* species and related genera, *C. procera* is potentially threatened by predation by rats. Habitat degradation by feral pigs is a potential threat (USFWS 1992).

Conservation Efforts

No species-specific conservation efforts have been undertaken for this taxa. General conservation efforts for the Molokai plant cluster taxa can be found in the Overall Conservation Efforts section of this plan.

Needed Recovery Actions

The general strategies discussed in a later section, 6. Overall Recovery Strategy, are appropriate for this species, but the following actions are felt to be particularly urgent.

In order to prevent this species from going extinct, the propagation and maintenance of *ex situ* genetic stock should be immediately undertaken, as well as the protection of remaining wild individuals from the effects of goats, pigs and rats. Following these immediate preservation measures, long-term recovery actions should be implemented.

***Hedyotis mannii*** Recovery Priority 5

Description and Taxonomy

No line drawing is available for this taxon.

Based upon a specimen he collected with Mann on West Maui, Brigham described *Kadua laxiflora* in Mann's list of 1867. In his revision of *Hedyotis*, Fosberg (1943) included *Kadua* in the genus *Hedyotis*, and he published the following names, which are synonymized under *Hedyotis mannii* in the current treatment of the genus (Wagner *et al.* 1990): *H. mannii* var. *laxiflora*, *H. mannii* var. *munroi*, *H. mannii* var. *scaposa*, *H. molokaiensis*, *H. thyrsoidea*, and *H. thyrsoidea* var. *hillebrandii* (Fosberg 1943), as well as *H. mannii* var. *cuspidata* (Fosberg 1956).

*Hedyotis mannii*, a member of the coffee family (Rubiaceae), is a perennial plant with smooth, usually erect stems 30 to 60 centimeters (1 to 2 feet) long, which are woody at the base and four-angled or winged. The leaves are opposite, thin in texture, elliptic to sometimes lance-shaped, and are usually 8 to 18 centimeters (3 to 7 inches) long and 2.5 to 6.5 centimeters (1 to 2.6 inches) wide. Stipules (leaf-like appendages), which are attached to the slightly winged leaf stalks where they join and clasp the stem, are triangular, 5 to 14 millimeters (0.2 to 0.6 inch) long, and have a point usually 4 to 11 millimeters (0.2 to 0.4 inch) long. Flowers are arranged in loose clusters up to 30 centimeters (1 foot) long at the ends of the stems and are either bisexual or female. The green hypanthium is top-shaped, about 1 to 1.5 millimeters (0.05 inch) long, with sepals 1.5 to 3 millimeters (0.06 to 0.1 inch) long and 1 to 2 millimeters (0.04 to 0.08 inch) wide at the top. The greenish-white, fleshy petals are fused into a trumpet-shaped tube 5 to 14 millimeters (0.2 to 0.6 inch) long. Capsules are top-shaped and measure 2 to 3 millimeters (0.08 to 0.1 inch) long and about 3 to 4 millimeters (0.1 inch) in diameter. This species' growth habit; its quadrangular or winged stems; the shape, size, and texture of its leaves; and its dry capsule, which opens when mature, separate it from other species of the genus (USFWS 1992).

Life History

Currently, no life history information is available for this species.

Habitat Description

*Hedyotis mannii* typically grows on dark, narrow, rocky gulch walls in mesic and perhaps wet forests at 150 to 1,050 meters (490 to 3,450 feet) in elevation (USFWS 1992). Associated plant species include mamaki, *Cibotium*

(hapuu), *Cyanea* (haha), and *Psychotria* (kopiko) (USFWS 1992).

Current and Historic Ranges and Population Status

*Hedyotis mannii* was once widely scattered on three islands: Lanai, West Maui, and Molokai (USFWS 1992). After not being seen for 50 years, this species was rediscovered in 1987 by Steve Perlman on private land in Kawela Gulch on East Molokai. Only five plants are known to exist in this area (S. Perlman, personal communication 1995). In 1991, an additional nine plants of this species were discovered on the island of Lanai: five mature and three juvenile plants were found at an elevation of 960 meters (3,150 feet) at the head of Hauola Gulch, and a single mature plant at 805 meters (2,640 feet) elevation in the gulch between Waialala and Kunoa Gulches (USFWS 1992). The Lanai populations now number between 35 and 40 individuals (20 at Waialala and 15-20 at upper Hauola Gulch). Recently, a population of 10-20 individuals has been discovered at Kauaula in West Maui. A total of 50-65 individuals of this species are thought to exist in the wild (S. Perlman, personal communication 1995).

Reasons for Decline and Current Threats

The limited number of individuals of *Hedyotis mannii* makes it extremely vulnerable to extinction by random naturally occurring events. Feral pigs and alien plants such as molasses grass degrade the habitat of this species and contribute to its vulnerability (USFWS 1992).

Conservation Efforts

Seeds of this species have been collected and propagated by the National Tropical Botanical Garden. No additional species-specific conservation efforts have been undertaken. General conservation efforts for the Molokai plant cluster taxa can be found in the Overall Conservation Efforts section of this plan.

Needed Recovery Actions

The general strategies discussed in a later section, 6. Overall Recovery Strategy, are appropriate for this species, but the following actions are felt to be particularly urgent.

In order to prevent this species from going extinct, the propagation and

maintenance of *ex situ* genetic stock should be continued, as well as the protection of remaining wild individuals from the effects of pigs and alien plants. Following these immediate preservation measures, long-term recovery actions should be implemented.

***Hibiscus arnottianus ssp. immaculatus*** Recovery Priority 3

Description and Taxonomy

Appendix B contains a line drawing of this taxon.

Sister Margaret James Roe (1961) described *Hibiscus immaculatus* based upon specimens collected by Forbes on Molokai in 1912. The specific epithet refers to the plant's pure white flowers. In his current treatment of the genus, David M. Bates regards the taxon as *Hibiscus arnottianus* ssp. *immaculatus* (Bates 1990). A line drawing of this species can be found in Appendix B.

*Hibiscus arnottianus* ssp. *immaculatus*, a member of the hibiscus family (Malvaceae), is a tree up to 3 meters (10 feet) tall with alternate, oval, toothed leaves measuring 5 to 7 centimeters (2 to 2.8 inches) long and 4 to 6.5 centimeters (1.6 to 2.6 inches) wide. Six lance-shaped bracts (leaf-like structures), 5 to 8 millimeters (0.2 to 0.3 inch) long, are found under each of the faintly fragrant flowers, which are arranged singly near the ends of the branches. The calyx is 2.5 to 3.0 centimeters (1 to 1.2 inches) long and cleft into five teeth with long, narrow points. The flaring petals are white and measure 8 to 11 centimeters (3.1 to 4.3 inches) long and 2.5 to 3.5 centimeters (1 to 1.4 inches) wide. Anthers, on spreading filament tips 1 to 2 centimeters (0.4 to 0.8 inch) long, are arranged along the upper third of the white staminal column, which measures 10 to 14 centimeters (4 to 5.5 inches) in length. Capsules are enclosed by the sepals and contain 4 millimeter-long (0.2 inch) seeds which are covered with yellowish-brown hair. This subspecies is distinguished from other native Hawaiian members of the genus by its white petals and white staminal column (USFWS 1992).

Life History

This species was observed in flower during July 1990 (HHP 1994b). Currently, no additional life history information is available for this species.

Habitat Description

*Hibiscus arnottianus* ssp. *immaculatus* typically occurs in mesic forests between 15 and 480 meters (50 and 1,600 feet) in elevation (USFWS 1992).

Current and Historic Ranges and Population Status

*Hibiscus arnottianus* ssp. *immaculatus* once ranged from Waihanau Valley east to Papalaua Valley on East Molokai. This taxon is now confined to a 5-kilometer (3-mile) stretch of the northern coast of East Molokai from Waiehu to between Papalaua and Wailau valleys (USFWS 1992) on private and State land. The three populations, scattered along steep sea cliffs with native plant species such as alahee, hame, lama, mamaki, and ohia, are believed to total no more than 100 individuals (USFWS 1992).

Reasons for Decline and Current Threats

The major threats to *Hibiscus arnottianus* spp. *immaculatus* are habitat destruction by feral goats and the small number of remaining populations (USFWS 1992).

Conservation Efforts

This species has been propagated by the National Tropical Botanical Garden. No additional species-specific conservation efforts have been undertaken. General conservation efforts for the Molokai plant cluster taxa can be found in the Overall Conservation Efforts section of this plan.

Needed Recovery Actions

The general strategies discussed in a later section, 6. Overall Recovery Strategy, are appropriate for this species, but the following actions are felt to be particularly urgent.

In order to prevent this species from going extinct, the propagation and maintenance of *ex situ* genetic stock should be continued, as well as the protection

of remaining wild individuals from the effects of goats. Following these immediate preservation measures, long-term recovery actions should be implemented.

### ***Melicope reflexa*** Recovery Priority 8

Description and Taxonomy

No line drawing is available for this taxon.

St. John (1944) described and named *Pelea reflexa* based upon a specimen Rock collected on Molokai in 1910. The specific epithet refers to the slightly reflexed capsules. After further study of the genus, Thomas G. Hartley and Benjamin C. Stone (1989) placed *Pelea* into synonymy with *Melicope*, resulting in the new combination *Melicope reflexa* (USFWS 1992).

*Melicope reflexa*, a member of the citrus family (Rutaceae), is a sprawling shrub 1 to 3 meters (3.3 to 10 feet) tall with short, yellowish-brown, short-lived hairs on new growth. The opposite, thin, and leathery leaves are elliptical and measure 8 to 14 centimeters (3.1 to 5.5 inches) long and 4 to 7 centimeters (1.6 to 2.8 inches) wide. Flowers arise singly or in clusters of two or three from the leaf axil. The flower cluster has a stalk 3 to 15 millimeters (0.1 to 0.6 inch) long, and each flower is on a stalk 15 to 20 millimeters (0.6 to 0.8 inch) long. Male flowers have not been seen, but female flowers are made up of four overlapping sepals about 3 to 4 millimeters (0.1 inch) long; four petals about 4.8 millimeters (0.2 inch) long; an eight-lobed nectary disk; eight reduced, nonfunctional stamens; and a style about 4 millimeters (0.2 inch) long. The capsules are 20 to 33 millimeters (0.8 to 1.3 inches) wide with four sections 10 to 17 millimeters (0.4 to 0.7 inch) long which are fused to each other along about one-fourth of their length. One or two glossy black seeds, about 7 to 8 millimeters (0.3 inch) long, are found in each section of the capsule. This species' opposite leaves with leaf stalks usually over 1 centimeter (0.4 inch) long, its larger leaves and fruit, and the partially fused sections of its capsule separate it from other species of the genus (USFWS 1992).

Life History

Currently, no life history information is available for this species.

Habitat Description

*Melicope reflexa* typically grows in wet ohia-dominated forests with native trees such as olapa at elevations between 760 and 1,190 meters (2,490 and 3,900 feet) (USFWS 1992).

Current and Historic Ranges and Population Status

Historically, *Melicope reflexa* occurred from a ridge between Hanalilolilo and Pepeopae in Kamakou Preserve to as far east as Halawa on East Molokai (USFWS 1992). The three remaining populations of fewer than a total of 1,000 individuals are at Wailau-Mapulehu summit, Kukuinui Ridge, and Honomuni, and are distributed over a distance of about 12 kilometers (7.5 miles) (USFWS 1992).

Reasons for Decline and Current Threats

Major threats to *Melicope reflexa* include habitat degradation by ungulates (axis deer and feral pigs) and competition with the alien plant *Clidemia hirta* (Koster's curse). Because this species is known from a single restricted area, it is possible for one human-caused or natural event to destroy all or a significant portion of the remaining individuals. Predation by deer or pigs is a potential threat in areas inhabited by these animals (USFWS 1992).

Conservation Efforts

No species-specific conservation efforts have been undertaken for this taxon. General conservation efforts for the Molokai plant cluster taxa can be found in the Overall Conservation Efforts section of this plan.

Needed Recovery Actions

The general strategies discussed in a later section, 6. Overall Recovery Strategy, are appropriate for this species.

***Phyllostegia mannii*** Recovery Priority 5

Description and Taxonomy

No line drawing is available for this taxon.

Mann (1868) published the name *Stenogyne parviflora* for a plant he and Brigham collected on Haleakala, Maui. In 1934, Sherff transferred this taxon to the genus *Phyllostegia*; as the name *Phyllostegia parviflora* had previously been used for another species, he selected a new name, *Phyllostegia mannii*, for the taxon (Sherff 1934b). In the same year, Sherff (1934a) published the name *Phyllostegia racemosa* var. *bryanii* for the plants from the island of Molokai. In the current treatment (Wagner *et al.* 1990), *Phyllostegia mannii* is the name applied to both the Molokai plants and specimens of the apparently extinct Maui plants.

*Phyllostegia mannii*, a nonaromatic member of the mint family (Lamiaceae), is a climbing vine with many-branched, four-sided, hairy stems. The opposite, hairy leaves, which are shaped like narrow triangles or narrow triangular ovals, measure 2 to 5.5 centimeters (0.8 to 2.2 inches) long and 0.7 to 2.3 centimeters (0.3 to 0.9 inch) wide and have coarsely toothed margins. Clusters of four to six flowers are arranged in each of several false whorls along an unbranched flowering stem 4 to 15 centimeters (1.6 to 6 inches) long. The calyx is a bell-shaped, lobed structure. The slightly curved, two-lipped corolla tube is about 7 to 8 millimeters (0.3 inch) long and is thought to be white. The fleshy, dark-green to black nutlets (dry seeds with a hard outer covering) are 2 to 2.5 millimeters (0.08 to 0.1 inch) long. This species is distinguished from others in the genus by its hairiness; its thin, narrow leaves, which are not pinnately divided; and the usually six flowers per false whorl in a terminal inflorescence (USFWS 1992).

Life History

This species was observed with fruit in July 1979 (HHP 1990f). Currently, no additional life history information is available for this species.

Habitat Description

It grows in shaded sites in sometimes foggy and windswept, wet, open, ohia-dominated forests with a native shrub and tree fern (hapuu) understory at 1,010 to 1,525 meters (3,300 to 5,000 feet) in elevation (USFWS 1992). Associated plant species include olapa, a few native ferns, and *Hedyotis* (manono).

Current and Historic Ranges and Population Status

Historically, *Phyllostegia mannii* was found from Hanalilolilo to Ohialele on East Molokai and at Ukulele on East Maui. It has not been seen on Maui for over 70 years and is apparently extirpated on that island (USFWS 1992). This species is now known only from Hanalilolilo within Kamakou Preserve on privately owned land (USFWS 1992). The two currently known populations contain a total of four individuals.

Reasons for Decline and Current Threats

The two known populations of *Phyllostegia mannii* are threatened by feral pigs. Because of the small number of individuals, a natural or human-caused event could extirpate all or a significant portion of the individuals (USFWS 1992).

Conservation Efforts

Seeds of this species have been collected and propagated by NTBG. No additional species-specific conservation efforts have been undertaken. General conservation efforts for the Molokai plant cluster taxa can be found in the Overall Conservation Efforts section of this plan.

Needed Recovery Actions

The general strategies discussed in a later section, 6. Overall Recovery Strategy, are appropriate for this species, but the following actions are felt to be particularly urgent.

In order to prevent this species from going extinct, the propagation and maintenance of *ex situ* genetic stock should be continued, as well as the protection of remaining wild individuals from the effects of pigs. Following these immediate preservation measures, long-term recovery actions should be implemented.

***Pritchardia munroi*** Recovery Priority 5

Description and Taxonomy

No line drawing is available for this taxon.

Joseph F. Rock discovered a new palm on Molokai in 1920 and named it *Pritchardia munroi* in honor of James Munro, manager of Molokai Ranch (USFWS 1992).

*Pritchardia munroi*, a member of the palm family (Arecaceae), is a tree about 4 to 5 meters (13 to 16 feet) tall with a trunk up to about 20 centimeters (7.8 inches) in diameter. The leaf blade is about 88 centimeters (35 inches) long and has a petiole about 85 centimeters (33 inches) long. The leaves and petioles have scattered, mostly deciduous scales and hairs, somewhat larger on the lower leaf ribs. The leaves are deeply divided into segments, which have long, drooping tips. Numerous bisexual or functionally male flowers are arranged in clusters on hairy, branching stalks about 52 centimeters (20 inches) long, which originate at the leaf bases. The flower consists of a cup-shaped, three-lobed calyx; three petals; six stamens; and a three-lobed stigma. The mature fruit is shiny, black, nearly spherical, and about 2 to 2.2 centimeters (0.8 inch) in diameter. This species is distinguished from others of the genus by its relatively smooth leaves; the grayish-brown hair on the inflorescence stalks, which are shorter than the petioles; and the small size of the fruits (USFWS 1992).

Life History

Currently, no life history information is available for this species.

Habitat Description

The only remaining wild individual grows in a remnant dry to mesic forest at an elevation of about 610 meters (2,000 feet). Associated plant species include aalii, ohia, pukiawe, and *Pleomele aurea* (hala pepe) (USFWS 1992).

Current and Historic Ranges and Population Status

Historically, *Pritchardia munroi* was found in leeward East Molokai, above Kamalo and near Kapuaokoolau (USFWS 1992). The last known wild specimen grows near the base of a small ravine at an elevation of about 610 meters (2,000 feet) on privately owned land (USFWS 1992).

Reasons for Decline and Current Threats

A variety of threats affects the only known wild individual of *Pritchardia*

*munroi*. Ungulates (axis deer, goats, and pigs) continue to degrade the habitat around its fenced enclosure and prevent the establishment of seedlings. Other serious threats include fire and predation of seeds by rats. The one known wild individual is vulnerable to extinction in its natural habitat because a single random naturally occurring event could destroy the plant (USFWS 1992).

Conservation Efforts

In 1989, the State of Hawaii constructed an exclosure fence around the last remaining individual of this species in the wild (R. Hobdy, personal communication 1995). Approximately 22 plants of *Pritchardia munroi* are in cultivation in various arboreta and institutions throughout the world (USFWS 1992). However, little is known about the reproduction or genetics of this species and it is unclear whether hybridization with other species occurs, resulting in the questionable species integrity of the cultivated plants. This species has been propagated by the National Botanical Garden and Waimea Arboretum.

General conservation efforts for the Molokai plant cluster taxa can be found in the Overall Conservation Efforts section of this plan.

Needed Recovery Actions

The general strategies discussed in a later section, 6. Overall Recovery Strategy, are appropriate for this species, but the following actions are felt to be particularly urgent.

In order to prevent this species from going extinct, the propagation and maintenance of *ex situ* genetic stock should be continued. The exclosure fence should be enlarged and maintained to protect the last remaining individual from deer, goats, and pigs and allow for the establishment of additional individuals. Rodent control should be conducted to protect any viable seeds produced. This individual should also be protected from fires. Following these immediate preservation measures, long-term recovery actions should be implemented.

***Schiedea lydgatei*** Recovery Priority 8

Description and Taxonomy

No line drawing is available for this taxon.

Hillebrand (1888) described *Schiedea lydgatei*, naming it in honor of the Reverend John M. Lydgate, who, as a student, accompanied Hillebrand on collecting trips. Later, Otto Degener and Sherff (Sherff 1944) described a new variety of the taxon, naming it variety *attenuata*. No infraspecific taxa are recognized in the most recent treatment of the species (Wagner *et al.* 1990).

*Schiedea lydgatei*, a member of the pink family (Caryophyllaceae), is a low, hairless perennial plant with branched stems 10 to 40 centimeters (4 to 16 inches) long that are woody at the base. The opposite, three-veined leaves are elliptic, 2 to 4.5 centimeters (0.8 to 1.8 inches) long, and 0.6 to 1.5 centimeters (0.2 to 0.6 inch) wide. Bisexual flowers are arranged in loosely spreading clusters 10 to 17 centimeters (4 to 6.6 inches) long. The flowers comprise usually 5 distinct but overlapping, narrowly oval, green sepals, 3 to 4.5 millimeters (0.1 to 0.2 inch) long; 5 nectaries about 2.5 to 3 millimeters (0.1 inch) long; 10 stamens; and usually 3 styles. Petals are lacking. The capsules are about 4 to 5.5 millimeters (0.2 inch) long and open when mature to reveal dark reddish-brown seeds about 0.8 millimeters (0.03 inch) long. The opposite, thin, three-veined leaves with petioles and the smooth, open flower clusters with relatively larger, green sepals separate this species from other members of the genus (USFWS 1992).

Life History

This species was observed with flowers and fruit in June 1990 (HHP 1990g). Currently, no additional life history information is available.

Habitat Description

This species is found along ridges and on cattle trails in dry to mesic grasslands, shrublands, and forests with scattered native and alien trees. It ranges in elevation from about 600 to 650 meters (2,000 to 2,100 feet). Associated plant species include aalii, ohia, pukiawe, and uluhe (USFWS 1992).

Current and Historic Ranges and Population Status

Historically, *Schiedea lydgatei* was found in Kalae, Poholua, Makolelau, and Ohia Gulch on East Molokai. This species is now known from four scattered populations in a more restricted area in Makakupaia, Kawela, and Makolelau.

The 4 populations are distributed over an area of less than 1.6 by 5.6 kilometers (1 by 3.5 miles), totaling over 8,000 individuals (L. Mehrhoff, personal communication 1995).

Reasons for Decline and Current Threats

The major threats to *Schiedea lydgatei* are fire and habitat degradation and competition with molasses grass. Because fire is a pervasive threat in this species' dry, windswept habitat, a single fire potentially could destroy a majority of the populations (USFWS 1992).

Conservation Efforts

Seeds of this species have been collected by the National Botanical Garden. No additional species-specific conservation efforts have been undertaken. General conservation efforts for the Molokai plant cluster taxa can be found in the Overall Conservation Efforts section of this plan.

Needed Recovery Actions

The general strategies discussed in a later section, 6. Overall Recovery Strategy, are appropriate for this species.

***Silene alexandri*** Recovery Priority 5

Description and Taxonomy

No line drawing is available for this taxon.

*Silene alexandri* was described by Hillebrand (1888) based upon a specimen he discovered on Molokai (USFWS 1992).

*Silene alexandri*, a member of the pink family, is an erect, perennial herb, 30 to 60 centimeters (1 to 2 feet) tall, and woody at the base. The narrow, elliptic leaves are 30 to 65 millimeters (1.2 to 2.5 inches) long by 6 to 14 millimeters (0.2 to 0.6 inch) wide and hairless except for a fringe along the margins. Flowers are arranged in open clusters with stalks 10 to 19 millimeters (0.4 to 0.7 inch) long. The 5-lobed, 10-veined, tubular calyx is 19 to 25 millimeters (0.7 to 1 inch) long, and the 5 white, deeply-lobed, clawed petals extend about 4 to 6 millimeters (0.2

inch) beyond the calyx. The capsule is about 14 to 16 millimeters (0.6 inch) long, but seeds have never been seen. The hairless stems, flowering stalks, and sepals and the larger flowers with white petals separate this species from other members of the genus (USFWS 1992).

Life History

Currently, no life history information is available for this species.

Habitat Description

The two known populations are found in remnant dry forest and shrubland at an elevation between 610 and 760 meters (2,000 and 2,500 feet). Associated plant species include aalii, ohia, pukiawe, and uluhe (USFWS 1992).

Current and Historic Ranges and Population Status

Historically, *Silene alexandri* was known from Makolelau and Kamalo on East Molokai. There are currently 2 known populations of this species, comprising approximately 35 individuals. These populations occur at Makolelau and Kawela, on privately owned remnant dry forest and shrubland at an elevation between 610 and 760 meters (2,000 and 2,500 feet) (USFWS 1992).

Reasons for Decline and Current Threats

Feral goats continue to degrade the habitat of *Silene alexandri* and pose a serious threat to remaining populations. Predation of this species by goats and cattle may possibly occur. Fire also is an immediate threat. Because of the small number of individuals and their severely restricted distribution, extinction from random naturally occurring events is a very real threat (USFWS 1992).

Conservation Efforts

Seeds of this species have been collected and propagated by the National Tropical Botanical Garden. No additional species-specific conservation efforts have been undertaken. General conservation efforts for the Molokai plant cluster taxa can be found in the Overall Conservation Efforts section of this plan.

Needed Recovery Actions

The general strategies discussed in a later section, 6. Overall Recovery Strategy, are appropriate for this species, but the following actions are felt to be particularly urgent.

