2004 STATUS UPDATE

IMPLEMENTATION PLAN

MAKUA MILITARY RESERVATION
ISLAND OF OAHU

September 2004

Prepared by:
United States Army Garrison, Hawaii
Directorate of Public Works
Environmental Division
Schofield Barracks, Hawaii 96857

TABLE OF CONTENTS

List of Figures

List of Tables

LIST OF CONTRIBUTORS

Jane R. Beachy	Natural Resources Management Coordinator Pacific Cooperative Studies Unit
Matthew D. Burt	Natural Resources Management Coordinator Pacific Cooperative Studies Unit
L. Leilani Z. Durand	Natural Resources Implementation Manager Pacific Cooperative Studies Unit
H. Kapua Kawelo	Biologist Department of Public Works U.S. Army Garrison Hawaii
Matthew J. Keir	Natural Resources Management Coordinator Pacific Cooperative Studies Unit
Michelle Mansker	Natural Resources Manager Department of Public Works U.S. Army Garrison Hawaii
Jobriath L. Rohrer	Senior Natural Resources Management Coordinator Pacific Cooperative Studies Unit

1.0 INTRODUCTION

The Makua Implementation Plan (MIP) was finalized in May 2003. Since that time a lot has happened. We are currently working on Urgent Actions 3 and gearing up for Year 1, which is scheduled to begin in October 2004. This report serves as the annual status report to the Implementation Team (IT) on the IP actions that have occurred between September 2003 and September 2004.

Current status of the Implementation Plan

The Army sent a letter to the USFWS in 2003 agreeing to implement the MIP if the USFWS agreed to work with the Army to reduce the cost and scope of the plan. The MIT met in April 2004 to discuss a reduced MIP, which was then submitted to the USFWS for review. The USFWS comments on this reduced plan are still pending.

The USFWS is currently working on two revised Biological Opinions (BO) for Makua Valley. The first BO, revision 3, will include critical habitat and will consider the 41 listed endangered species found in Makua Valley. This BO should be finished in late September 2004. The second BO, revision 4, will include the use of additional weaponry in Makua Valley. Some of the MIP management units (MUs) will be designated as 'permanent' areas for rare species management actions in this BO. The 4th revised BO should be completed in January 2005.

We currently have MOUs with Board of Water Supply (BWS) and The Nature Conservancy (TNC) to do management actions on their lands. Our partnerships are going well. At this time, we have one full-time person working at TNC doing MIP management actions at Honouliuli, and we are working with BWS on the environmental assessment for a large fence in Makaha. We are still waiting for Dole Foods, Kamehameha Schools and the State of Hawaii to sign MOUs with us. The State of Hawaii wants to see a finalized MIP before they agree to work with the Army on the management actions. The Navy and Dillingham Ranch are not interested in participating in the MIP, and management actions have been revised to exclude those landowners.

Status of fire management plans

Army Natural Resource's staff (NRS) is currently working with Andy Beavers, a fire modeler at Colorado State University, to complete a fire management plan for the Kaluakauila management unit. In addition, the Army's Range Division will receive funding this year to hire 10 fire management staff to help implement fire management plans on-site.

Funding and staffing levels

Urgent Actions 3 actions are scheduled to be completed by October 1, 2004. Given the amount of funding available for UA3, Army NRS have done an excellent job working to achieve this goal (see Chapter 2). Unfortunately, only 43% of the funding necessary to complete UA3 was allocated to NRS. UA3 actions required $2,046,500 after overhead for full implementation, but only $900,000 after overhead was allocated for all UA3 actions.

There are currently 14 field staff and field supervisors (including one person at TNC), one implementation manager, one administrative assistant, one horticulturist and one database/GIS

specialist contracted through RCUH to do natural resources work on Army training areas. Full implementation of UA3 required 21 field staff, 2 implementation managers, 2 horticulturists, one administrative assistant, one database manager and one GIS specialist, a shortfall of ten people.

Full implementation of the revised Year 1 actions, including project-wide NEPA documentation, requires $3,690,000 in funding, including overhead. At this time, it is not known how much funding Army NRS will receive for next fiscal year. Space to house the required increase in staff is also a concern. The current NRS facility is unable to hold any more than the current 18 staff persons, and Year 1 requires an additional 10 staff persons.

Status of Urgent Actions 3

This year, the lean NRS staff accomplished many of the UA3 requirements. Ten small-scale fences were completed around small *in situ* populations of *Delissea subcordata, Schiedea kaalae, Hesperomannia arbuscula, Alsinidendron obovatum* and *Cyanea grimesiana,* and one fence was built around an outplanting of *Phyllostegia kaalaensis*. Of the 66 *in situ* 'manage for stability populations' in the revised MIP, 37 are currently fenced (56%). All of the UA2 and UA3 small-scale fences that could be built (populations are extant and landowners were cooperative) have been completed. A large Makaha fence has been scoped, and the EA is currently in pre-draft review. Thirteen populations have full representation in genetic storage, and many more have partial collections. The table in Chapter 2 covers the status of UA3 actions in detail.