In order to prevent this species from going extinct, the propagation and maintenance of *ex situ* genetic stock should be continued, as well as the protection of remaining wild individuals from the effects of goats, fire, and cattle. Following these immediate preservation measures, long-term recovery actions should be implemented.

***Silene lanceolata*** Recovery Priority 2

Description and Taxonomy

No line drawing is available for this taxon.

*Silene lanceolata* is based upon fertile specimens collected on Kauai during the United States Exploring Expedition in 1840, as well as vegetative material collected during the same expedition the following year on Maui. Gray (1854) described the species, naming it for its narrow leaves. Hillebrand (1888) recognized one variety, var. *angustifolia*; later, Sherff (1946) described and named two additional varieties, vars. *hillebrandii* and *forbesii*. The current treatment does not recognize any subspecific taxa (USFWS 1992).

*Silene lanceolata*, a member of the pink family, is an upright, perennial plant with stems 15 to 50 centimeters (6 to 20 inches) long, which are woody at the base. The narrow leaves are 25 to 80 millimeters (1 to 3 inches) long, 2 to 11 millimeters (0.08 to 0.4 inch) wide, and smooth except for a fringe of hairs near the base. Flowers are arranged in open clusters with stalks 8 to 23 millimeters (0.3 to 0.9 inch) long. The 5-toothed, 10-veined calyx is about 7 to 9 millimeters (0.3 inch) long, and the wide portion of the 5 white, deeply-lobed, clawed petals is about 6 millimeters (0.2 inch) long. The capsule is about 8 to 9 millimeters (0.3 inch) in length and opens at the top to release reddish-brown seeds about 1 millimeter (0.04 inch) in diameter. This species is distinguished from *S. alexandri*, the only other member of the genus found on Molokai, by its smaller

flowers and capsules and its stamens, which are shorter than the sepals (USFWS 1992).

Life History

Currently, no life history information is available for this species.

Habitat Description

The populations on the island of Hawaii grow in two dry habitat types: shrubland dominated by dense *Myoporum sandwicensis* (naio), *Sophora chrysophylla* (mamane), and pukiawe with aalii, pilo, and *Pennisetum setaceum* (fountain grass); and on aa lava in a former *Chamaesyce olowaluana* (akoko) forest now converted to fountain grass grassland with aalii, mamane, naio, and *Chenopodium oahuense* (aheahea). On Molokai, this species grows on cliff faces and ledges of gullies in dry to mesic shrubland at an elevation of about 800 meters (2,600 feet) (USFWS 1992).

Current and Historic Ranges and Population Status

The historical range of *Silene lanceolata* includes five Hawaiian Islands: Kauai, Makua on Oahu, below Puu Kolekole on East Molokai, Maunalei on Lanai, and Mauna Kea on Hawaii Island. *Silene lanceolata* is presently extant on the islands of Molokai, Oahu, and Hawaii. A single population of approximately 100 individuals was found in 1987 on Molokai, where it remains on private land near Puu Kolekole (USFWS 1992). The Hawaii Island population at Puu Ahi was last seen in 1949. In 1991, two populations of this species were discovered on Federally owned land in Kipuka Kalawamauna and Kipuka Alala in the Pohakuloa Training Area, which is located in the saddle between Mauna Kea and Mauna Loa. The three Hawaii Island populations are distributed over a distance of roughly 15 kilometers (9 miles) between about 1,600 and 1,800 meters (5,200 and 6,000 feet) elevation (USFWS 1992). It is not known whether the Puu Ahi population still exists after decades of ungulate, human-caused, and natural disturbances. The 2 populations at the Pohakuloa Training Area number between 95 and 125 individuals (USFWS 1992). A fifth population was discovered in 1991 by Steve Perlman at the Makua Military Reservation in the Waianae Mountains on the island of Oahu. This population consists of approximately 40

individuals (USFWS 1992), giving a total of fewer than 1,500 known individuals for the species (L. Mehrhoff, personal communication 1995).

Reasons for Decline and Current Threats

Habitat destruction by feral ungulates (goats, pigs, and sheep), wildfires resulting from hunting activities and military maneuvers, and alien plant invasion (fountain grass) are immediate threats to *Silene lanceolata*. Military exercises and predation by goats and sheep pose probable threats (USFWS 1992).

Conservation Efforts

Seeds of this species have been collected by theTropical Botanical Garden. No additional species-specific conservation efforts have been undertaken. General conservation efforts for the Molokai plant cluster taxa can be found in the Overall Conservation Efforts section of this plan.

Needed Recovery Actions

The general strategies discussed in a later section, 6. Overall Recovery Strategy, are appropriate for this species.

***Stenogyne bifida*** Recovery Priority 2

Description and Taxonomy

No line drawing is available for this taxon.

Hillebrand discovered *Stenogyne bifida* on Molokai in 1870 and named it in reference to the deeply two-lobed upper lip of its corolla. The name is accepted in the latest revision of the genus (USFWS 1992).

*Stenogyne bifida*, a nonaromatic member of the mint family, is a perennial herb, evidently climbing, with smooth or slightly hairy, four-angled stems. The opposite, membranous, toothed leaves are oval or elliptical in shape, measure 4.2 to 10 centimeters (1.7 to 4 inches) long and 1.7 to 3.6 centimeters (0.7 to 1.4 inches) wide, and are hairless except for the midribs. Flowers are usually arranged in groups of two to six in each of several whorls at the ends of the stems. The sepals are fused into a toothed calyx, which is almost hairless, radially

symmetrical, narrowly bell-shaped, and 8 to 12 millimeters (0.3 to 0.5 inch) long. The petals are fused into a nearly straight, yellow tube 10 to 16 millimeters (0.4 to 0.6 inch) long that flares into pale-brown lobes comprising an upper lip about 4 to 6 millimeters (0.2 inch) long and a lower lip about 2 to 4 millimeters (0.1 inch) long. The fruits are fleshy, black nutlets about 2.5 to 3 millimeters (0.1 inch) long. The long, narrow calyx teeth and the deep lobe in the upper lip of the yellow corolla separate this species from others of the genus (USFWS 1992).

Life History

Currently, no life history information is available for this species.

Habitat Description

*Stenogyne bifida* typically grows on steep ridges in ohia-dominated Montane Mesic to Wet Forests with native species such as hapuu, manono, olapa, *Broussaisia arguta* (kanawao), and *Pouteria* (alaa) at elevations between 450 and 1,200 meters (1,450 and 4,000 feet) (USFWS 1992).

Current and Historic Ranges and Population Status

Historically, *Stenogyne bifida* was known from scattered populations from Waianui in central Molokai to Pukoo Ridge on East Molokai. This species is now known from only one East Molokai population (L. Mehrhoff, personal communication 1995). Recent observations show this population to number 12 individuals (TNC 1995).

Reasons for Decline and Current Threats

Ungulates (axis deer, goats, and pigs) are pervasive threats to populations of *Stenogyne bifida.* The remaining population is near a trail and could be destroyed by over-collecting for scientific purposes or by vandals.

Conservation Efforts

Seeds of this species have been collected and propagated by the National Tropical Botanical Garden. Alien plant control was conducted in 1995 around the population of *Stenogyne bifida* on Kamakou Preserve. General conservation efforts for the Molokai plant cluster taxa can be found in the Overall Conservation

Efforts section of this plan.

Needed Recovery Actions

The general strategies discussed in a later section, 6. Overall Recovery Strategy, are appropriate for this species, but the following actions are felt to be particularly urgent.

In order to prevent this species from going extinct, the propagation and maintenance of *ex situ* genetic stock should be continued, as well as the protection of remaining wild individuals from the effects of deer, goats, and pigs. Following these immediate preservation measures, long-term recovery actions should be implemented.

***Tetramolopium rockii*** Recovery Priority 14

Description and Taxonomy

Appendix B contains a line drawing of this taxon.

Sherff (1934c) described *Tetramolopium rockii*, naming it in honor of Joseph Rock, who first collected the plant in 1910 on Molokai. St. John (1974) described a new genus, *Luteidiscus*, for the species of *Tetramolopium* with yellow disk flowers. He transferred *T. rockii* to the new genus and also described a new species, *L. calcisabulorum*. The current treatment reduces St. John's two species to varieties of *Tetramolopium rockii*: the nominative variety and var. *calcisabulorum* (USFWS 1992). A line drawing of this species can be found in Appendix B.

*Tetramolopium rockii*, a member of the aster family, is a glandular, hairy, prostrate shrub, which forms complexly branching mats 5 to 10 centimeters (2 to 4 inches) tall and 8 to 40 centimeters (3 to 16 inches) in diameter. Leaves of variety *calcisabulorum* are 2 to 3 centimeters (0.8 to 1.2 inches) long and 5 to 7 millimeters (0.2 to 0.3 inch) wide, have slightly inrolled edges, and are whitish due to the long silky hairs on their surfaces. Variety *rockii* has smaller, less hairy, flat, yellowish-green leaves, 1.5 to 2.1 centimeters (0.6 to 0.8 inch) long and about 0.4 to 0.6 centimeters (0.2 inch) wide. The leaves of both varieties are spatula-shaped with glands and smooth margins. Flower heads, arranged singly at the

ends of flowering stalks 4 to 12 centimeters (1.6 to 4.7 inches) long, have a hemispherical involucre (set of bracts beneath the florets) 4 to 8 millimeters (0.2 to 0.3 inch) high and 10 to 18 millimeters (0.4 to 0.7 inch) in diameter. Approximately 60 to 100 white ray florets, 3 to 4.5 millimeters (0.1 to 0.2 inch) long and 0.5 to 1 millimeters (0.02 to 0.04 inch) wide, surround 30 to 55 functionally male, yellow, funnel-shaped disk florets. Fruits are achenes, 2 to 2.5 millimeters (0.08 to 0.1 inch) long and about 0.7 to 0.9 millimeters (0.03 inch) wide when fertile, and are topped with white bristles 2.5 to 4 millimeters (0.1 to 0.2 inch) long. This species differs from others of the genus by its growth habit, its hairy and glandular surfaces, its spatulate leaf shape, and its yellow disk florets (USFWS 1992).

Life History

Currently, no life history information is available for this species.

Habitat Description

*Tetramolopium rockii* is restricted to hardened calcareous sand dunes or ash-covered basalt in the coastal spray zone or Coastal Dry Shrublands and Grasslands between 10 to 200 meters (30 and 650 feet) in elevation. Native plant species associated with this species include *Fimbristylis cymosa, Heliotropium anomalum* (hinahina), *Lipochaeta integrifolia* (nehe), *Sida fallax* (ilima), and *Sporobolus virginicus* (akiaki) (USFWS 1992).

Current and Historic Ranges and Population Status

Of the two recognized varieties of *Tetramolopium rockii*, variety *rockii* was first discovered at Moomomi about 80 years ago and is still extant in that area. *Tetramolopium rockii* var. *rockii* remains in two areas: from Kapalauoa to Kahinaakalani on West Molokai, and north of Kalawao on Kalaupapa Peninsula on East Molokai. Variety *calcisabulorum* is only reported west of Moomomi, from west of Manalo Gulch to Kalani, intergrading with variety *rockii* where their ranges overlap. The only known population of *Tetramolopium rockii* var. *calcisabulorum* and the scattered populations of *T. rockii* var. *rockii* extend over a distance of about 7 kilometers (4.5 miles) along the northern coast, sometimes locally dominating the vegetation (USFWS 1992). Twelve miles to the east, the

Kalawao population of variety *rockii* encompasses approximately 35 hectares (95 acres). The 4 populations of this species are estimated to number a total of 174,000 individuals (USFWS 1992).

Reasons for Decline and Current Threats

The major threats to *Tetramolopium rockii* are ungulate (axis deer and cattle) activity, competition with the alien plant *Prosopis pallida* (kiawe), human recreational impacts, and fire. Predation by deer and cattle are potential threats. Although the threat to this species is limited because of the large number of existing individuals, *T. rockii* is likely to become endangered in the foreseeable future if the threats are not curbed (USFWS 1992).

Conservation Efforts

Seeds of both varieties of this species have been collected and propagated by the National Tropical Botanical Garden. No additional species-specific conservation efforts have been undertaken. General conservation efforts for the Molokai plant cluster taxa can be found in the Overall Conservation Efforts section of this plan.

Needed Recovery Actions

The general strategies discussed in a later section, 6.Overall Recovery Strategy, are appropriate for this species.

## 6. Overall Recovery Strategy

The highest priority for the recovery of the Molokai plant cluster taxa is the implementation of immediate recovery actions needed to keep "on-the-brink" species (those that number fewer than 100 individuals in the wild) from going extinct. These actions include propagation and maintenance of genetic stock *ex situ,* and protection of remaining wild individuals from threats.

Secondly, the plan proposes the delineation of management units to conserve not only these taxa, but their habitats as well. These units should be managed to preserve as many native species (flora and fauna) as possible, through threat-control and forest-restoration programs. Current threats to the species are addressed through fencing and/or hunting to control ungulates; control of alien plants; protection from fire; control of rodents; protection from human disturbance; collection, storage and maintenance of genetic material; a comprehensive monitoring program; and, if deemed necessary, protection from insects and disease.

The next step in the recovery of these species is augmentation of small populations and re-establishment of new populations within the historical range of the species. This includes selection of areas for augmentation and re-establishment, determination of the best methods for *ex situ* propagation and transplanting, selection of the best genetic stock for each area, propagation of suitable stock, preparation of sites for seeding and/or transplanting, and monitoring and maintenance of new individuals and populations as they are established.

A research program is also recommended to study the growth and reproductive viability of each taxon, determine the parameters of viable populations of each taxon, study the reproductive strategy and pollinators of each taxon, and study possible pests and diseases. The research should be designed to guide management practices.

Finally, the recovery criteria should be refined and revised as new information becomes available.

# RECOVERY

## 1. Objectives

Objectives for stabilizing, downlisting, and delisting are provided for the Molokai plant cluster taxa. The order of tasks listed in the step-down outline and narrative does not necessarily designate the order in which these tasks should be implemented. Priorities for action and recommended time-frames are contained in the Implementation Schedule of this plan.

An endangered species is defined in section 3 of the ESA as any species which is in danger of extinction throughout all or a significant portion of its range. A threatened species is defined as any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

For the purposes of this section, a population is defined as a discrete unit with sufficient distance between neighboring populations that the two are not affected by the same small-scale events (such as a landslide), and are not believed to be cross-pollinated. Mature individuals are defined as those either known or believed to be capable of reproduction. In general, long-lived perennials are those taxa either known or believed to have life spans greater than 10 years; short-lived perennials are those known or believed to have life spans greater than 1 year but fewer than 10 years.

The long-lived perennials in this plan are *Brighamia rockii*, *Hibiscus arnottianus ssp. immaculatus*, *Melicope reflexa*, and *Pritchardia munroi*.

The short-lived perennials in this plan are *Bidens wiebkei, Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *Cyanea procera*, *Hedyotis mannii*, *Phyllostegia mannii*, *Schiedea lydgatei*, *Silene alexandri*, *Silene lanceolata*, *Stenogyne bifida*, and *Tetramolopium rockii*.

Because we have only limited knowledge of the life history of each 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 Molokai cluster taxa so that more meaningful recovery criteria can be quantified.

Interim Objectives

The interim objective is to stabilize all existing populations of the Molokai 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 Molokai, and if possible, at least one other island where they now occur or occurred historically. 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 and a minimum of 50 mature individuals per population for short-lived perennials.

Downlisting Criteria

For downlisting, a total of five to seven populations of each taxon should be documented on Molokai and at least one other island where they now occur or occurred historically. In certain cases, however, a particular taxon may be eligible for downlisting even if all five to seven of the populations are on only one island, provided all of the other recovery criteria have been met and the populations in question are widely distributed and secure enough that one might reasonably conclude that the taxon is not in danger of extinction throughout all or a significant part of its range.

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, and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered.

Delisting Criteria

For taxa other than *Tetramolopium rockii*, the following delisting criteria are recommended.

A total of 8 to 10 populations of each taxon should be documented on Molokai and at least 1 other island where they now occur or occurred historically. As with downlisting, there may be cases in which a particular taxon may be eligible for delisting even if all 8 to10 of the populations are on only 1 island, provided all of the other recovery criteria have been met and the populations in question are widely distributed and secure enough that one might reasonably conclude that the taxon is not likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

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 and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years.

Delisting Criteria for *Tetramolopium rockii*:

Due to this taxon's limited historic distribution and relatively large population size, delisting criteria for the threatened *Tetramolopium rockii* differ from the general criteria given above.

The three existing populations of *Tetramolopium rockii* must be protected from all known threats and the total number of individuals must remain at current levels or increase. These levels must be sustained or exceeded for a period of 5 consecutive years. Species-specific recovery actions must no longer be required.

These recovery criteria may be refined and this recovery plan revised as more is learned about the life history of the taxa and population modeling is conducted.

## 2. Step-down Outline

1. Protect habitat and control threats.

    11. Conduct immediate preservation measures for taxa facing imminent extinction.

        111. Collect, propagate and maintain ex situ genetic stock of taxa facing imminent extinction.

        112. Protect remaining wild individuals of taxa facing imminent extinction from immediate threats.

    12. Identify and map all extant wild populations.

    13. Delineate management units.

    14. Ensure long-term protection of habitat.

    15. Identify and control threats.

        151. Control feral ungulates.

            1511. Construct and maintain fencing.

            1512. Evaluate the potential for controlling ungulates through eradication programs or establishment of game preserves.

        152. Conduct alien plant control.

        153. Provide necessary fire protection.

        154. Control rodents, if necessary.

        155. Propagate and maintain genetic stock *ex situ*.

        156. Ensure availability of pollination vectors.

        157. Protect areas from human disturbance.

        158. Control insects and/or disease, if necessary.

159. Control all other identified threats.

2. Expand existing wild populations.

21. Select populations for expansion.

22. Prepare sites and plant.

3. Conduct essential research.

31. Collect diagnostic data on crucial associated ecosystem components.

32. Map alien vegetation.

33. Study various aspects of growth.

34. Study reproductive viability.

35. Determine parameters of viable populations.

36. Determine effects of and control methods for insects and/or diseases, as needed.

37. Evaluate results and use in future management.

4. Develop and implement detailed monitoring plans for all species.

5. Reestablish wild populations within historic range.

51. Investigate feasibility and desirability of reintroduction.

52. Develop and implement specific plans for reestablishment.

6. Validate recovery criteria.

61. Determine number of populations and individuals needed for long-term survival.

62. Refine downlisting and delisting criteria.

## C. Stepdown Narrative

1. Protect habitat and control threats.

Given the altered nature of the Molokai Recovery Plan taxa's habitat, their low numbers, and the severity of the threats acting upon them, the highest priority recovery actions must be aimed at protecting those individuals and populations that currently exist, and managing their habitat to control the threats affecting their survival. Surveys should begin immediately for taxa that have not been observed for several years. If the species cannot be found, they may be considered for delisting due to extinction. A monitoring program is essential to track the status of the populations of all of the taxa covered in this plan, and to assess the effectiveness of threat management.

11. Conduct immediate preservation measures for taxa facing imminent extinction.

Immediate preservation measures must be taken in order to prevent the following taxa with extremely low numbers of individuals from going extinct: *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea procera*, *Hedyotis mannii*, *Hibiscus arnottianus* ssp. *immaculatus*, *Phyllostegia mannii*, *Pritchardia munroi*, *Silene alexandri*, and *Stenogyne bifida*. In some cases these measures have already been initiated and should continue. This task will be particularly important for *Clermontia oblongifolia* ssp. *brevipes*, which has not been seen since 1982.

111. Collect, propagate and maintain *ex situ* genetic stock of taxa facing imminent extinction.

Cultivated populations of each Molokai Recovery Plan taxon should be maintained in order to establish pools of genetic resources for reintroduction to appropriate sites and to safeguard against loss of the material due to catastrophe in wild populations.

As broad a complement as possible of the existing genetic stock for each taxon should be preserved. For each identifiable population (either from extant sites or traceable, pure, cultivated material), genetic material from as many individuals as feasible should be collected. Collection methods and quantities of materials collected should be devised so as to have minimal impact on wild populations. All collected materials should be labeled accurately as to exact origin, collection date, etc.

Seeds of each taxon should be collected and entrusted to seed banks for long-term storage using the best available techniques for preservation. Seeds in long-term storage should be periodically tested for viability and recollected as necessary.

112. Protect remaining wild individuals of taxa facing imminent extinction from immediate threats.

Remaining remnant populations should be protected from known imminent threats, such as feral ungulates, alien plants, fire, rodents, human disturbance, a lack of pollinators, development activities, and, potentially, insects and disease.

12. Identify and map all extant wild populations.

Protection of extant populations will involve locating all extant individuals, mapping their precise locations, and providing this information to the land managers.

Surveys of all reported and possible occurrences of each taxon should be conducted. Occurrence data, including presence in or absence from previously reported sites (as well as site notes) and all relevant information for newly reported occurrences, should be carefully documented. Detailed site information (including directions, maps, global positioning system (GPS) data, and narratives) is recommended for each site.

13. Delineate management units.

Management units should be identified for the 16 taxa covered by this recovery plan. In some cases, the ranges of the Molokai Recovery Plan taxa overlap and management units including multiple listed taxa can be delineated and managed. Management units should include areas adequate for buffer zones and fire breaks and for expansion of existing populations and establishment of new populations for recovery. Similar areas for newly discovered populations of each taxon should be identified and targeted for protection and management when necessary for recovery. The Hawaii and Pacific Plants Recovery Coordinating Committee and Plant Recovery Teams may assist the U.S. Fish and Wildlife Service, the Division of Forestry and Wildlife, and other landowners and managers in identifying these management units.

14. Ensure long-term protection of habitat.

The protection of Molokai Recovery Plan taxa management units is a primary concern. The protection currently provided to these taxa by various landowners should be continued and enhanced, and additional protective measures pursued as needed. These measures include, but are not limited to, protection provided by Federal and State laws, regulations, and policies; management plans and policies of Federal, State, and private landowners; and cooperative agreements and leases.

Molokai Recovery Plan taxa on Federal lands are located on portions of the Pohakuloa Training Area and Makua Military Reservation (both under the jurisdiction of the U.S. Army) and Kalaupapa National Historical Park. Federal agencies are required by section 7 of the ESA to insure that any action authorized, funded, or carried out by them is not likely to jeopardize the continued existence of any endangered or threatened species. Section 7 further stipulates that all federal agencies utilize their authorities in furtherance of the purposes of the Act by carrying out programs for the conservation of listed species. The Army and the National Park Service should be encouraged to develop and implement Endangered Species Management Plans for areas that are not currently covered by a plan, and undergo section 7 consultation with the U.S. Fish and Wildlife Service for any actions likely to affect the Molokai Recovery Plan taxa on their lands.

The State of Hawaii should ensure that all State departments responsible for land zoning, development projects, forestry projects, recreational programs, and other activities on their lands are made aware of the presence of these listed plant taxa. In addition, the State should review its proposed projects and ensure that appropriate measures are taken to minimize or preclude all negative impacts to the listed plant taxa. The Division of Forestry and Wildlife should develop and implement long-term management plans for the Molokai plant taxa on their lands.

The remaining habitat is owned or managed by various private landowners. Steps should be taken to ensure that all landowners are aware of the presence of the listed taxa on their lands and every effort should be made by the Division of Forestry and Wildlife and/or the U.S. Fish and Wildlife Service to assist the landowners, as necessary, in developing and implementing long-term management plans for these lands.

15. Identify and control threats.

For each population, threats to Molokai Recovery Plan taxa must be identified and prioritized, and steps taken to protect the taxa from those threats. Many of these threats have already been well documented, while others need to be further defined. Additional threats may become apparent if additional populations are located. Known threats include current and future development activities, feral ungulates, alien plants, fire, rodents, human disturbance, a lack of pollinators. Insects and disease represent potential threats.

Threat control plans should be developed for each area in which these taxa are found. Development of threat control plans should be carried out in as cooperative a manner as possible when populations occupy habitats owned by different parties. The delineation of management units should allow for the cooperative management of logical groupings of populations. Threat control plans should be as all-encompassing as possible, possibly incorporating several management units and other listed, proposed, and candidate taxa into one overall plan for restoration and management of the habitats that support the taxa identified in this recovery plan, along with other native components.

151. Control feral ungulates.

The numbers of goats, pigs, cattle, and other introduced ungulates in the forests of Hawaii are extensive. Controlling these ungulates to the point where they are no longer impacting native vegetation is absolutely imperative.

The most effective method currently known for providing immediate protection from introduced ungulates in Hawaii is fencing of discrete management units, accompanied by the removal of ungulates from within the fenced areas. Although this approach is costly, it does work, as demonstrated at Hawaii Volcanoes and Haleakala National Parks and elsewhere, and is a feasible solution for introduced ungulate control in Hawaii. Eradication of introduced animals may sometimes be an option, given public support, and should also be considered.

1511. Construct and maintain fencing.

A combination of methods will probably be the most effective strategy, using short-term, small-scale fencing to

protect those populations under immediate threat from ungulates while longer-term, large-scale fencing projects are being undertaken. However, even "small" exclosures should be designed with a minimum area sufficient to offset the negative impacts of construction and maintenance (e.g., scarification of fenceline and adjacent area and potential introduction of new pests into the area). As a general guideline, exclosures should have their perimeters located at least 50 meters (164 feet) from the nearest individual of the target species.

Fences should include the target populations and a buffer area of good-quality, similar habitat, for potential replanting efforts (and/or native buffer habitat that is resistant to invasion of alien species and fire). To reduce maintenance costs, fences should be constructed along ridgelines and tied into streamcourses and natural barriers, such as the tops of waterfalls.

Once the best method for fencing the management areas is determined, fencing and maintenance plans should begin as soon as possible. Fences should be impervious to all ungulates found in the area. Ongoing inspection and maintenance of fences are necessary to ensure the continued exclusion of ungulates from the fenced areas.

When each fence is completed, all enclosed ungulates should be removed. It is important to realize the potentially detrimental impact management activities may have. Soil and vegetation disturbance by managers can create open areas for new alien species invasions, and direct damage can result from inappropriate or careless activities. Eradication options may include hunting, snaring, and poisoning. Hunting from helicopters is a highly effective method for removing introduced ungulates, particularly for situations such as steep cliffs. Hunters and others who will be working in the habitat of the Molokai Recovery Plan taxa should be apprised of the existence of the plants so that they do not inadvertently damage them.

Ongoing monitoring for ungulates within the large fenced areas is necessary to ensure their continued absence. Monitoring should also include determining the effects of

the exclusion of ungulates, since their herbivory may have a more dramatic impact on invasive alien plants than on the endangered taxa. It is possible that without browsing by ungulates (until other management efforts can be devised and implemented) the present abundance of alien plants could quickly overwhelm some of the endangered taxa.

1512. Evaluate the potential for controlling ungulates through eradication programs or establishment of game preserves.

Ideally, island-wide programs to eradicate introduced ungulates should be initiated and supported, where applicable. Fences are maintenance-intensive, cannot be built in all areas due to topography, and are not a foolproof method of protecting habitats necessary for the perpetuation of the Molokai Recovery Plan taxa. Ultimately, the eradication of introduced ungulate populations is the only way to completely eliminate ungulate damage. Removal of introduced animals will also slow down the degradation of watershed lands. However, public support of hunting is fervent, and the likelihood of acceptance of island-wide ungulate eradication programs is remote. Developing game preserves, where areas are set aside for hunting of game animals, should be a high priority within the State.

152. Conduct alien plant control.

One of the most important aspects of habitat management for the Molokai Recovery Plan taxa is the control of invasive alien weeds. Weed control may become even more important for some species if the removal of ungulates relieves grazing and browsing pressure on alien plants. It is important to realize the potentially detrimental impact management activities may have. Soil and vegetation disturbance by managers can create open areas for new alien species invasions, and direct damage can result from inappropriate or careless activities. Steps should always be taken to minimize these effects. Alien plants are believed to be a threat to the following Molokai plant cluster species: *Bidens wiebkei, Brighamia rockii, Canavalia molokaiensis, Hedyotis mannii, Melicope reflexa, Schiedea lydgatei, Silene lanceolata,* and *Tetramolopium rockii.*

Effective weed control methods must be developed. Control methods may include, but are not limited to, hand-pulling, local herbicide application, and biocontrol. Weed control should be aggressively implemented in the vicinity of the Molokai Recovery Plan taxa, particularly within and around fenced management units. Weed control should be prioritized for each population, beginning in the immediate vicinity of the existing plants, and continuing until control is achieved in the full management unit. Follow-up visits to each site are necessary to ensure that weeds are permanently controlled, so sites should be monitored periodically to determine when additional intervention is necessary.

Control efforts should be supervised by personnel experienced in safe control methods to insure that crews do not compact soil, damage root systems, or improperly apply herbicides. Also, care should be taken to protect associated native species, as well as the endangered species, during weed removal.

Introduction of alien plants and other species to the State of Hawaii, and between islands within the State, needs to be controlled to prevent further threats to the Molokai Recovery Plan taxa and their habitats. In order to prevent the introduction of potentially detrimental alien species, support should be given to legislation, programs, or activities that limit the possibility of future introductions of alien species. The success of such programs or activities would contribute not only to the perpetuation of the endangered species in this plan, but to the quality of all native ecosystems as well as agricultural concerns in the State of Hawaii.

153. Provide necessary fire protection.

Protection from fire is critical to the survival of Molokai taxa that occur in dry or mesic habitats (see Table 1). These plants are not well-adapted to survive fire, particularly those fires fed by unnatural buildup of fuel (such as that provided by the growth of alien grasses). In addition, many introduced plant species are better adapted to recovery after fires and often invade burned areas, permanently changing the habitat. Protection must be both local and on a larger scale to prevent fires from spreading to areas where the plants grow. Fire is known to be a threat to the following Molokai plant cluster species: *Bidens wiebkei, Pritchardia munroi, Schiedea lydgatei, Silene alexandri, Silene lanceolata*, and

*Tetramolopium rockii.*

Plans to protect each site from fire should be developed and implemented. Makua Military Reservation currently has a fire control plan; PTA does not. "Fire-free" zones should be established, with hunters and other land users apprised of the dangers of smoking and open flames in sensitive areas. Firebreaks with a minimum width of 6 meters (20 feet) should be constructed around fire-prone populations of the Molokai Recovery Plan taxa wherever feasible. This minimum width is a guideline only and may not be sufficient to protect populations from fire in especially dry conditions.

154. Control rodents, if necessary.

Control of rodents is needed in some cases to allow reproduction of endangered plant taxa. Measures need to be taken as necessary to control rodent damage to the endangered plants and their fruits and seeds to allow reproduction of the plants. Methods could include trapping, poisoning, and/or the use of rodent barriers. Intensive rodent control over a period prior to and during fruit production is recommended for at least one season or until a good production season occurs, in order to have a viable crop of seeds for collection and *ex situ* propagation. Rats are believed to be a threat to the following Molokai plant cluster species: *Brighamia rockii, Clermontia oblongifolia* ssp. *brevipes, Cyanea mannii, Cyanea procera,* and *Pritchardia munroi.*

155. Propagate and maintain genetic stock *ex situ*.

Although cultivation of these plants is not a substitute for their preservation in the wild, cultivated populations of each Molokai Recovery Plan taxon should be maintained in order to establish pools of genetic resources for reintroduction to appropriate sites and to safeguard against loss of the material due to catastrophe in wild populations. Additionally, the existence of cultivated plants may reduce any demand for field-collected specimens of these rare taxa by providing a propagated source of those taxa for which there might be a horticultural and/or research demand.

As broad a complement as possible of the existing genetic stock for each taxon should be preserved. For each identifiable population (either from extant sites or traceable, pure, cultivated material),

genetic material from as many individuals as feasible should be collected. Collection methods and quantities of materials collected should be devised so as to have minimal impact on wild populations. All collected materials should be labeled accurately as to exact origin, collection date, etc.

Seeds of each taxon should be collected and entrusted to seed banks for long-term storage using the best available techniques for preservation. Seeds in long-

term storage should be periodically tested for viability and recollected as necessary.

156. Ensure availability of pollination vectors.

Based on research findings, measures should be established to ensure that pollination vectors remain available to the Molokai Recovery Plan taxa. If it is discovered that pollination vectors for certain taxa are missing, necessary measures should be taken to compensate for these, especially for *Brighamia rockii.*

157. Protect areas from human disturbance.

The Molokai Recovery Plan taxa should be protected as much as possible from hikers, vehicles, and other possibilities of direct human disturbance. Public awareness and education activities regarding the Molokai taxa and native habitats in general should be done in conjunction with public education for other listed taxa. Human disturbance is believed to be a threat to the following Molokai plant cluster species: *Bidens wiebkei, Melicope reflexa, Phyllostegia mannii, Stenogyne bifida,* and *Tetramolopium rockii.*

Signs designating sensitive environmental areas and/or research areas should be placed near sites where human contact may occur. "Kapu/No Trespassing" signs should prohibit entry to these areas. However, signs may not be necessary for some populations that are in remote areas and/or areas not frequently visited or where signs may attract undue attention to these populations, thereby exposing them to vandalism. The decision regarding sign placement should be based on the circumstances surrounding each population.

Where possible, access to roads and/or trails that pass through habitat of the Molokai Recovery Plan taxa should be allowed only for necessary management activities (e.g., fire control, hunting, monitoring, etc.). Care should be taken during road or trail maintenance in or near habitat of the endangered taxa to avoid practices that would cause opening of canopies, excessive erosion, or other damage to the Molokai Recovery Plan taxa or their habitats. If hiking is permitted in management areas, hikers should be informed of the presence of sensitive environments and precautions that should be taken to avoid disturbance of such areas (e.g., the importance of staying on existing trails and of cleaning of boots and clothing). These activities should be closely monitored by an appropriate conservation agency.

158. Control insects and/or disease, if necessary.

If the results of research show that insects and/or disease are a threat to any of the Molokai Recovery Plan taxa, control measures should be implemented.

159. Control all other identified threats.

The need for control of other threats may become apparent as more is learned about the Molokai Recovery Plan taxa. New threats may also arise with further changes to natural habitats in Hawaii, such as introduction of new alien species. As new threats arise, management actions to reduce and/or eliminate their effects on the Molokai Recovery Plan taxa should be implemented.

2. Expand existing wild populations.

The Molokai cluster taxa may expand naturally following the elimination of current threats through management. However, in certain instances, wild populations may need to be augmented in order to reach down/delisting criteria. Suitable sites for population augmentation should be selected after careful evaluation of the threat of introducing detrimental organisms into the wild populations. Augmentation efforts should always be well-documented as to lineage and methods.

21. Select populations for expansion.

The need for expansion of current populations should be evaluated, and specific plans should be created for the augmentation of wild populations

that need to be enhanced.

22. Prepare sites and plant.

Plans should describe the plant material to be used and the most appropriate methods. Each selected site must be prepared and protected appropriately, including building exclosures and controlling alien species within.

After sites are protected, *ex situ*-propagated material should be added to existing wild populations in quantities and times deemed appropriate based on population and growth studies. Normally, progeny from plants of the same site/population should be used to augment a population to avoid contamination of the existing local gene pool with genetic material from other origins. Managers should ensure that selected materials are free from pests, diseases, and pathogens that might be introduced to the new or nearby wild populations. This aspect is particularly critical since cultivated plants may have been grown in the presence of other pathogen-carrying plants, and nearby wild populations may have lower resistance to such introductions. Care should be taken regarding the matching of soils if transplanting already started plants due to differences in water retention around the root areas (i.e., if surrounding soil is more absorptive, the soil directly around the roots could become overly dry and weaken or kill the newly transplanted specimen).

Augmented populations should be monitored carefully (see Task #4), and ongoing maintenance of each site should begin after initial preparation and planting.

3. Conduct essential research.

Research into various aspects of the life history, habitat, pollinators, reproductive biology, symbionts, optimum requirements for growth, requirements for population viability, and control of threats for each of the Molokai Recovery Plan taxa is needed in order to better understand the requirements necessary for perpetuation of these plants. Additional knowledge would allow more appropriate management and assessment techniques to be developed, and is needed in order to determine meaningful parameters for definition of specific recovery criteria for each taxon.

31. Collect diagnostic data on crucial associated ecosystem components.

The composition of flora and of invertebrate, bird, and other fauna populations within each management area should be established to attempt to gain an understanding of any relationships between these organisms and the Molokai Recovery Plan plants.

32. Map alien vegetation.

Periodic mapping of alien vegetation is recommended using various techniques, including direct ground observations as well as aerial color and/or infrared photographs. Advantages of aerial techniques include (1) the approach is not directly invasive into the sensitive habitat of the endangered plants; and (2) large, inaccessible areas may be monitored. Mapping would allow changes in distributions and abundance of alien plants to be followed so that appropriate management actions may be taken.

33. Study various aspects of growth.

Various aspects of the growth of each taxon need to be studied, including growth and mortality of seedlings; growth of mature plants, including seasonal changes, optimum conditions, and limiting factors; seasonal differences in temperature and light needs; water sources and requirements; and soil and nutrient requirements.

34. Study reproductive viability.

Factors affecting the reproductive viability of each of the Molokai Recovery Plan taxa need to be investigated, including: breeding systems, including self-compatibility; pollination vectors; and preferred conditions for flowering and seed set. This information will allow development of the best management strategy for each taxon.

35. Determine parameters of viable populations.

Definitions of viable populations need to be established to more precisely determine criteria for consideration of downlisting or delisting. These definitions should include minimum numbers of individuals and populations needed for long-term survival; demographics; longevity; minimum range needed for long-term survival; genetic relationships and susceptibility to inbreeding depression; and dispersal potential.

36. Determine effects of and control methods for insects and/or diseases, as needed.

Effective control methods for insects and disease found to be harmful to native taxa must be developed.

37. Evaluate results and use in future management.

The results of the above studies should be evaluated and incorporated into the management process and the development of recovery criteria.

4. Develop and implement detailed monitoring plans for all species.

All populations of the Molokai Recovery Plan taxa should be monitored to ensure that current information is available for each. A detailed monitoring plan should be designed and implemented for each taxon. Permanent plots should be set up for each population, and individuals mapped by size class, in order to establish baseline information regarding population size, local distribution patterns and threats. As new populations are discovered or established, they should be added to the monitoring program.

Individual plants may also be carefully tagged as appropriate for monitoring purposes. Data collection should include quantities and locations of all extant plants as well as any other relevant observations regarding phenology, habitat or threats. Plots should be set up to allow point-and/or line-intercept monitoring methods as appropriate for each situation. Information such as changes in numbers of plants by size class, changes in vigor of individual plants, and changes or disturbances to the environment should be noted as appropriate and that data recorded.

5. Reestablish wild populations within historic range.

If necessary to meet recovery objectives, populations should be reestablished in areas where they are known or believed to have occurred historically, particularly if genetically uncontaminated, cultivated materials exist that are known to have originated from the historical site. The goal of reintroduction is to permanently re-establish viable populations of these taxa in stable and secure conditions.

51. Investigate feasibility and desirability of reintroduction.

For each taxon, appropriateness of reintroduction into wild situations should be assessed. Genetic purity of populations is a prime concern, as is the possibility of introducing pathogens to natural areas. Reintroduction

efforts should always be well-documented as to lineage and methods.

52. Develop and implement specific plans for reestablishment.

Specific plans should be created for each reestablishment effort and should identify reestablishment sites, plant materials and methods to be used. Methods used should ensure that selected materials are free from pests, diseases, and pathogens that might be introduced to the new or nearby wild populations. This aspect is particularly critical since cultivated plants may have been grown in the presence of other pathogen-carrying plants, and nearby wild populations may have lower resistance to such introductions. If the reestablishment sites are outside the management units already established, they should be protected as discussed above (Task #1).

Each site must be prepared appropriately, including construction of exclosures and control of alien species therein, as necessary. The selected material should then be planted. Care should be taken regarding the matching of soils if transplanting already started plants due to differences in water retention around the root areas (i.e., if surrounding soil in the transplant area is more absorptive than the soil used to start the plant, the roots could be overly dried and the newly transplanted specimen could be weakened or could die).

Newly established populations should be monitored carefully (see Task #4), and maintenance should begin soon after initial preparation and planting.

6. Validate recovery criteria.

The scientific validity of the recovery criteria should be reviewed and revised as appropriate as more information becomes available.

61. Determine number of populations and individuals needed for long-term survival.

For each of the Molokai Recovery Plan taxa, the number of populations and the number of individuals needed for long-term survival should be determined.

62. Refine downlisting and delisting criteria.

Based on scientific information gathered during recovery efforts (e.g. data on viable population sizes, longevity, etc.), recovery criteria for each of the Molokai Recovery Plan taxa should be revised. Until this additional information is available, the criteria presented in this recovery plan should be used as the bases for downlisting and delisting.

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# IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows outlines actions and estimated cost for the Molokai plant cluster recovery program, as set forth in this recovery plan. It is a guide for meeting the objectives discussed in Part II of this plan. This schedule indicates task priority, task numbers, task descriptions, duration of tasks, the agencies responsible for committing funds, and lastly, estimated costs. The agencies responsible for committing funds are not, necessarily, the entities that will actually carry out the tasks. When more than one agency 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, whenever 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 or to prevent the species from declining irreversibly. |
| Priority 2 | - | An action that must be taken to prevent a significant decline in species' population/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.) |
| C | - | Task will need to be performed continuously |
| DOD | - | U.S. Department of Defense |
| DOFAW | - | Division of Forestry and Wildlife, Hawaii Department of Land and Natural Resources |
| FWS-PIE | - | U.S. Fish & Wildlife Service, Pacific Islands Ecoregion, Honolulu, Hawaii |
| HDOA | - | Hawaii Department of Agriculture |
| HHL | - | Hawaiian Home Lands |
| NBS | - | National Biological Service |
| NPS | - | National Park Service |
| O | - | Task is ongoing |
| OTHER | - | Various Private Landowners |
| TBD | - | Funding and/or timing of task to be determined |
| TNCH | - | The Nature Conservancy - Hawaii |

RECOVERY PLAN IMPLEMENTATION SCHEDULE FOR THE MOLOKAI PLANT CLUSTER

| Priority Number | Task Number | Task Description | Task Duration (Years) | Responsible Party | Total Cost through FY 2017 | Cost Estimates ($1,000's) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | FY 1997 | FY 1998 | FY 1999 | FY 2000 | FY 2001 |
| 1 | 111 | Collect, propagate, and maintain *ex situ* genetic stock of taxa facing imminent extinction | O | DOFAW* | 330.0 | 30 | 30 | 30 | 30 | 30 |
| | | | | FWS-PIE | 110.0 | 10 | 10 | 10 | 10 | 10 |
| | | | | BOT | 111.0 | 10 | 10 | 10 | 10 | 10 |
| 1 | 112 | Protect remaining wild individuals of taxa facing imminent extinction from immediate threats | O | DOFAW* | 0.0 | TBD | | | | |
| | | | | FWS-PIE | 0.0 | TBD | | | | |
| | | | | DOD | 0.0 | TBD | | | | |
| | | | | TNCH | 0.0 | TBD | | | | |
| | | | | OTHER | 0.0 | TBD | | | | |
| 1 | 12 | Identify and map all extant wild populations | 5 | DOFAW* | 250.0 | 50 | 50 | 50 | 50 | 50 |
| | | | | FWS-PIE | 50.0 | 10 | 10 | 10 | 10 | 10 |
| | | | | TNCH | 50.0 | 10 | 10 | 10 | 10 | 10 |
| | | | | NPS | 50.0 | 10 | 10 | 10 | 10 | 10 |
| | | | | DOD | 50.0 | 10 | 10 | 10 | 10 | 10 |

RECOVERY PLAN IMPLEMENTATION SCHEDULE FOR THE MOLOKAI PLANT CLUSTER

| Priority Number | Task Number | Task Description | Task Duration (Years) | Responsible Party | Total Cost through FY 2017 | Cost Estimates ($1,000's) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | FY 1997 | FY 1998 | FY 1999 | FY 2000 | FY 2001 |
| 1 | 13 | Delineate management units | 3 | FWS-PIE* | 15.0 | 5 | 5 | 5 | | |
| | | | | DOFAW | 6.0 | 2 | 2 | 2 | | |
| | | | | TNCH | 6.0 | 2 | 2 | 2 | | |
| | | | | OTHER | 0.0 | | | | | |
| 1 | 14 | Ensure long-term protection of habitat | O | DOFAW* | 105.0 | 5 | 5 | 5 | 5 | 5 |
| | | | | NPS | 63.0 | 3 | 3 | 3 | 3 | 3 |
| | | | | TNCH | 63.0 | 3 | 3 | 3 | 3 | 3 |
| | | | | DOD | 63.0 | 3 | 3 | 3 | 3 | 3 |
| | | | | FWS-PIE | 105.0 | 5 | 5 | 5 | 5 | 5 |
| | | | | OTHER | 63.0 | 3 | 3 | 3 | 3 | 3 |
| 1 | 1511 | Construct and maintain fencing | C | DOFAW* | 2,100.0 | 100 | 100 | 100 | 100 | 100 |
| | | | | NPS | 2,100.0 | 100 | 100 | 100 | 100 | 100 |
| | | | | TNCH | 2,100.0 | 100 | 100 | 100 | 100 | 100 |
| | | | | DOD | 2,100.0 | 100 | 100 | 100 | 100 | 100 |
| | | | | FWS-PIE | 2,100.0 | 100 | 100 | 100 | 100 | 100 |
| | | | | OTHER | 0.0 | TBD | | | | |

RECOVERY PLAN IMPLEMENTATION SCHEDULE FOR THE MOLOKAI PLANT CLUSTER

| Priority Number | Task Number | Task Description | Task Duration (Years) | Responsible Party | Total Cost through FY 2017 | Cost Estimates ($1,000's) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | FY 1997 | FY 1998 | FY 1999 | FY 2000 | FY 2001 |
| 1 | 152 | Conduct alien plant control | O | DOFAW* | 2,100.0 | 100 | 100 | 100 | 100 | 100 |
| | | | | TNCH | 420.0 | 20 | 20 | 20 | 20 | 20 |
| | | | | DOD | 1,050.0 | 50 | 50 | 50 | 50 | 50 |
| | | | | NPS | 840.0 | 40 | 40 | 40 | 40 | 40 |
| | | | | FWS-PIE | 420.0 | 20 | 20 | 20 | 20 | 20 |
| | | | | OTHER | 0.0 | TBD | | | | |
| 1 | 153 | Provide necessary fire protection | C | DOFAW* | 800.0 | | 40 | 40 | 40 | 40 |
| | | | | DOD | 600.0 | | 30 | 30 | 30 | 30 |
| | | | | NPS | 400.0 | | 20 | 20 | 20 | 20 |
| | | | | TNCH | 200.0 | | 10 | 10 | 10 | 10 |
| | | | | FWS-PIE | 200.0 | | 10 | 10 | 10 | 10 |
| 1 | 154 | Control rodents | TBD | DOFAW* | 0.0 | TBD | | | | |
| | | | | FWS-PIE | 0.0 | TBD | | | | |
| | | | | NPS | 0.0 | TBD | | | | |
| | | | | DOD | 0.0 | TBD | | | | |
| | | | | OTHER | 0.0 | TBD | | | | |

RECOVERY PLAN IMPLEMENTATION SCHEDULE FOR THE MOLOKAI PLANT CLUSTER

| Priority Number | Task Number | Task Description | Task Duration (Years) | Responsible Party | Total Cost through FY 2017 | Cost Estimates ($1,000's) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | FY 1997 | FY 1998 | FY 1999 | FY 2000 | FY 2001 |
| 1 | 155 | Propagate and maintain genetic stock of each taxa *ex situ* | O | DOFAW* | 1,680.0 | 80 | 80 | 80 | 80 | 80 |
| | | | | FWS-PIE | 210.0 | 10 | 10 | 10 | 10 | 10 |
| | | | | BOT | 315.0 | 15 | 15 | 15 | 15 | 15 |
| 1 | 156 | Ensure availability of pollination vectors | C | DOFAW* | 0.0 | TBD | | | | |
| | | | | FWS-PIE | 0.0 | TBD | | | | |
| 1 | 157 | Protect areas from human disturbance | O | DOFAW* | 420.0 | 20 | 20 | 20 | 20 | 20 |
| | | | | TNCH | 210.0 | 10 | 10 | 10 | 10 | 10 |
| | | | | NPS | 5,210.0 | 10 | 10 | 10 | 10 | 10 |
| | | | | DOD | 210.0 | 10 | 10 | 10 | 10 | 10 |
| | | | | FWS-PIE | 210.0 | 10 | 10 | 10 | 10 | 10 |
| | | | | OTHER | 105.0 | 5 | 5 | 5 | 5 | 5 |

RECOVERY PLAN IMPLEMENTATION SCHEDULE FOR THE MOLOKAI PLANT CLUSTER

| Priority Number | Task Number | Task Description | Task Duration (Years) | Responsible Party | Total Cost through FY 2017 | Cost Estimates ($1,000's) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | FY 1997 | FY 1998 | FY 1999 | FY 2000 | FY 2001 |
| 1 | 158 | Control insects and/or disease, if necessary | TBD | DOFAW* | 0.0 | TBD | | | | |
| | | | | TNCH | 0.0 | TBD | | | | |
| | | | | DOD | 0.0 | TBD | | | | |
| | | | | HDOA | 0.0 | TBD | | | | |
| | | | | NPS | 0.0 | TBD | | | | |
| | | | | FWS-PIE | 0.0 | TBD | | | | |
| | | | | OTHER | 0.0 | TBD | | | | |
| 1 | 159 | Control all other identified threats | TBD | DOFAW | 0.0 | TBD | | | | |
| | | | | DOD | 0.0 | TBD | | | | |
| | | | | TNCH | 0.0 | TBD | | | | |
| | | | | NPS | 0.0 | TBD | | | | |
| | | | | FWS-PIE | 0.0 | TBD | | | | |
| | | | | OTHER | 0.0 | TBD | | | | |
| 2 | 1512 | Evaluate the potential for controlling ungulates through eradication programs or establishment of game preserves | 3 | DOFAW* | 15.0 | | 5 | 5 | 5 | |
| | | | | FWS-PIE | 15.0 | | 5 | 5 | 5 | |
| | | | | OTHER | 0.0 | TBD | | | | |

RECOVERY PLAN IMPLEMENTATION SCHEDULE FOR THE MOLOKAI PLANT CLUSTER

| Priority Number | Task Number | Task Description | Task Duration (Years) | Responsible Party | Total Cost through FY 2017 | Cost Estimates ($1,000's) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | FY 1997 | FY 1998 | FY 1999 | FY 2000 | FY 2001 |
| NEED 1 (Protect habitat and control threats) | | | | | 22,619.0 | 1,071 | 1,191 | 1,191 | 1,182 | 1,172 |
| 2 | 21 | Select populations for expansion | 2 | DOFAW* | 4.0 | | | | 2 | 2 |
| | | | | FWS-PIE | 4.0 | | | | 2 | 2 |
| | | | | OTHER | 4.0 | | | | 2 | 2 |
| 2 | 22 | Prepare sites and plant | TBD | DOFAW* | 0.0 | | | | | TBD |
| | | | | OTHER | 0.0 | | | | | TBD |
| | | | | FWS-PIE | 0.0 | | | | | TBD |
| NEED 2 (Expand existing wild populations) | | | | | 12.0 | 0 | 0 | 0 | 6 | 6 |
| 2 | 31 | Collect diagnostic data on crucial associated ecosystem components | 5 | NBS* | 150.0 | 30 | 30 | 30 | 30 | 30 |
| | | | | DOFAW | 50.0 | 10 | 10 | 10 | 10 | 10 |
| 2 | 32 | Map alien vegetation | O | NBS* | 180.0 | 20 | 20 | 20 | 20 | 20 |
| | | | | DOFAW | 82.0 | 10 | 10 | 10 | 10 | 10 |
| | | | | FWS-PIE | 82.0 | 10 | 10 | 10 | 10 | 10 |
| 2 | 33 | Study various aspects of growth | 5 | NBS* | 100.0 | 20 | 20 | 20 | 20 | 20 |
| | | | | DOFAW | 50.0 | 10 | 10 | 10 | 10 | 10 |
| | | | | FWS-PIE | 50.0 | 10 | 10 | 10 | 10 | 10 |

RECOVERY PLAN IMPLEMENTATION SCHEDULE FOR THE MOLOKAI PLANT CLUSTER

| Priority Number | Task Number | Task Description | Task Duration (Years) | Responsible Party | Total Cost through FY 2017 | Cost Estimates ($1,000's) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | FY 1997 | FY 1998 | FY 1999 | FY 2000 | FY 2001 |
| 2 | 34 | Study reproductive viability | 5 | NBS* | 100.0 | 20 | 20 | 20 | 20 | 20 |
| | | | | DOFAW | 50.0 | 10 | 10 | 10 | 10 | 10 |
| | | | | FWS-PIE | 50.0 | 10 | 10 | 10 | 10 | 10 |
| 2 | 35 | Determine parameters of viable populations | 5 | FWS-PIE* | 100.0 | 20 | 20 | 20 | 20 | 20 |
| | | | | DOFAW | 100.0 | 20 | 20 | 20 | 20 | 20 |
| | | | | NBS | 100.0 | 20 | 20 | 20 | 20 | 20 |
| 2 | 36 | Determine effective control methods for insects and/or diseases, as needed | TBD | DOFAW* | 0.0 | TBD | | | | |
| | | | | FWS-PIE | 0.0 | TBD | | | | |
| | | | | NBS | 0.0 | TBD | | | | |
| 2 | 37 | Evaluate results and use in future management | O | DOFAW* | 42.0 | 2 | 2 | 2 | 2 | 2 |
| | | | | FWS-PIE | 42.0 | 2 | 2 | 2 | 2 | 2 |
| NEED 3 (Conduct essential research) | | | | | 1,328.0 | 224 | 224 | 224 | 224 | 224 |

RECOVERY PLAN IMPLEMENTATION SCHEDULE FOR THE MOLOKAI PLANT CLUSTER

| Priority Number | Task Number | Task Description | Task Duration (Years) | Responsible Party | Total Cost through FY 2017 | Cost Estimates ($1,000's) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | FY 1997 | FY 1998 | FY 1999 | FY 2000 | FY 2001 |
| 3 | 4 | Develop and maintain long-term monitoring programs for all species | C | DOFAW* | 210.0 | 10 | 10 | 10 | 10 | 10 |
| | | | | NPS | 105.0 | 5 | 5 | 5 | 5 | 5 |
| | | | | TNCH | 105.0 | 5 | 5 | 5 | 5 | 5 |
| | | | | DOD | 105.0 | 5 | 5 | 5 | 5 | 5 |
| | | | | BOT | 105.0 | 5 | 5 | 5 | 5 | 5 |
| | | | | FWS-PIE | 105.0 | 5 | 5 | 5 | 5 | 5 |
| NEED 4 (Develop and implement detailed monitoring plans for all species) | | | | | 735.0 | 35 | 35 | 35 | 35 | 35 |
| 3 | 51 | Investigate feasibility and desirability of reintroduction | 2 | FWS-PIE* | 10.0 | | | | | |
| | | | | DOFAW | 10.0 | | | | | |
| | | | | NBS | 10.0 | | | | | |
| 3 | 52 | Develop and implement specific plans for reestablishment | TBD | DOFAW* | 0.0 | TBD | | | | |
| | | | | FWS-PIE | 0.0 | TBD | | | | |
| | | | | NBS | 0.0 | TBD | | | | |
| | | | | OTHER | 0.0 | TBD | | | | |
| NEED 5 (Reestablish wild populations within the historic range) | | | | | 30.0 | 0 | 0 | 0 | 0 | 0 |

RECOVERY PLAN IMPLEMENTATION SCHEDULE FOR THE MOLOKAI PLANT CLUSTER

| Priority Number | Task Number | Task Description | Task Duration (Years) | Responsible Party | Total Cost through FY 2017 | Cost Estimates ($1,000's) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | FY 1997 | FY 1998 | FY 1999 | FY 2000 | FY 2001 |
| 3 | 61 | Determine number of populations and individuals needed for long-term survival | 2 | FWS-PIE* | 10.0 | | | | | |
| | | | | DOFAW | 10.0 | | | | | |
| | | | | NBS | 10.0 | | | | | |
| 3 | 62 | Refine downlisting and delisting criteria | 2 | FWS-PIE | 10.0 | | | | | |
| | | | | DOFAW | 10.0 | | | | | |
| | | | | NBS* | 10.0 | | | | | |
| NEED 6 (Validate recovery criteria) | | | | | 60.0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL COST | | | | | 24,784.0 | 1,330 | 1,450 | 1,450 | 1,447 | 1,437 |

# APPENDIX A
# AGENCY AND PEER REVIEWERS

FWS Washington, D.C.

Chief, Fish and Wildlife Service
Division of Endangered Species
Arlington Square Building
4401 N. Fairfax Dr., Room 452
Arlington, VA 22203

Chief, Office of Public Affairs
U.S. Fish and Wildlife Service, Main Interior Building
1849 C. St, NW, Room 3447
Washington, D.C. 20240

Chief, Fish and Wildlife Service
Division of Refuges and Wildlife
4401 N. Fairfax Dr., Rm. 670
Arlington, VA 22203

Others - Washington, D.C.

Environmental Protection (*)
Agency
Hazard Evaluation Division
EEB (TS769C), 401 M St., SW
Washington, D.C. 20460

National Biological Service
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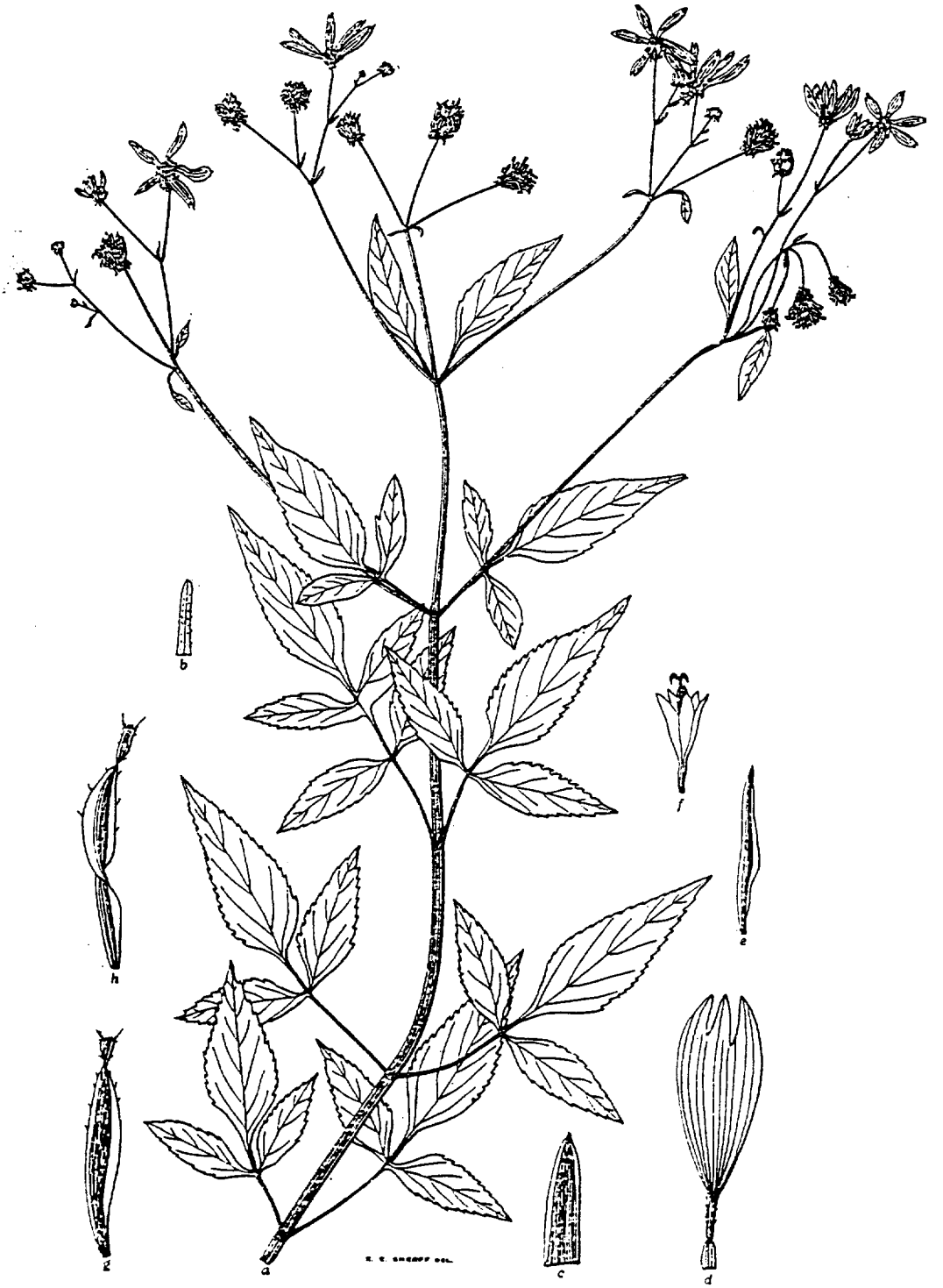
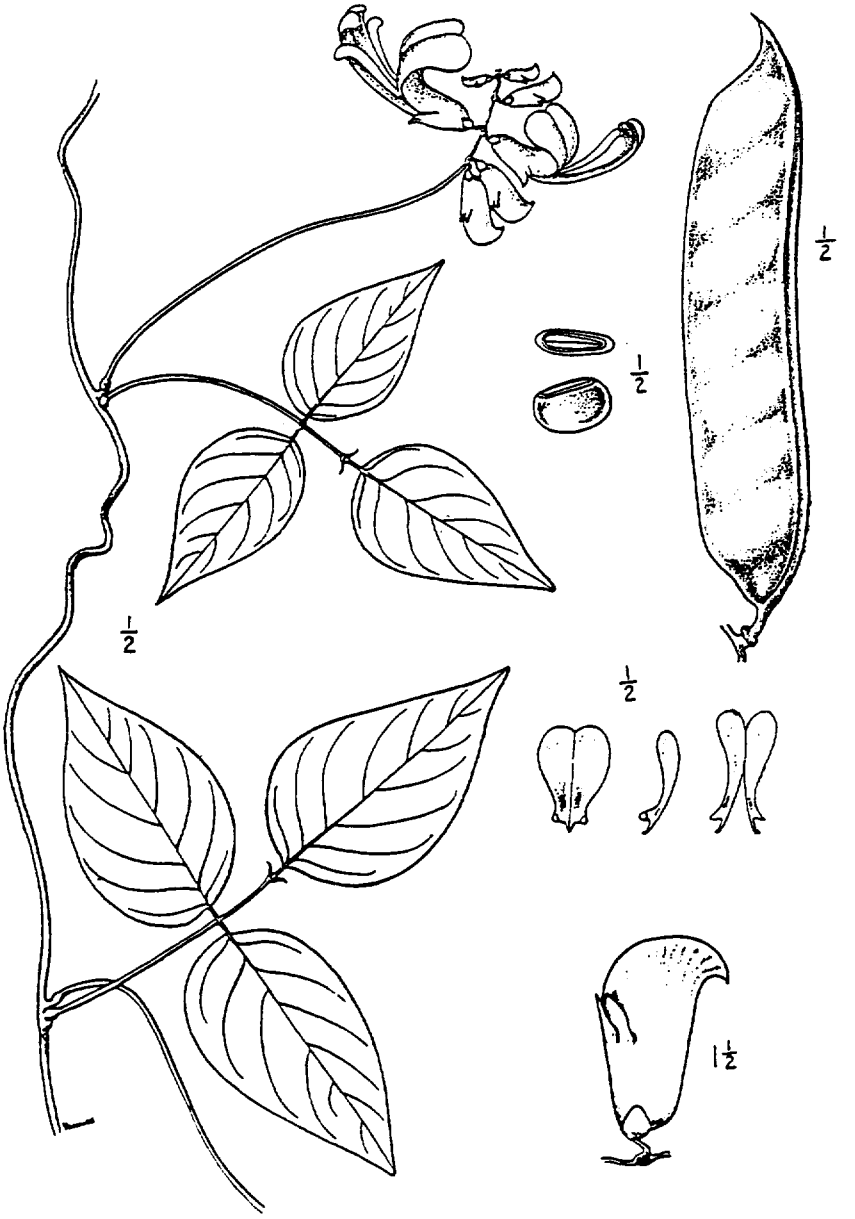
# APPENDIX B
# LINE DRAWINGS OF PLANTS

No line drawings were available for the following species:

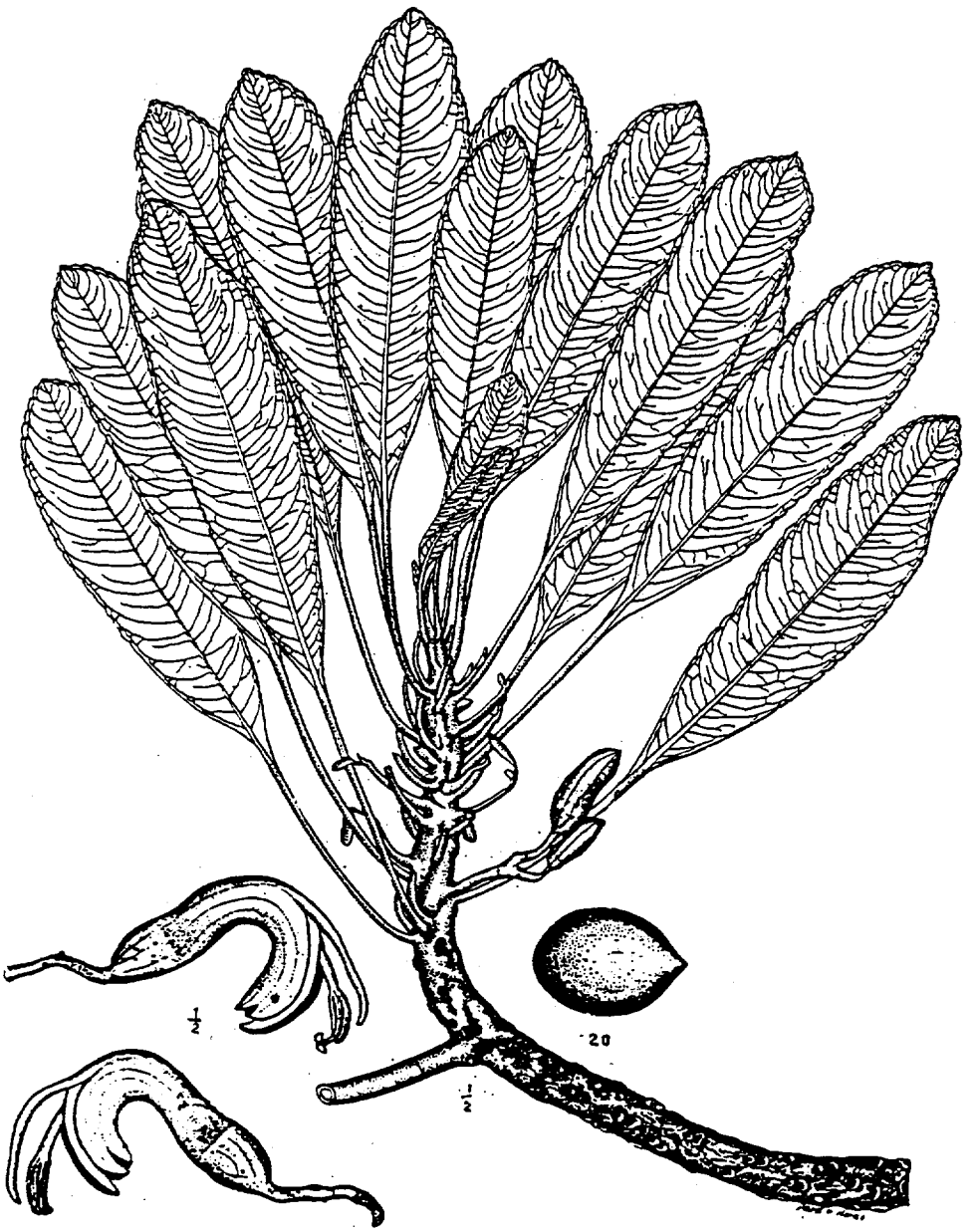
*Brighamia rockii*
*Cyanea mannii*
*Cyanea procera*
*Hedyotis mannii*
*Melicope reflexa*
*Phyllostegia mannii*
*Pritchardia munroi*
*Schiedea lydgatei*
*Silene alexandri*
*Silene lanceolata*
*Stenogyne bifida*



Line drawing of *Bidens wiebkei* from Degener (1937a).

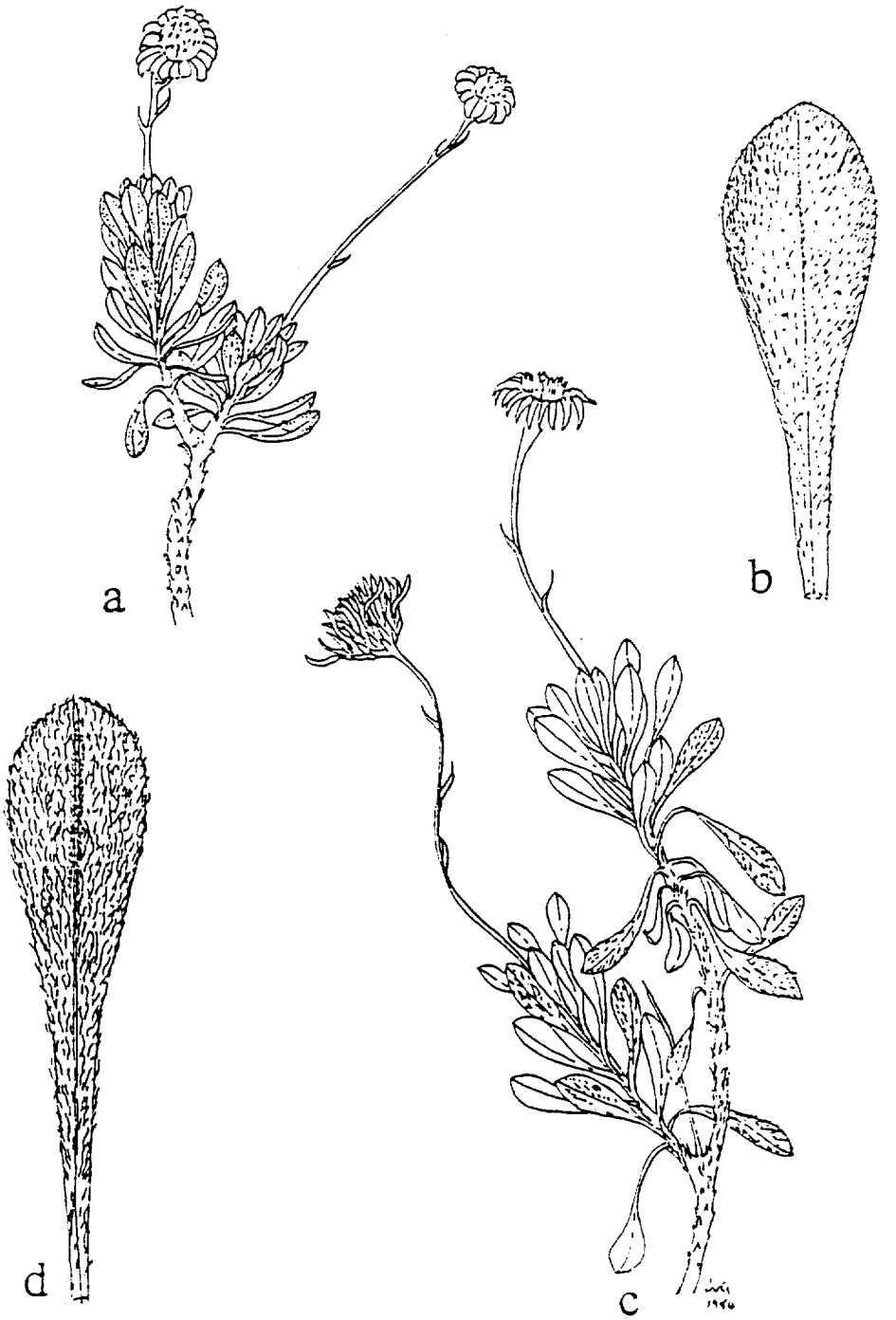



Line drawing of *Canavalia molokaiensis* from Degener and Degener (1960).



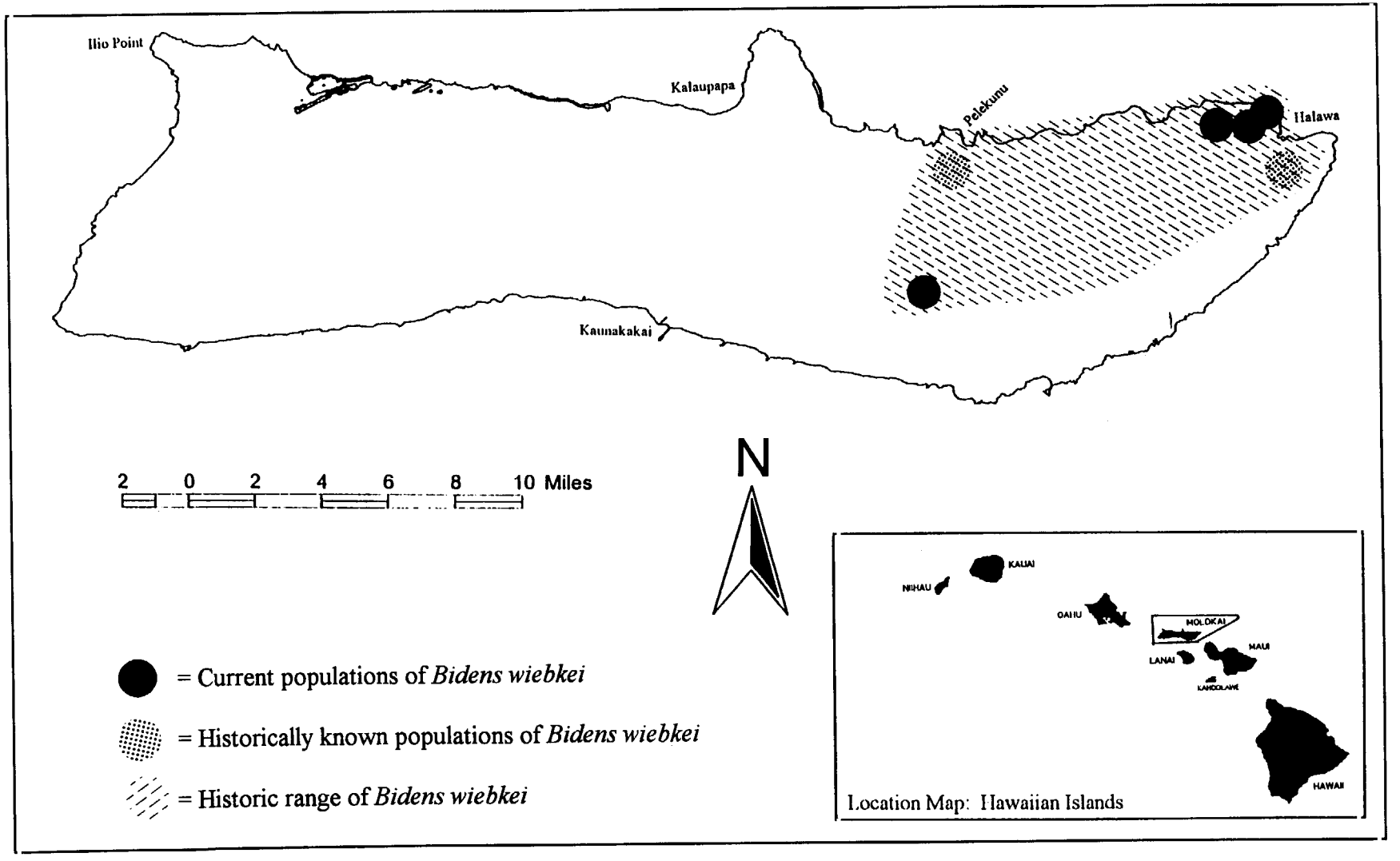

Line drawing of *Clermontia oblongifolia* from Degener (1937b).

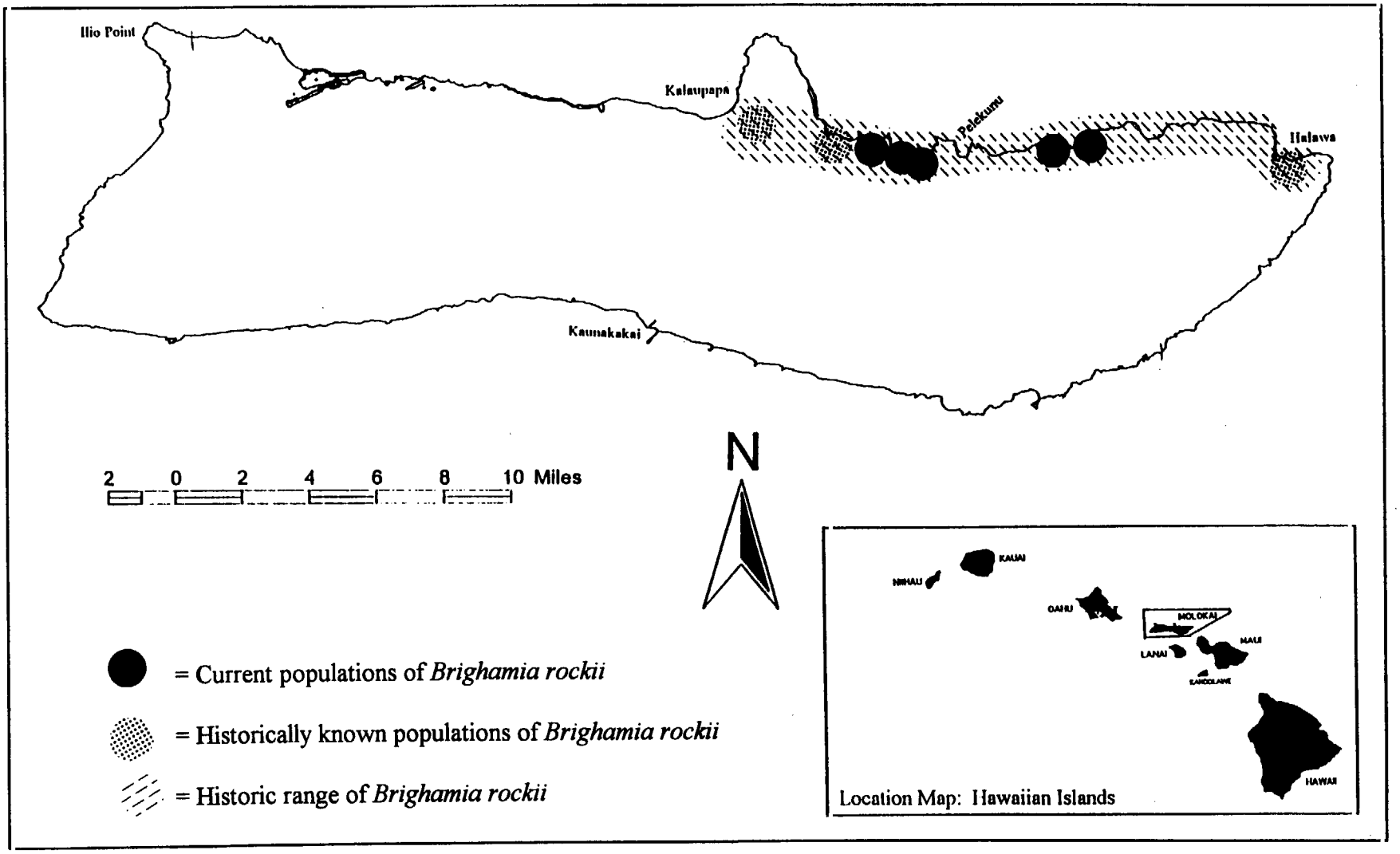
Line drawing of *Hibiscus arnottianus* ssp. *immaculatus* from Roe (1959).

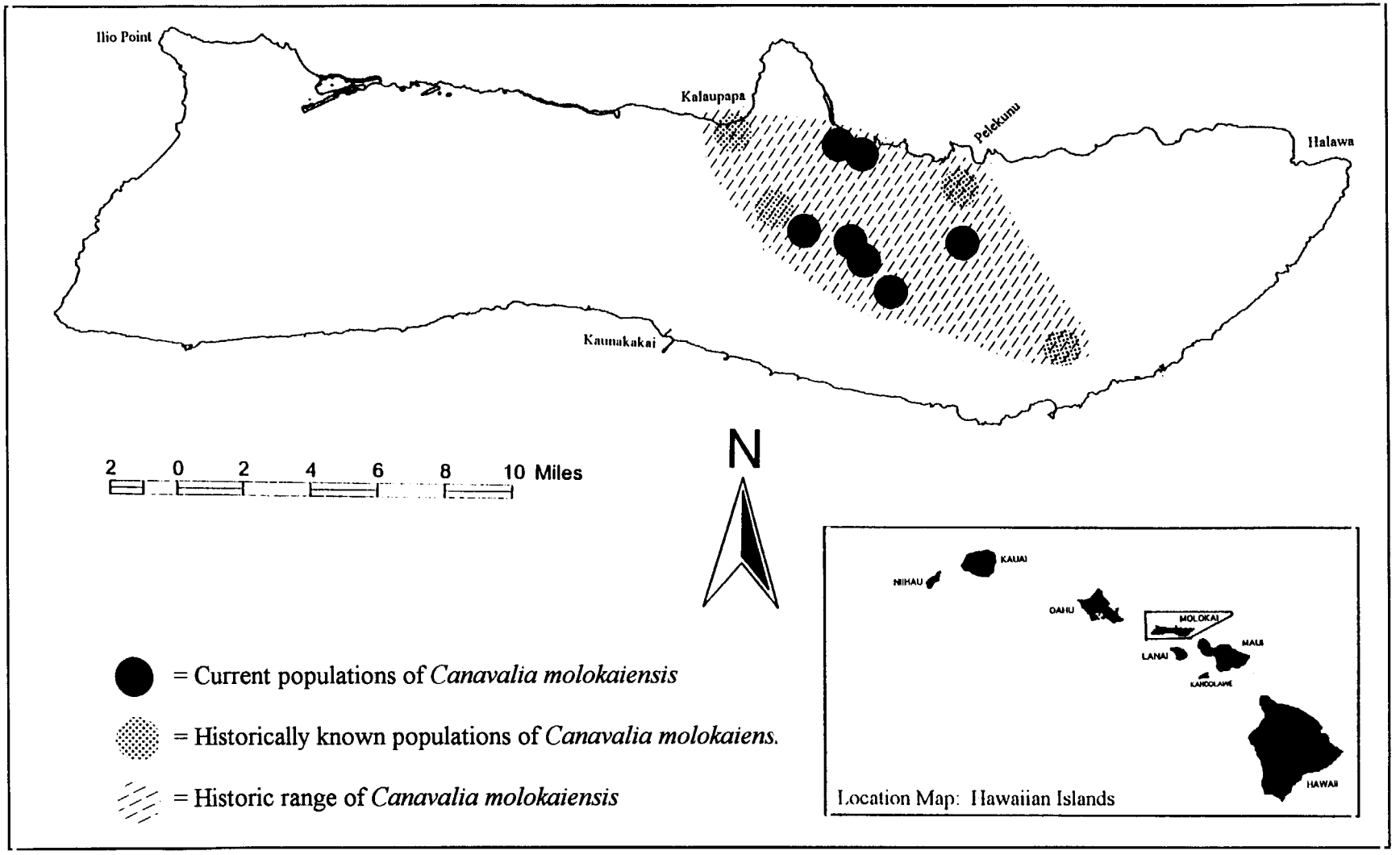


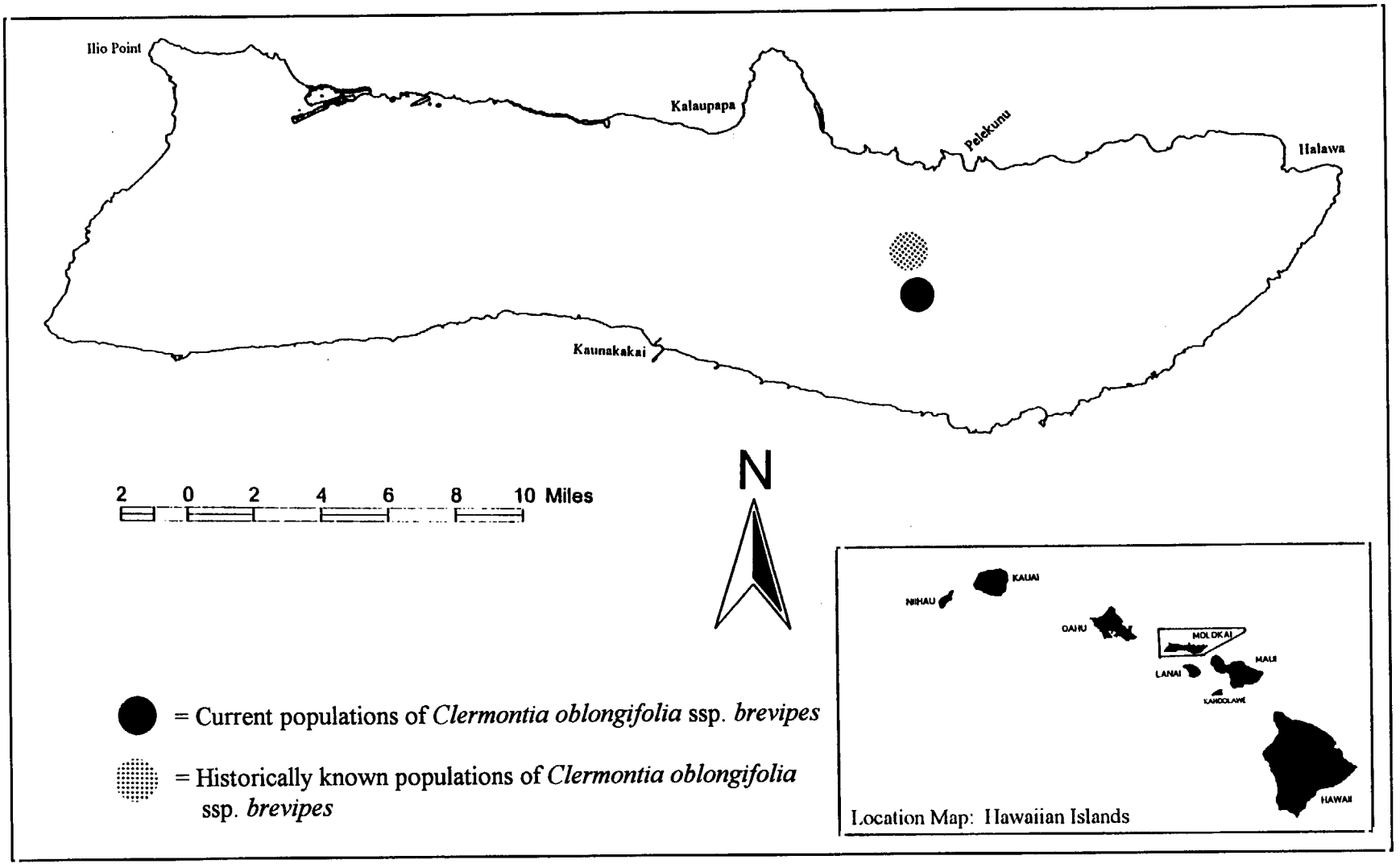

Line drawing of *Tetramolopium rockii* var. *rockii* (a & b) and *Tetramolopium rockii* var. *calcisabulorum* (c & d) from Lowrey (1986).

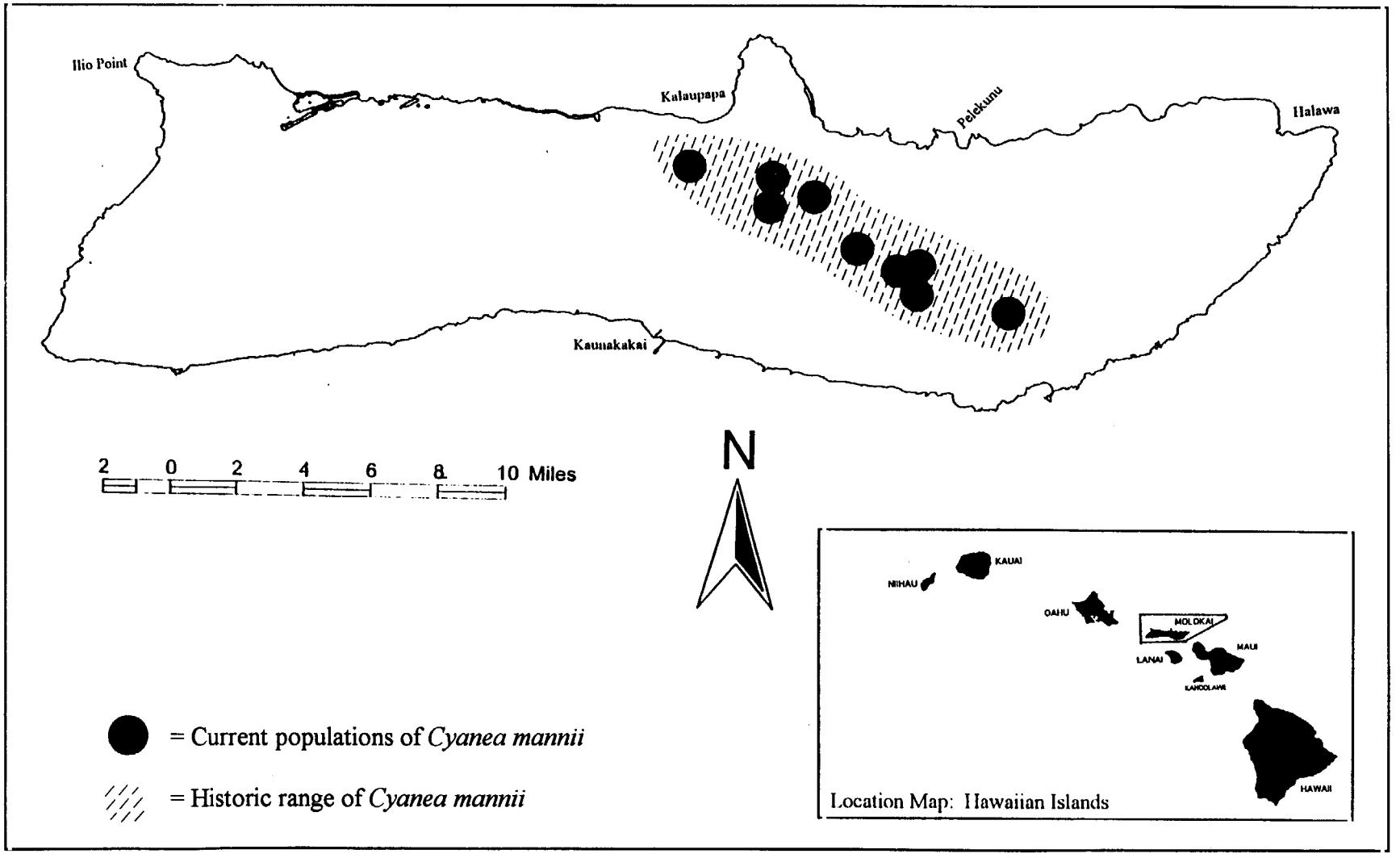
# APPENDIX C
# HISTORIC AND CURRENT DISTRIBUTION MAPS

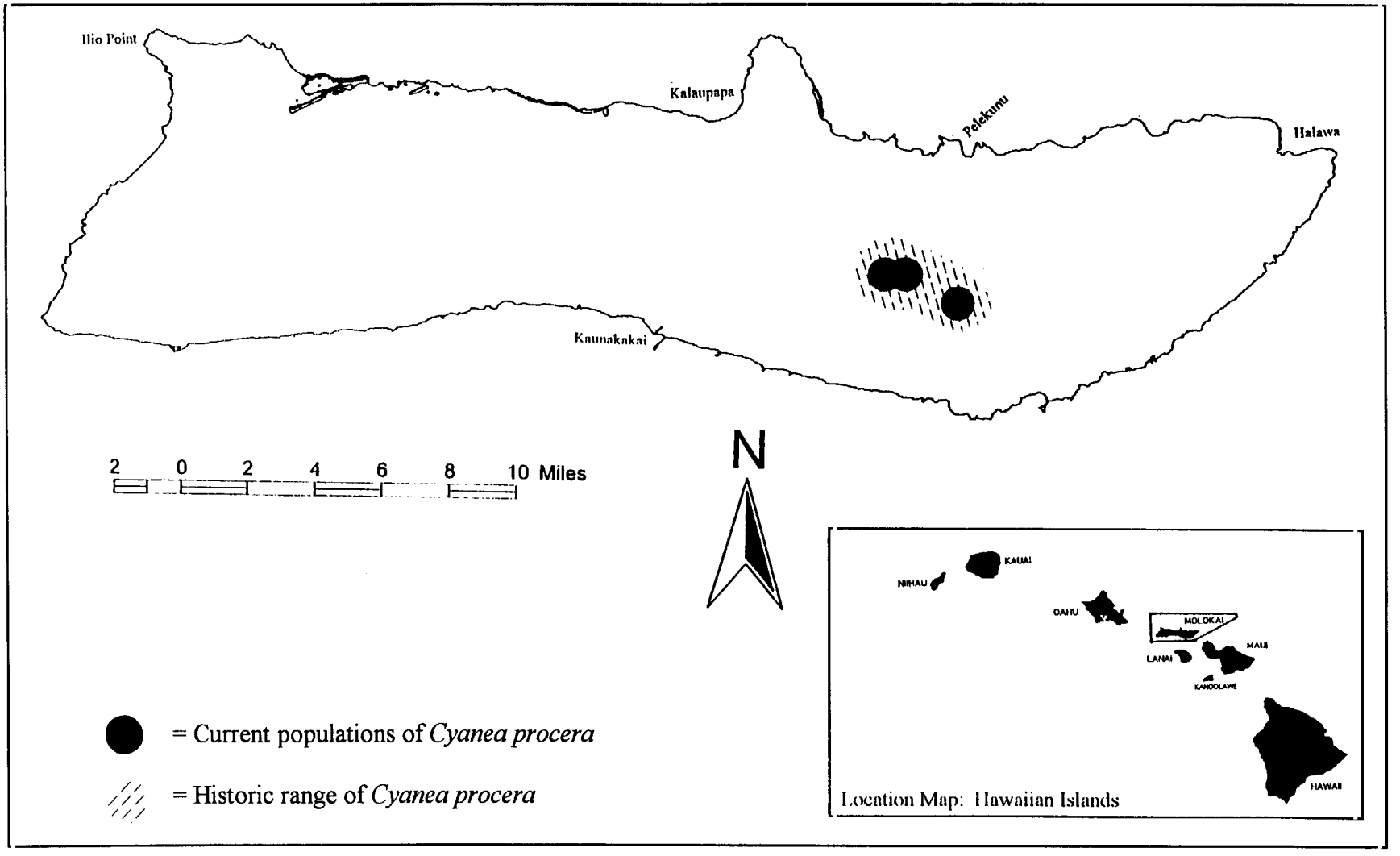

Ilio Point
Kalaupapa
Pelekunu
Halawa
Kaunakakai
2 0 2 4 6 8 10 Miles
N
= Current populations of *Bidens wiebkei*
= Historically known populations of *Bidens wiebkei*
= Historic range of *Bidens wiebkei*
KAUAI
NIIHAU
OAHU
MOLOKAI
MAUI
LANAI
KAHOOLAWE
HAWAII
Location Map: Hawaiian Islands

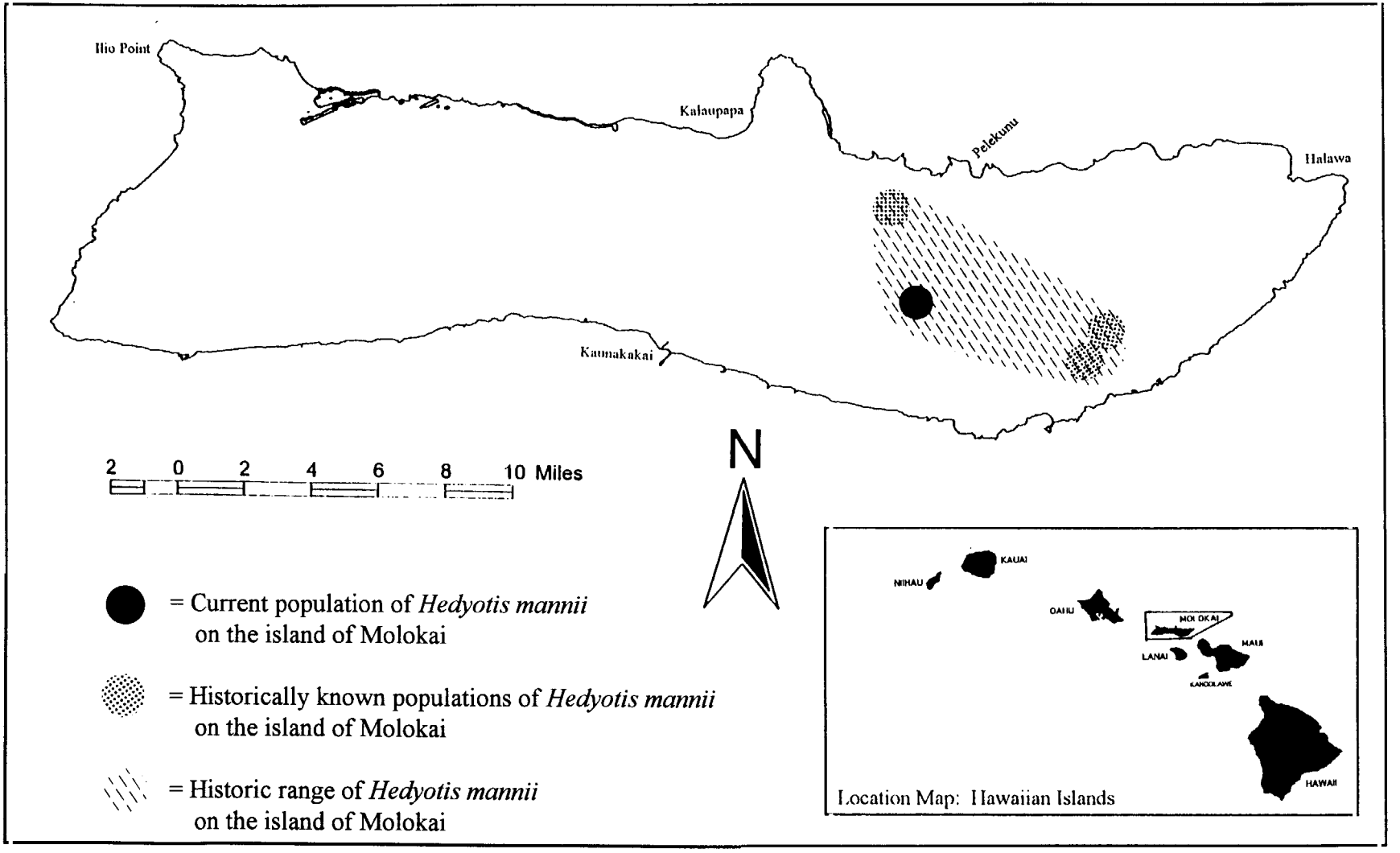

Ilio Point
Kalaupapa
Pelekunu
Halawa
Kaunakakai
2 0 2 4 6 8 10 Miles
N
= Current populations of *Brighamia rockii*
= Historically known populations of *Brighamia rockii*
= Historic range of *Brighamia rockii*
KAUAI
NIIHAU
OAHU
MOLOKAI
LANAI
MAUI
KAHOOLAWE
HAWAII
Location Map: Hawaiian Islands

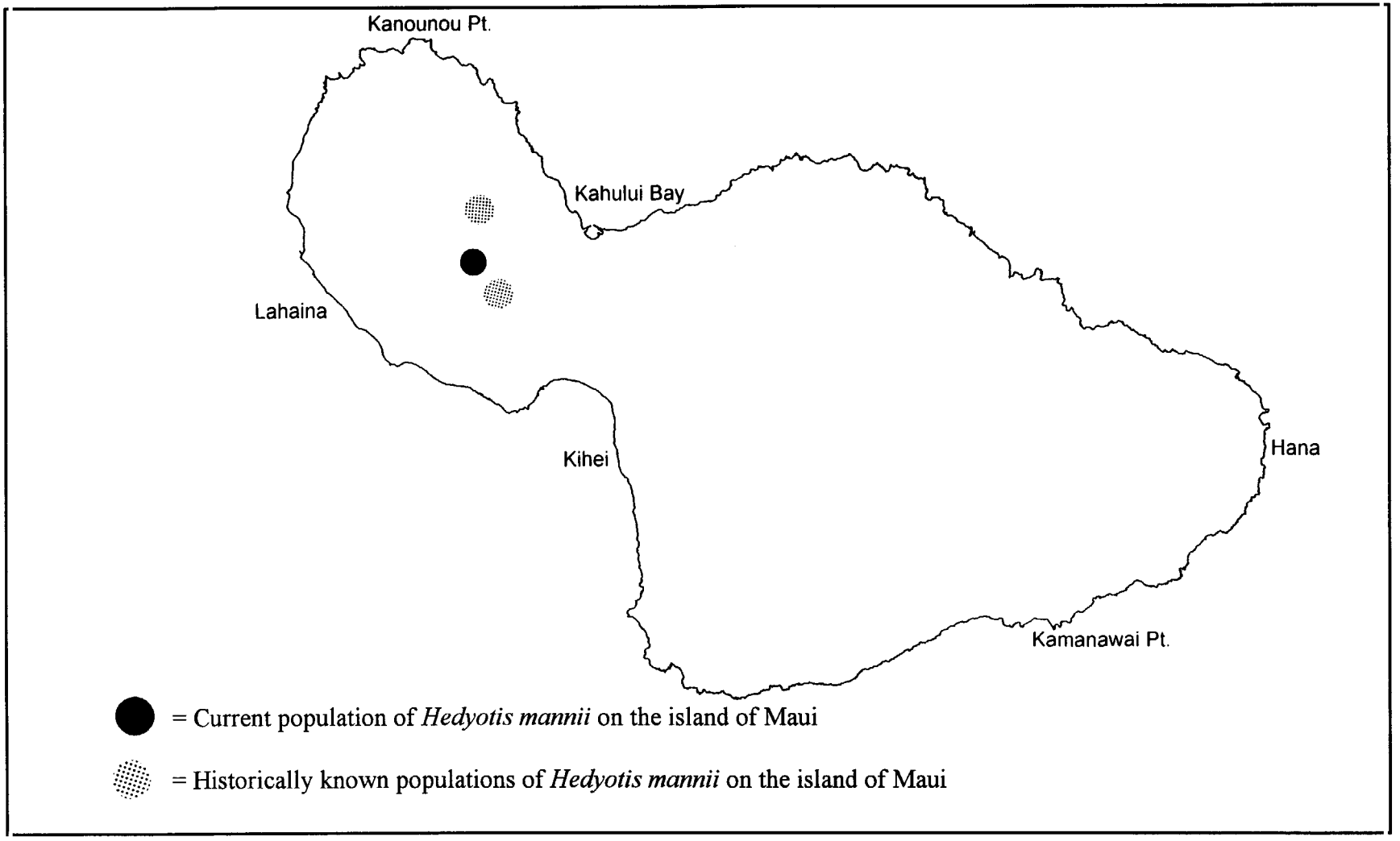

Ilio Point
Kalaupapa
Pelekunu
Halawa
Kaunakakai
2 0 2 4 6 8 10 Miles
N
= Current populations of *Canavalia molokaiensis*
= Historically known populations of *Canavalia molokaiens.*
= Historic range of *Canavalia molokaiensis*
NIIHAU
KAUAI
OAHU
MOLOKAI
LANAI
MAUI
KAHOOLAWE
HAWAII
Location Map: Hawaiian Islands

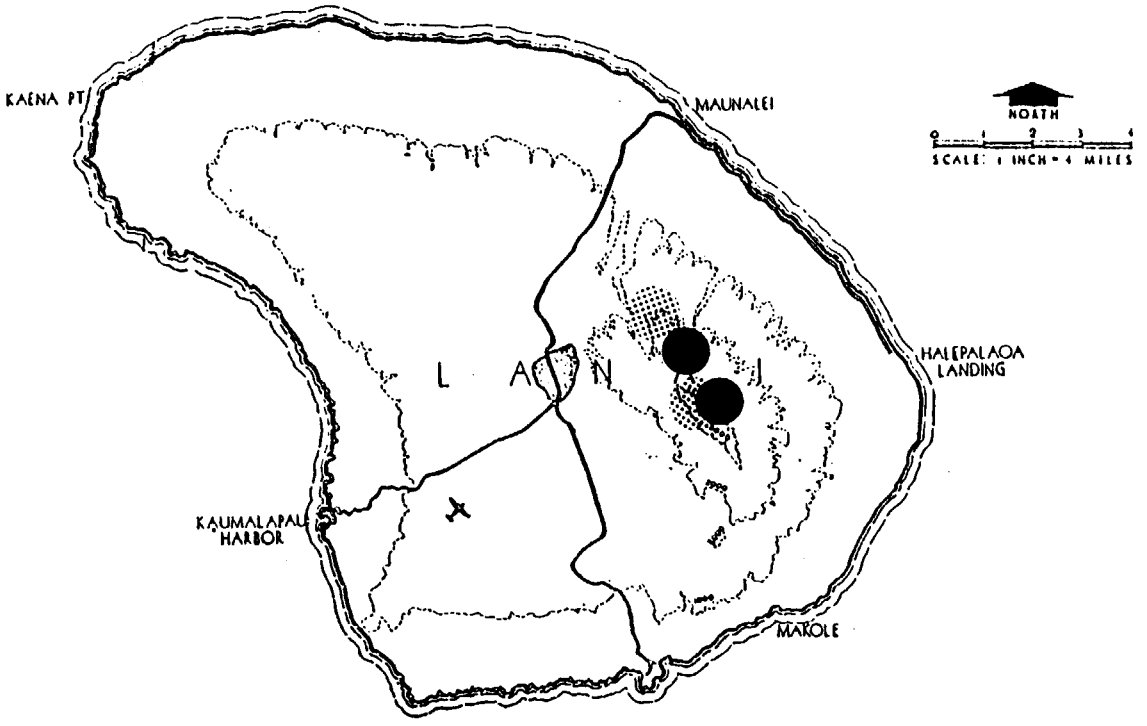

Ilio Point
Kalaupapa
Pelekunu
Halawa
Kaunakakai
2 0 2 4 6 8 10 Miles
N
= Current populations of *Clermontia oblongifolia* ssp. *brevipes*
= Historically known populations of *Clermontia oblongifolia* ssp. *brevipes*
KAUAI
NIHAU
OAHU
MOLOKAI
LANAI
MAUI
KAHOOLAWE
HAWAII
Location Map: Hawaiian Islands


Ilio Point
Kalaupapa
Pelekunu
Halawa
Kaunakakai
2 0 2 4 6 8 10 Miles
N
= Current populations of Cyanea mannii
= Historic range of Cyanea mannii
KAUAI
NIIHAU
OAHU
MOLOKAI
LANAI
MAUI
KAHOOLAWE
HAWAII
Location Map: Hawaiian Islands


Ilio Point
Kalaupapa
Pelekunu
Halawa
Kaumakakai
2 0 2 4 6 8 10 Miles
N
= Current populations of *Cyanea procera*
= Historic range of *Cyanea procera*
KAUAI
NIIHAU
OAHU
MOLOKAI
MAUI
LANAI
KAHOOLAWE
HAWAII
Location Map: Hawaiian Islands

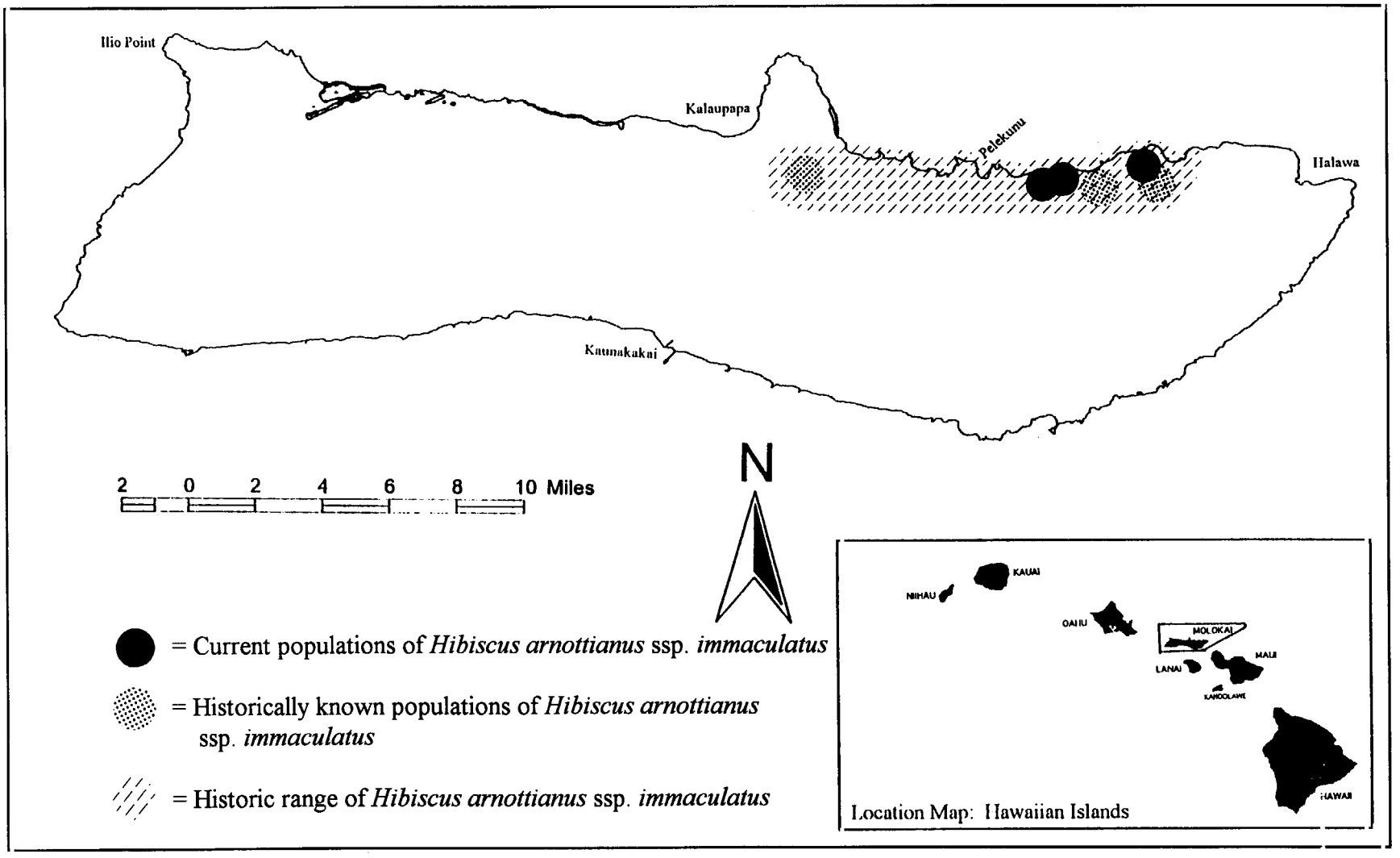

Ilio Point
Kalaupapa
Pelekunu
Halawa
Kaunakakai
2 0 2 4 6 8 10 Miles
N
= Current population of *Hedyotis mannii* on the island of Molokai
= Historically known populations of *Hedyotis mannii* on the island of Molokai
= Historic range of *Hedyotis mannii* on the island of Molokai
KAUAI
NIIHAU
OAHU
MOLOKAI
MAUI
LANAI
KAHOOLAWE
HAWAII
Location Map: Hawaiian Islands

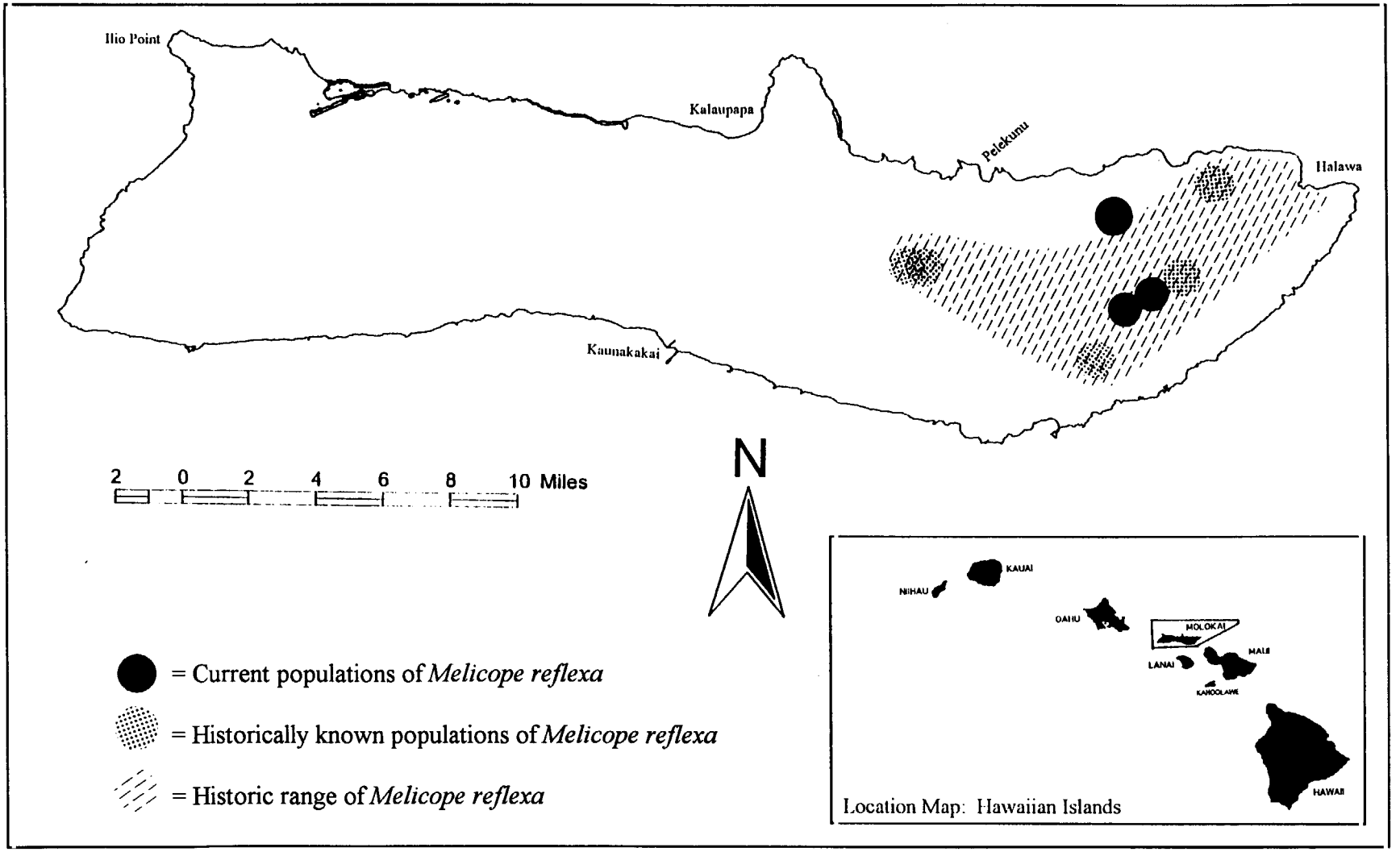

Kanounou Pt.
Kahului Bay
Lahaina
Kihei
Hana
Kamanawai Pt.
= Current population of *Hedyotis mannii* on the island of Maui
= Historically known populations of *Hedyotis mannii* on the island of Maui

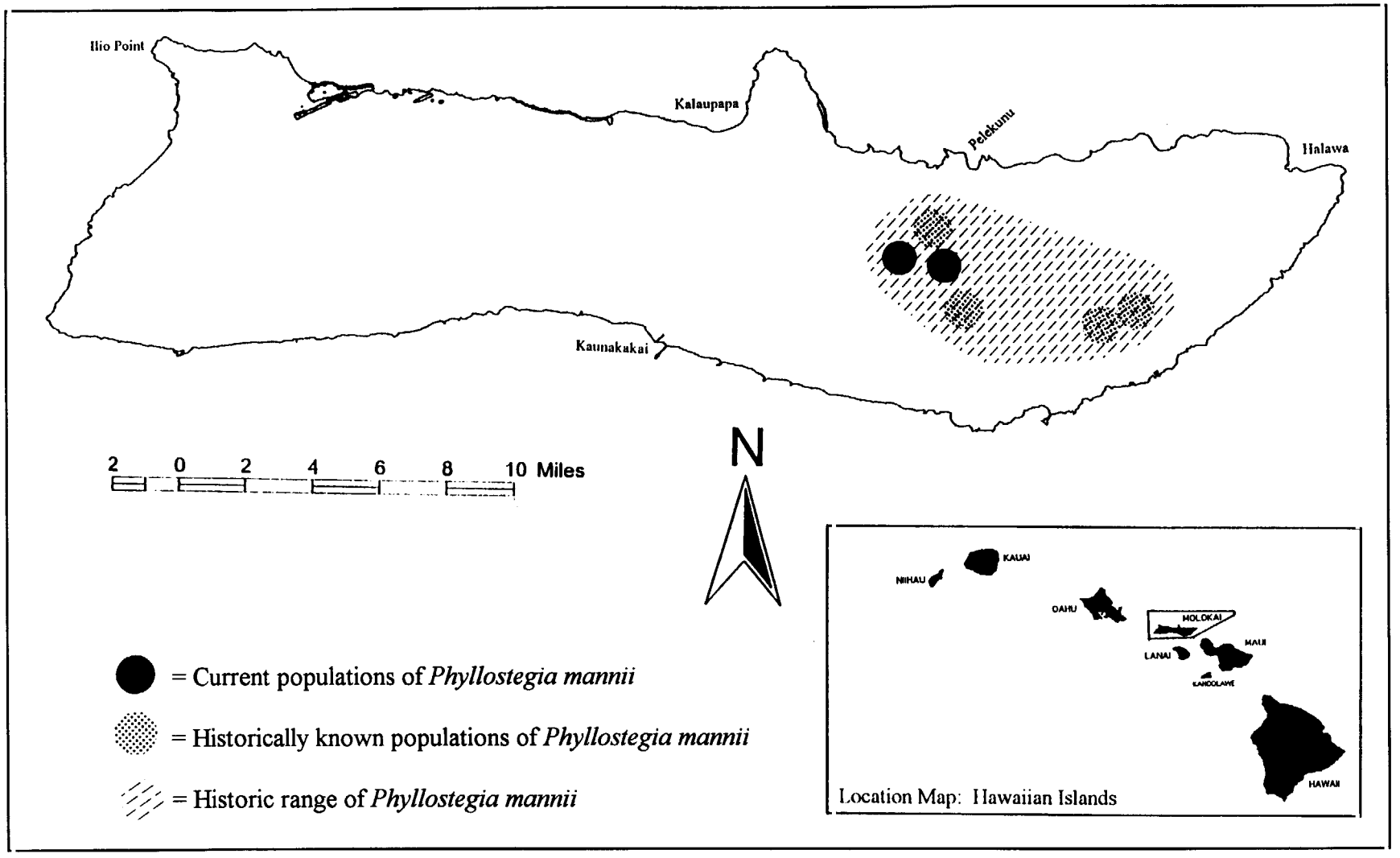


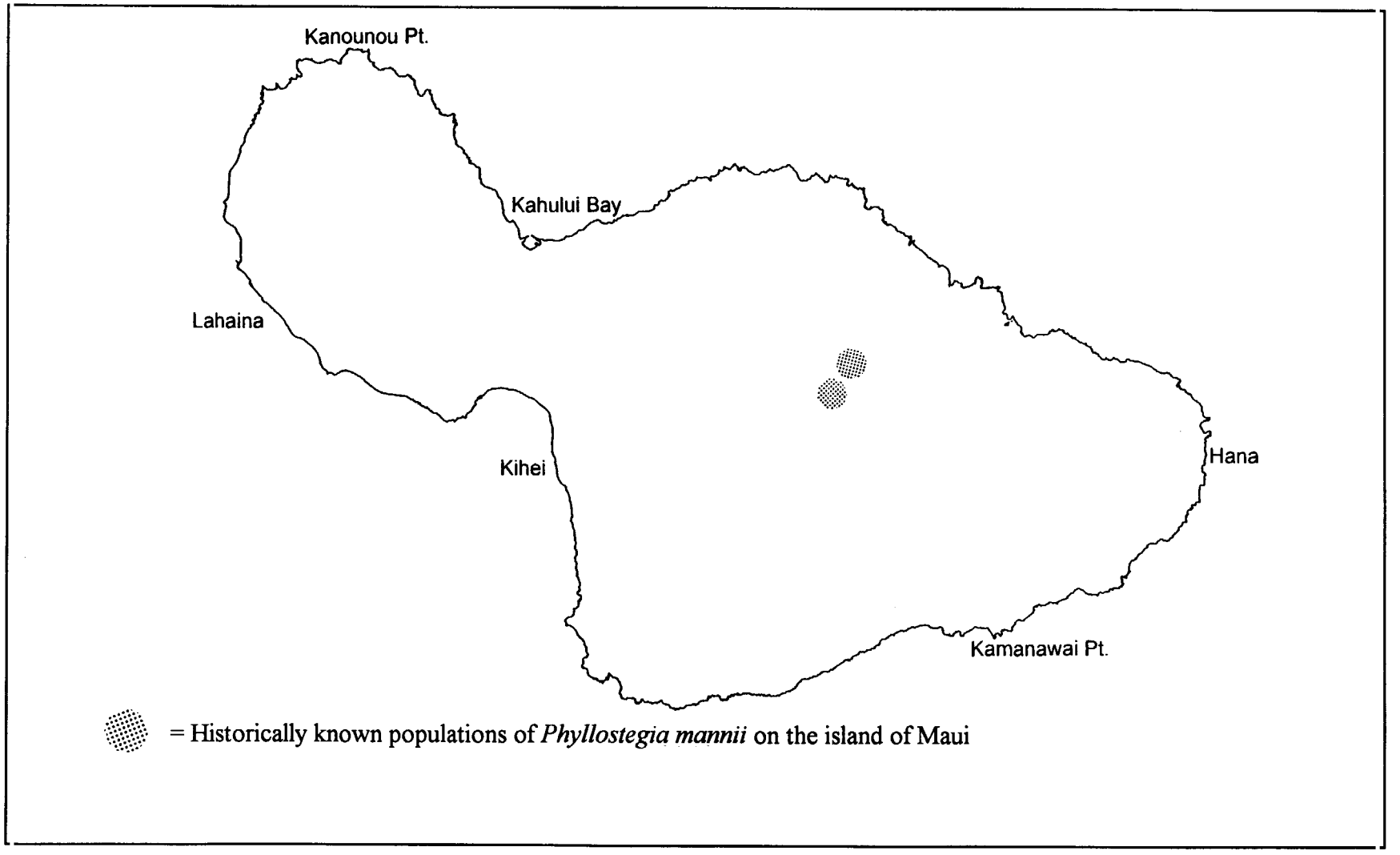

● = Current populations of *Hedyotis mannii* on the island of Lanai

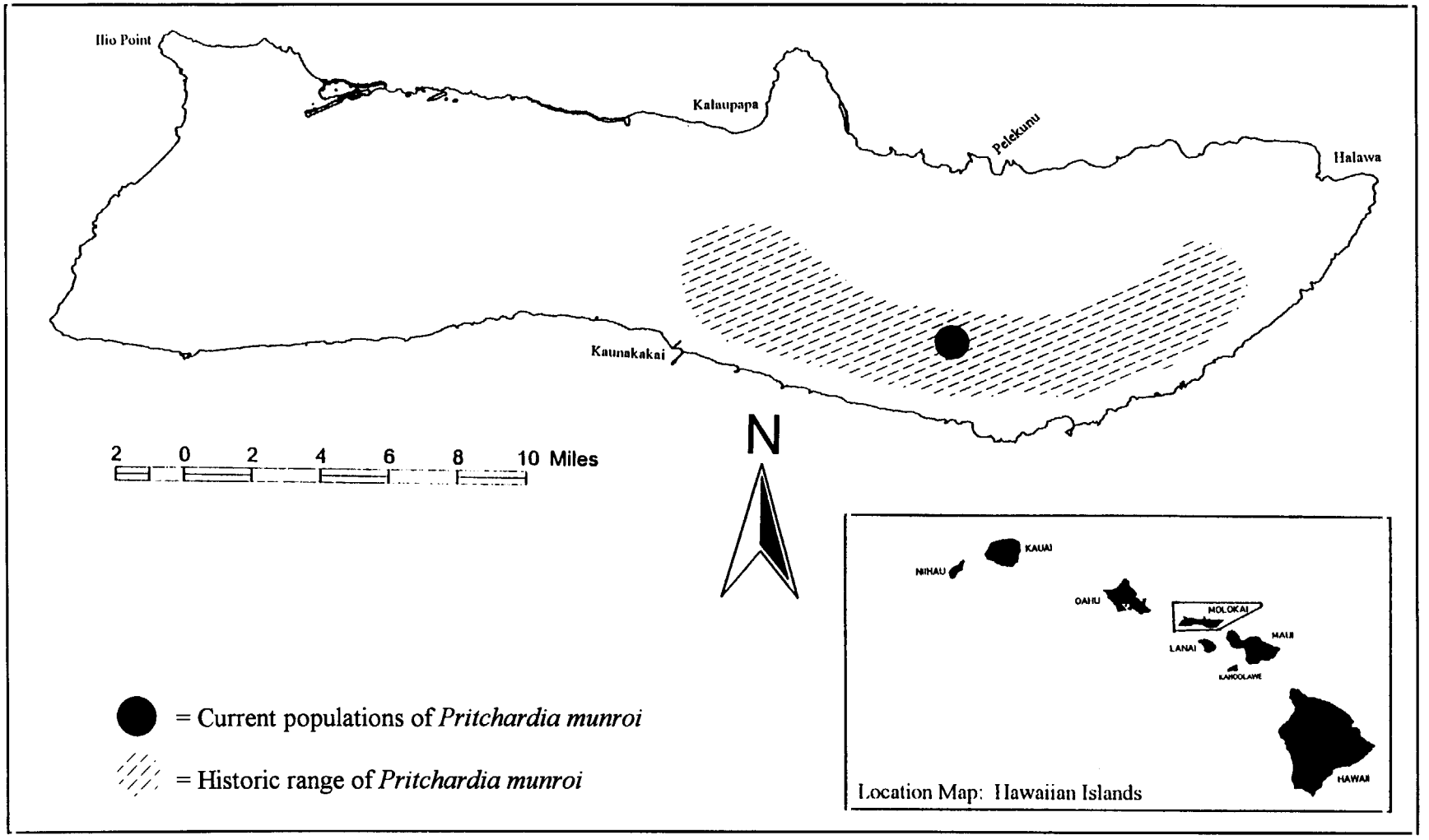
▒ = Historically known populations of *Hedyotis mannii* on the island of Lanai

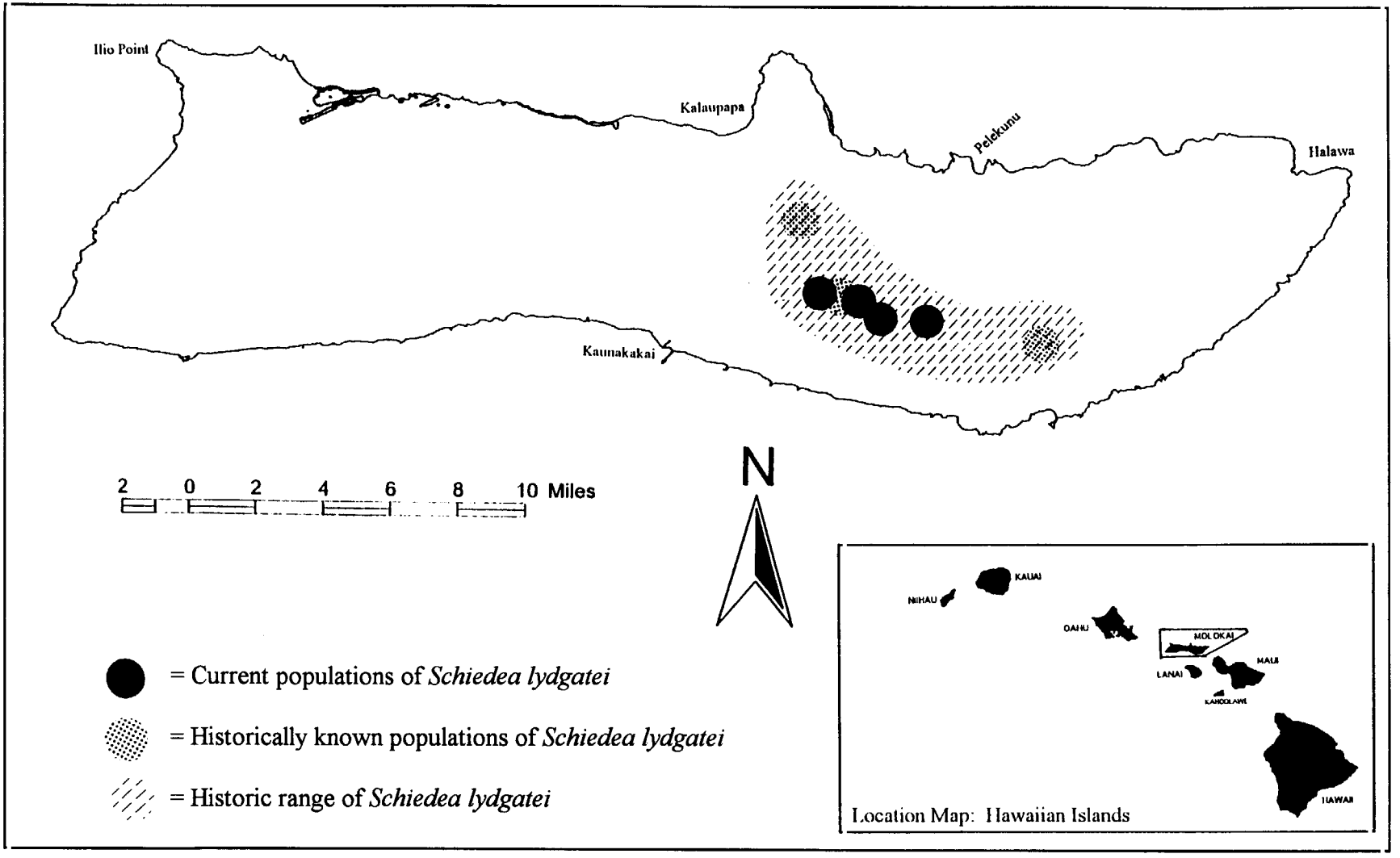

Ilio Point
Kalaupapa
Pelekunu
Halawa
Kaunakakai
2 0 2 4 6 8 10 Miles
N
= Current populations of *Hibiscus arnottianus* ssp. *immaculatus*
= Historically known populations of *Hibiscus arnottianus* ssp. *immaculatus*
= Historic range of *Hibiscus arnottianus* ssp. *immaculatus*
NIIHAU
KAUAI
OAHU
MOLOKAI
LANAI
MAUI
KAHOOLAWE
HAWAII
Location Map: Hawaiian Islands

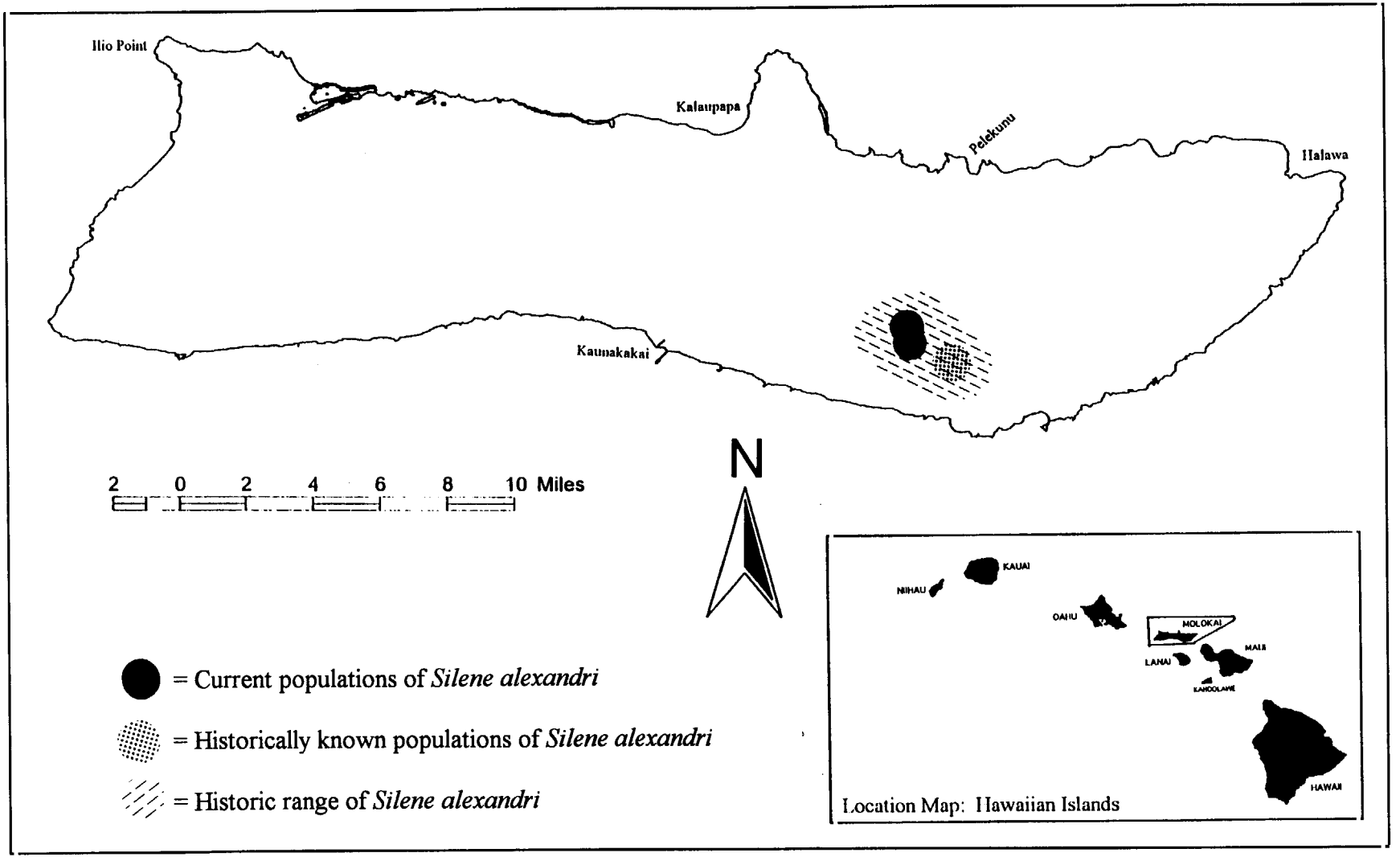

Ilio Point
Kalaupapa
Pelekunu
Halawa
Kaunakakai
2 0 2 4 6 8 10 Miles
N
= Current populations of *Melicope reflexa*
= Historically known populations of *Melicope reflexa*
= Historic range of *Melicope reflexa*
KAUAI
NIIHAU
OAHU
MOLOKAI
MAUI
LANAI
KAHOOLAWE
HAWAII
Location Map: Hawaiian Islands

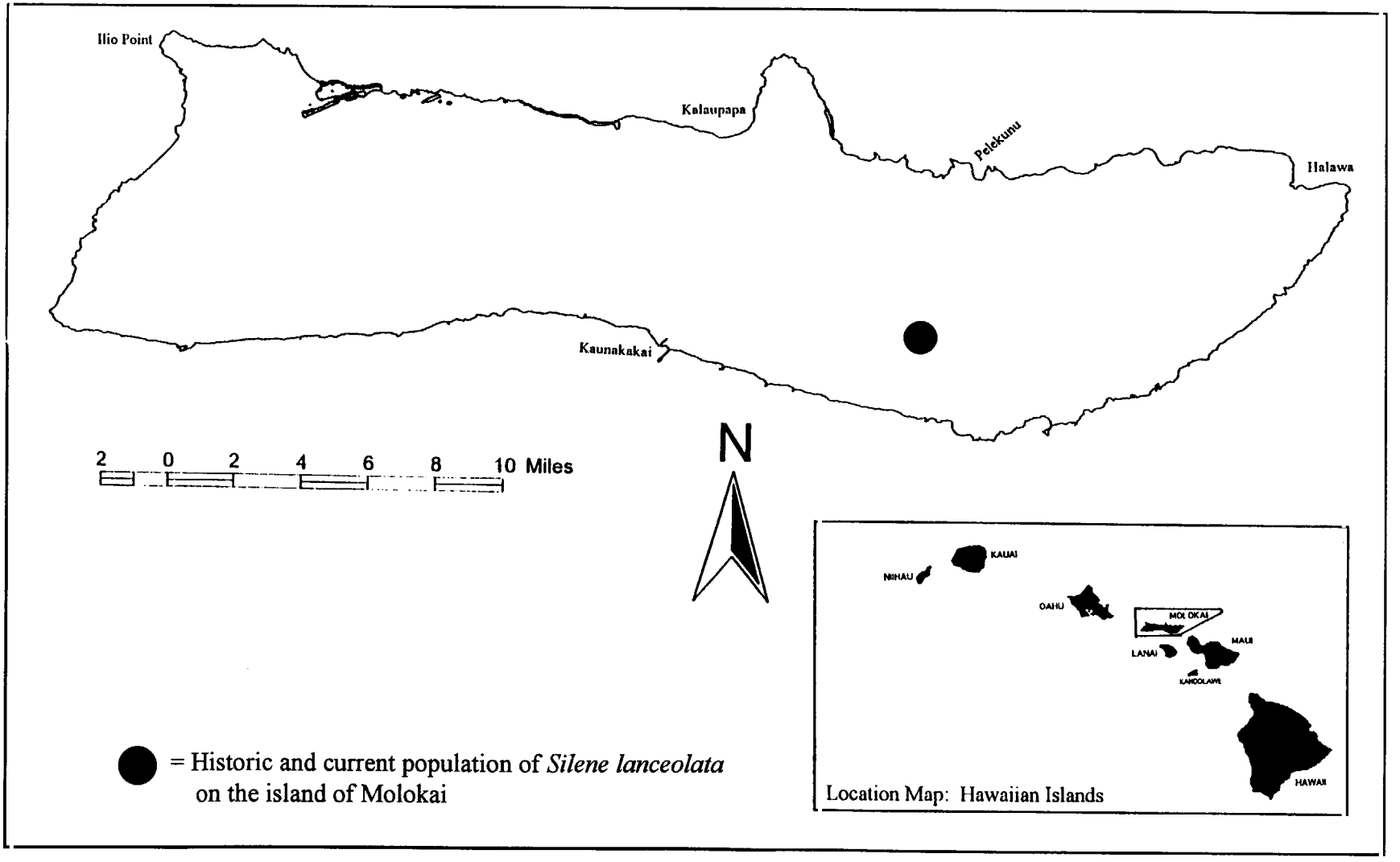

Ilio Point
Kalaupapa
Pelekunu
Halawa
Kaunakakai
2 0 2 4 6 8 10 Miles
N
= Current populations of *Phyllostegia mannii*
= Historically known populations of *Phyllostegia mannii*
= Historic range of *Phyllostegia mannii*
KAUAI
NIIHAU
OAHU
MOLOKAI
LANAI
MAUI
KAHOOLAWE
HAWAII
Location Map: Hawaiian Islands

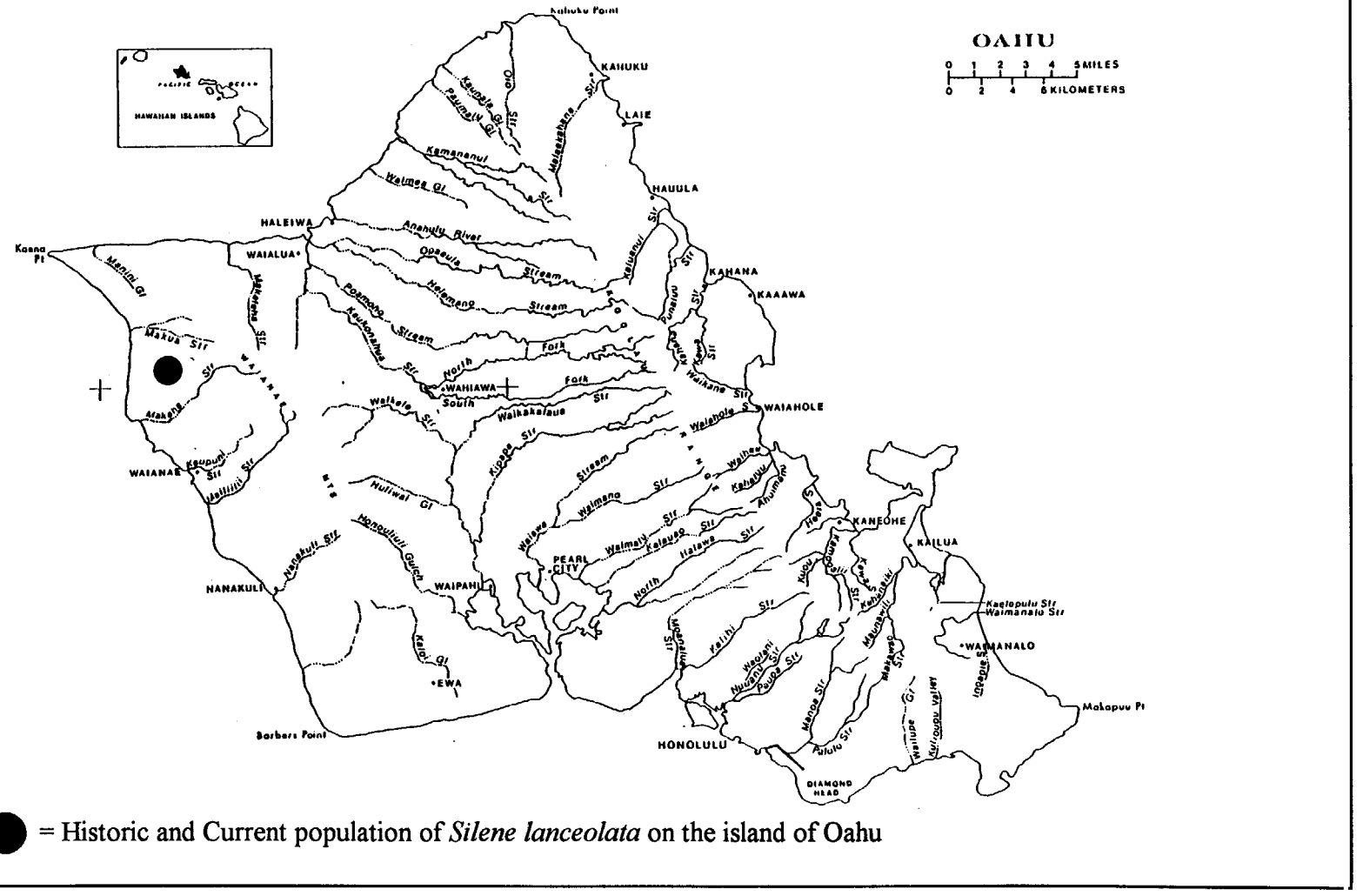

Kanounou Pt.
Kahului Bay
Lahaina
Kihei
Hana
Kamanawai Pt.
= Historically known populations of *Phyllostegia mannii* on the island of Maui


Ilio Point
Kalaupapa
Pelekunu
Halawa
Kaunakakai
2 0 2 4 6 8 10 Miles
N
= Current populations of *Pritchardia munroi*
= Historic range of *Pritchardia munroi*
KAUAI
NIHAU
OAHU
MOLOKAI
LANAI
MAUI
KAHOOLAWE
HAWAII
Location Map: Hawaiian Islands

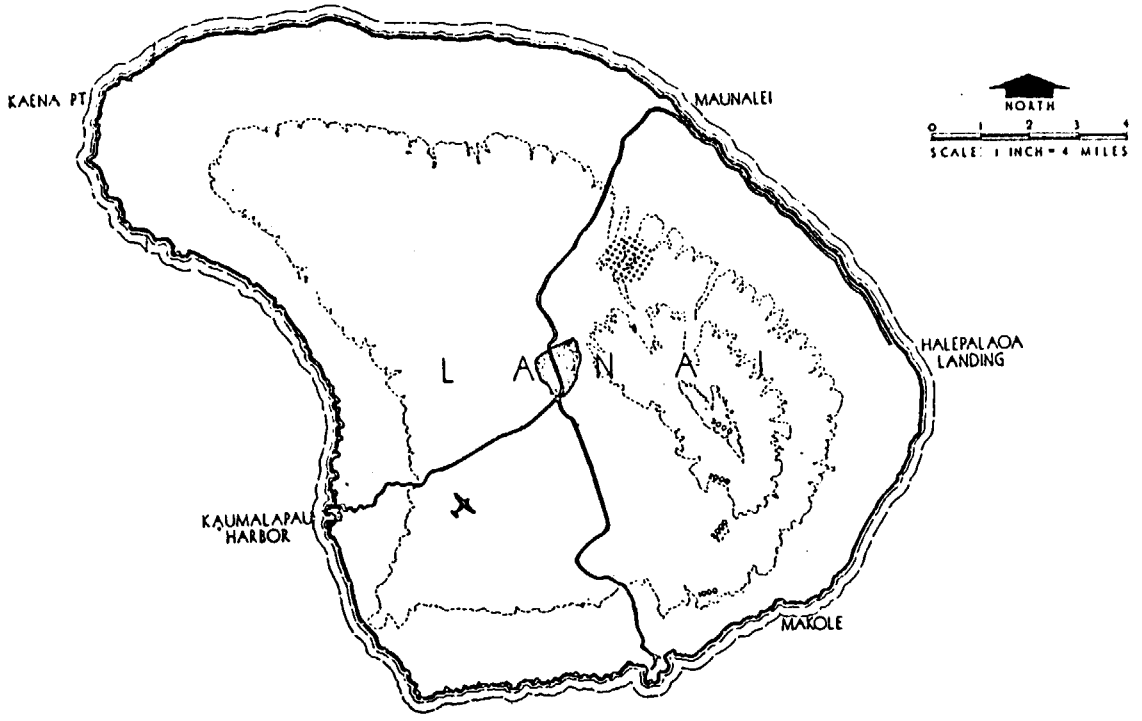

Ilio Point
Kalaupapa
Peleknu
Halawa
Kaunakakai
2 0 2 4 6 8 10 Miles
N
= Current populations of *Schiedea lydgatei*
= Historically known populations of *Schiedea lydgatei*
= Historic range of *Schiedea lydgatei*
KAUAI
NIHAU
OAHU
MOLOKAI
MAUI
LANAI
KAHOOLAWE
HAWAII
Location Map: Hawaiian Islands


Ilio Point
Kalaupapa
Pelekunu
Halawa
Kaunakakai
2 0 2 4 6 8 10 Miles
N
= Current populations of *Silene alexandri*
= Historically known populations of *Silene alexandri*
= Historic range of *Silene alexandri*
KAUAI
NIIHAU
OAHU
MOLOKAI
LANAI
MAUI
KAHOOLAWE
HAWAII
Location Map: Hawaiian Islands

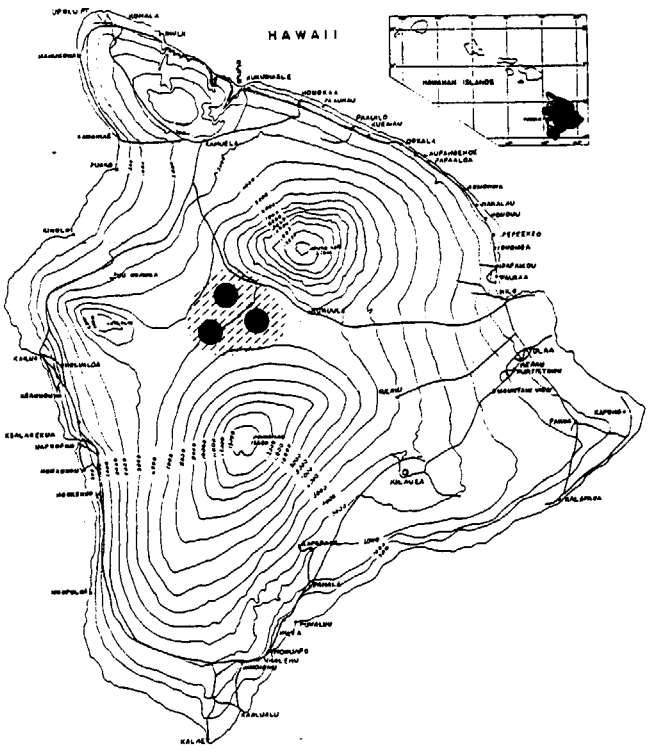

Ilio Point
Kalaupapa
Pelekunu
Halawa
Kaunakakai
2 0 2 4 6 8 10 Miles
N
= Historic and current population of *Silene lanceolata* on the island of Molokai
KAUAI
NIHAU
OAHU
MOLOKAI
LANAI
MAUI
KAHOOLAWE
HAWAII
Location Map: Hawaiian Islands




● = Historic and Current population of *Silene lanceolata* on the island of Oahu



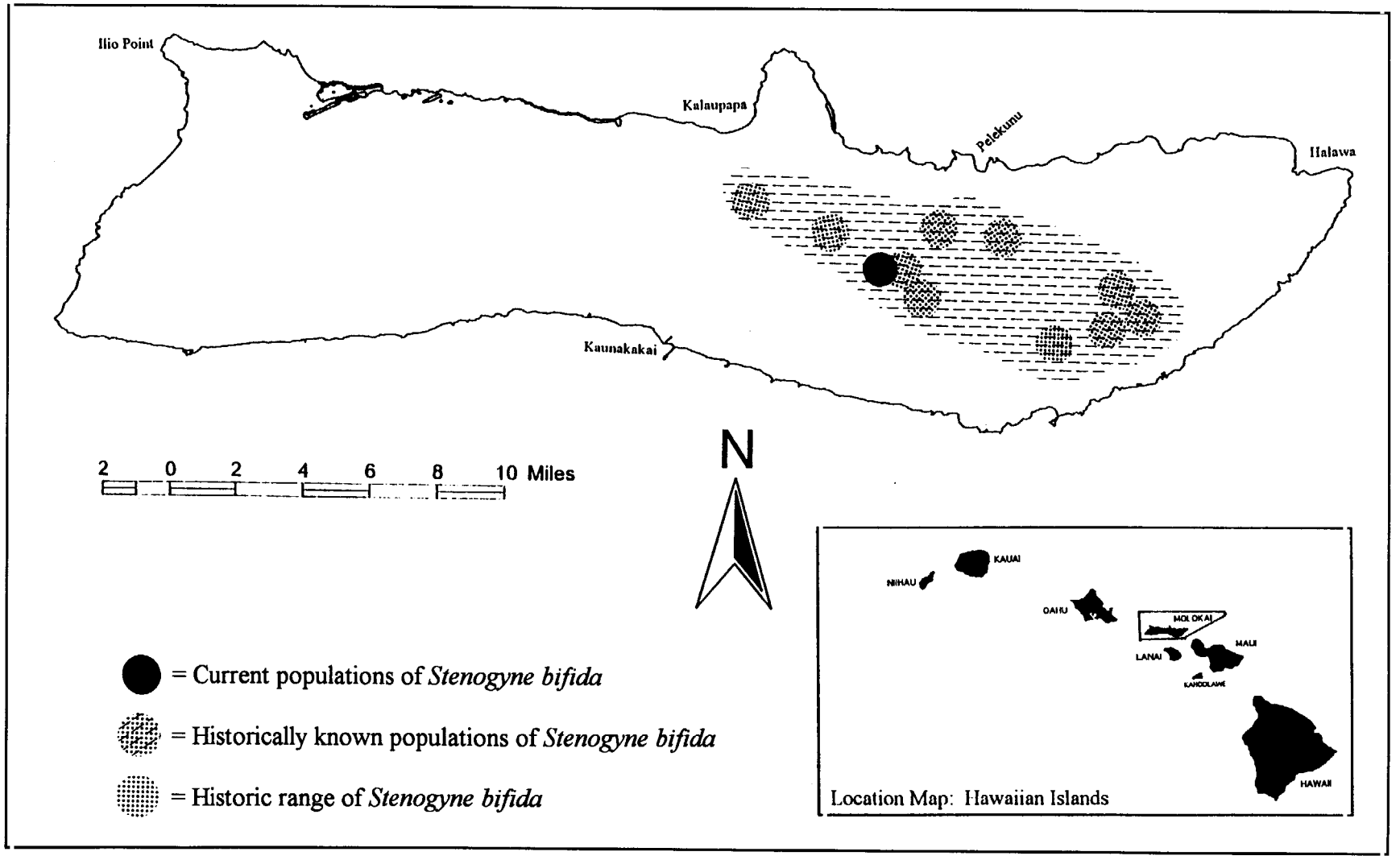

= Historic population of *Silene lanceolata* on the island of Lanai

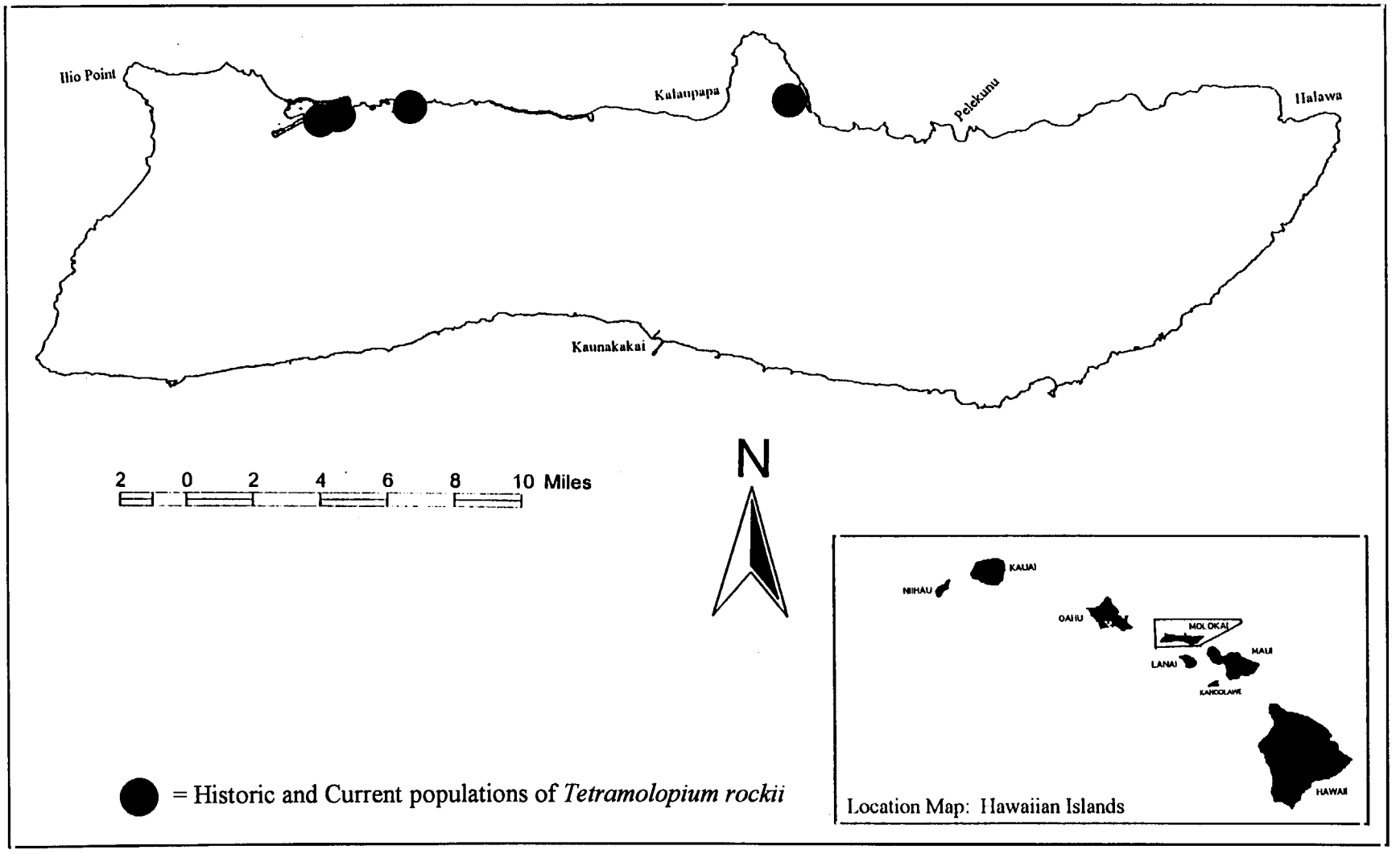



● = Current populations of *Silene lanceolata* on the island of Hawaii

= Historically known populations of *Silene lanceolata* on the island of Hawaii

= Historic range of *Silene lanceolata* on the island of Hawaii


Ilio Point
Kalaupapa
Pelekunu
Halawa
Kaunakakai
2 0 2 4 6 8 10 Miles
N
= Current populations of *Stenogyne bifida*
= Historically known populations of *Stenogyne bifida*
= Historic range of *Stenogyne bifida*
NIHAU
KAUAI
OAHU
MOLOKAI
LANAI
MAUI
KAHOOLAWE
HAWAII
Location Map: Hawaiian Islands


Ilio Point
Kalaupapa
Pelekunu
Halawa
Kaunakakai
2 0 2 4 6 8 10 Miles
N
= Historic and Current populations of *Tetramolopium rockii*
KAUAI
NIIHAU
OAHU
MOLOKAI
MAUI
LANAI
KAHOOLAWE
HAWAII
Location Map: Hawaiian Islands

# APPENDIX D
# SUMMARY OF LANDOWNERSHIP/MANAGEMENT

Department of Defense (Army) - Pohakuloa Training Area, Makua Military Reserve
*Silene lanceolata*

National Park Service - Kalaupapa National Historical Park
*Canavalia molokaiensis, Tetramolopium rockii*

State of Hawaii
*Brighamia rockii, Canavalia molokaiensis, Hibiscus arnottianus* ssp. *immaculatus, Schiedea lydgatei, Stenogyne bifida, Tetramolopium rockii*

Private Landowners
*Bidens wiebkei, Brighamia rockii, Canavalia molokaiensis, Clermontia oblongifolia* ssp. *brevipes, Cyanea mannii, Cyanea procera, Hedyotis mannii, Hibiscus arnottianus* ssp. *immaculatus, Melicope reflexa, Phyllostegia mannii, Pritchardia munroi, Schiedea lydgatei, Silene alexandri, Silene lanceolata, Stenogyne bifida, Tetramolopium rockii*

# APPENDIX E
# RECOVERY PRIORITY SYSTEM

The Recovery Priority System uses degree of threat, recovery potential, and taxonomic distinctiveness to assign a recovery priority number of 1-18 to all listed taxa. A fourth factor, conflict with construction or development projects, gives priority within each category.

A detailed discussion of the Recovery Priority System can be found in the Federal Register Vol. 48, No. 221, Pg 51985 of the issue Wednesday, September 21, 1983.

| Degree of Threat | Recovery Potential | Taxonomy | Priority | Conflict |
|---|---|---|---|---|
| High | High | Monotypic genus | 1 | 1C<br>1 |
| | High | Species | 2 | 2C<br>2 |
| | High | Subspecies | 3 | 3C<br>3 |
| | Low | Monotypic genus | 4 | 4C<br>4 |
| | Low | Species | 5 | 5C<br>5 |
| | Low | Subspecies | 6 | 6C<br>6 |
| Moderate | High | Monotypic genus | 7 | 7C<br>7 |
| | High | Species | 8 | 8C<br>8 |
| | High | Subspecies | 9 | 9C<br>9 |
| | Low | Monotypic genus | 10 | 10C<br>10 |
| | Low | Species | 11 | 11C<br>11 |
| | Low | Subspecies | 12 | 12C<br>12 |
| Low | High | Monotypic genus | 13 | 13C<br>13 |
| | High | Species | 14 | 14C<br>14 |
| | High | Subspecies | 15 | 15C<br>15 |
| | Low | Monotypic genus | 16 | 16C<br>16 |
| | Low | Species | 17 | 17C<br>17 |
| | Low | Subspecies | 18 | 18C<br>18 |

Recovery Priority System matrix.

# APPENDIX F - SUMMARY OF COMMENTS

The U.S. Fish and Wildlife Service received comments on the Draft Recovery Plan for the Molokai Plant Cluster from the Division of Forestry and Wildlife, the Hawaii Department of Agriculture, the US Environmental Protection Agency, the National Tropical Botanical Garden, the Waimea Arboretum, and John Obata. Most of these comments consisted of additional information on numbers of populations/individuals, distribution of certain taxa, cost estimates for tasks in the Implementation Schedule, and editorial changes and have been incorporated into the final plan. Additional comments are addressed below:

Comment 1: It may be difficult to realize some of the aims of the recovery plan. Reduction of ungulates is a touchy issue that may not be accepted by the local populace, especially in conjunction with fencing schemes.

Service Response: Recovery plans should recommend the actions necessary to recover threatened and endangered species. These actions may not always be popular with all segments of the population, but in the opinion of the Service, these actions are necessary for the recovery of these species.

Comment 2: The estimated costs given in the Implementation Schedule are much higher than the current the Department of Natural Resources budget will allow.

Service Response: As previously stated, recovery plans should recommend the actions necessary to recover threatened and endangered species. Recommending appropriate actions should not be limited by the availability of funds. Additionally, the costs given in the Implementation Schedule are rough estimates. In many cases, it may be possible to combine tasks carried out for a number of species, and thus minimize costs.

Comment 3: The State of Hawaii Department of Agriculture commented that it has an ongoing biological control program for the alien weed *Clidemia hirta*, which has been identified as a threat to some of the Molokai plant cluster taxa.

Service Response: This information was incorporated into the Overall Conservation Efforts section of this plan.

Comment 4: A table would be helpful that shows the species and the number of populations and plants that fall under each land ownership and jurisdiction. This would allow better coordination of recovery actions.

Service Response: Such a table was incorporated into the General Description of Habitat section of this recovery plan.

Comment 5: While preparing the Technical/Agency Draft of this recovery plan, we were told by a knowledgeable local botanist that some individuals originally thought to be *Tetramolopium rockii* were actually a different species, *T. sylvae*. This would make the population estimate for *T. rockii* 120,000 rather than 174,000, in 3 populations rather than 4. After the completion of the Technical/Agency Draft Recovery Plan, we were told by another knowledgeable local botanist that these individuals were indeed *T. rockii* (Arthur C. Medeiros III, NBS, personal communication 1996).

Service Response:
We foresee that further field visits and discussions will be necessary before this issue is resolved, and we believe that it is prudent to stick with the identification and population estimate given in the listing package until sufficient evidence is presented otherwise. The final identification of these individuals will not significantly effect this recovery plan. Delaying the distribution of a final version of the plan until this issue is resolved would delay recovery efforts for this species and the fifteen other taxa covered by this plan.

| Species | Interim | Downlisting | Delisting |
|---|---|---|---|
| *Bidens wiebkei*<br>Current status<br>4 populations<br>more than 100 total plants | N/A | Criteria<br>at least 5 populations<br>at least 300 plants each<br>at least 1,500 mature plants<br>Sustained for 5 years | Maintain additional 5 years |
| *Brighamia rockii*<br>Current status<br>5 populations<br>fewer than 200 total plants | N/A | Criteria<br>at least 5 populations<br>at least 100 plants each<br>at least 500 mature plants<br>Sustained for 5 years | Maintain additional 5 years |
| *Canavalia molokaiensis*<br>Current status<br>7 populations<br>fewer than 1,000 total plants | N/A | Criteria<br>at least 5 populations<br>at least 300 plants each<br>at least 1,500 mature plants<br>Sustained for 5 years | Maintain additional 5 years |
| *Clermontia oblongifolia ssp. brevipes*<br>Current status<br>1 population<br>fewer than 20 total plants | Criteria<br>3 populations<br>50 plants each<br>150 total plants | Criteria<br>at least 5 populations<br>at least 300 plants each<br>at least 1,500 mature plants<br>Sustained for 5 years | Maintain additional 5 years |

Appendix G. Current status and recovery criteria for the Molokai Plant Cluster Taxa.

| Species | Interim | Downlisting | Delisting |
|---|---|---|---|
| *Cyanea mannii*<br>Current status<br>9 populations<br>more than 1,000 total plants | N/A | Criteria<br>at least 5 populations<br>at least 300 plants each<br>at least 1,500 mature plants<br>Sustained for 5 years | Maintain additional 5 years |
| *Cyanea procera*<br>Current status<br>3 populations<br>8 total plants | Criteria<br>3 populations<br>50 plants each<br>150 total plants | Criteria<br>at least 5 populations<br>at least 300 plants each<br>at least 1,500 mature plants<br>Sustained for 5 years | Maintain additional 5 years |
| *Hedyotis mannii*<br>Current status<br>4 populations<br>50-65 total plants | Criteria<br>3 populations<br>50 plants each<br>150 total plants | Criteria<br>at least 5 populations<br>at least 300 plants each<br>at least 1,500 mature plants<br>Sustained for 5 years | Maintain additional 5 years |
| *Hibiscus arnottianus ssp. immaculatus*<br>Current status<br>3 populations<br>fewer than 100 total plants | Criteria<br>3 populations<br>25 plants each<br>75 total plants | Criteria<br>at least 5 populations<br>at least 100 plants each<br>at least 500 mature plants<br>Sustained for 5 years | Maintain additional 5 years |

Appendix G. Continued.

| Species | Interim | Downlisting | Delisting |
|---|---|---|---|
| *Melicope reflexa*<br>Current status<br>3 populations<br>fewer than 1,000 total plants | N/A | Criteria<br>at least 5 populations<br>at least 100 plants each<br>at least 500 mature plants<br>Sustained for 5 years | Maintain additional 10 years |
| *Phyllostegia mannii*<br>Current status<br>2 population<br>4 total plants | Criteria<br>3 populations<br>50 plants each<br>150 total plants | Criteria<br>at least 5 populations<br>at least 300 plants each<br>at least 1,500 mature plants<br>Sustained for 2-5 years | Maintain additional 5 years |
| *Pritchardia munroi*<br>Current status<br>1 populations<br>1 plant | Criteria<br>3 populations<br>25 plants each<br>75 total plants | Criteria<br>at least 5 populations<br>at least 100 plants each<br>at least 500 mature plants<br>Sustained for 5 years | Maintain additional 5 years |
| *Schiedea lydgatei*<br>Current status<br>4 populations<br>more than 8,000 total plants | N/A | Criteria<br>at least 5 populations<br>at least 300 plants each<br>at least 1,500 mature plants<br>Sustained for 5 years | Maintain additional 5 years |

Appendix G. Continued.

| Species | Interim | Downlisting | Delisting |
|---|---|---|---|
| *Silene alexandri*<br>Current status<br>2 populations<br>35 plants | Criteria<br>3 populations<br>50 plants each<br>150 total plants | Criteria<br>at least 5 populations<br>at least 300 plants each<br>at least 1,500 mature plants<br>Sustained for 5 years | Maintain additional 5 years |
| *Silene lanceolata*<br>Current status<br>5 populations<br>fewer than 1,500 total plants | N/A | Criteria<br>at least 5 populations<br>at least 300 plants each<br>at least 1,500 mature plants<br>Sustained for 2-5 years | Maintain additional 5 years |
| *Stenogyne bifida*<br>Current status<br>1 population<br>12 plants | Criteria<br>3 populations<br>50 plants each<br>150 total plants | Criteria<br>at least 5 populations<br>at least 300 plants each<br>at least 1,500 mature plants<br>Sustained for 5 years | Maintain additional 5 years |
| *Tetramolopium rockii*<br>Current status<br>4 populations<br>174,000 total plants | N/A | N/A | Criteria<br>at least 5 populations<br>at least 300 plants each<br>at least 1,500 mature plants<br>Sustained for 10 years |

Appendix G. Continued.