Genetic storage collection issues

Currently the MIP requires that the Army collect from all Oahu populations of all stabilization species. This means that the Army must collect from and provide funding to support the maintenance of propagules from 158 populations. This number is overwhelming considering that multiple monitoring visits are needed to represent the minimum numbers of plants required according to the MIP collection guidelines. Often field collections are difficult to secure and clones must be collected and maintained in the greenhouse until ample seed can be acquired. For example, a species like *Dubautia herbstobatae* is impossible to collect seed from in large quantities in the wild, and for a large population like the one at Ohikilolo the minimum requirement is to collect at least 50 seeds each from 50 individual plants. This species is on cliffs and would probably require at least 20 collection attempts on rappel to secure the minimum number. The other option is to collect clones of 50 plants and grow them until they are mature to collect from them ex-situ. This places an additional burden on already stretched horticultural resources.

In addition, the up-front research that is required to determine the best storage techniques for each taxon is not easy to conduct. Confirmed seed storage data is only available for one of the MIP species so far, though preliminary research has been conducted on several others. Hundreds of seeds and at least five years of testing are needed to determine the best storage technique for each taxon. From some taxa, hundreds of seeds are simply not available. In addition, yearly collections from populations will be necessary in order to account for the reduction in seed viability over time. This will be very time consuming, and may become a drain on the wild seed resources.

In light of the many un-anticipated challenges met in attempting to secure genetic storage for MIP species, this topic needs to be revisited by the IT to consider doing genetic collection efforts on fewer populations. Army Natural Resource Staff support collecting from populations that are threatened by fire from military training, from populations that will be actively managed for stability under the MIP, and for populations that will be used as propagule sources for augmentations or reintroductions.

Species status differences between the final MIP and this report

The numbers of individuals in the population units (PUs) in this report are generally lower than the numbers found in the final MIP. In most cases, this is because more extensive monitoring of the PUs has been done since the MIP PU numbers were finalized. Often, landowner permission and other access problems meant that best-guess estimates were including in the final MIP as PU numbers. Over the last three years, many of those populations have been visited, and more accurate numbers are included in this report. Unfortunately, in several cases, most notably *Chamaesyce herbstii*, *Delissea subcordata*, *Hesperomannia arbuscula*, and *Phyllostegia kaalaensis*, the decline is real, due to environmental factors beyond our control.

2.0 URGENT ACTIONS 3

Army Natural Resource's staff (NRS) are currently working on Urgent Actions 3 (UA3), and transitioning those actions into Year 1 actions. This chapter summarizes the progress made by NRS on UA3 between September 1, 2003 and September 1, 2004.

Achatinella mustelina actions
The MIP snail subcommittee held a meeting on May 12, 2004, and decided that at this time building exclosures around wild populations was not practical. All of the known, large wild populations are in very steep, remote sites and spread out over many acres. The subcommittee also agreed to follow the most recent genetic information, which indicates there are 6 Ecologically Significant Units (ESUs) as opposed to the 8 ESUs originally proposed. Eight populations will be managed, one population from each of the 6 ESUs and two populations from the two large ESUs. Since the May 12th meeting, NRS has visited all of the ESUs to count snails and assess which locations within each ESU are the best for management.

Fences
This year, nine small-scale fences not designated in UA3 were completed around small *in situ* populations of *Delissea subcordata, Schiedea kaalae, Hesperomannia arbuscula, Alsinidendron obovatum* and *Cyanea grimesiana*, and one fence was built around an outplanting of *Phyllostegia kaalaensis*. Of the fifteen small fences designated in UA3, one was constructed, five were not built because the populations have disappeared, two were not built because there was no immediate ungulate threat in the area, and seven were not built because they are on State or private land and permits have not yet been secured (see UA3 table below for details).

Rare plant surveys
The Hawaii Natural Heritage Program (HINHP) finished the UA2 rare plant surveys in June 2004, and are currently working on the Urgent Action 3 surveys. Army NRS has requested that HINHP focus its UA3 survey efforts on populations that are declining, and HINHP is currently surveying to try to find new populations of *Phyllostegia kaalaensis* and *Hesperomannia arbuscula.*

Genetic storage collections
Off-island propagule collections for genetic storage included in UA3 requirements were not undertaken due to changes to the Makua Implementation Plan (MIP) discussed at the March 29, 2004 meeting. Of the 34 UA3 'genetic storage collection' populations on Oahu, 16 populations were collected from. Two of the 34 populations are now gone, and one population was negatively impacted by the July 2003 Makua fire, setting back collection efforts. Air-layers were attempted on three species that produce little viable fruit, *Flueggea neowawraea, Alectryon macrococcus,* and *Hesperomannia arbuscula.* Because UA3 was not fully funded, and NRS was not at full staff, NRS were unable to visit all of 'genetic storage collection' populations this year. The populations that were not collected from are listed in the UA3 table below.

Genetic storage testing
Genetic storage testing is necessary for most species because little is known about seed viability or storage potential in micropropagation or seed storage. Of the 27 plant species in the MIP,

seed storage testing has been conducted on 22 of them at Lyon Arboretum's seed storage facility. Most of the species require further testing. Details on genetic storage testing results are included in Chapter 5: Rare Plant Stabilization Status.

Management as a propagule source
Based on the April 29, 2004 Implementation Team (IT) meeting, 'manage as a propagule source' is no longer a management designation. Populations will be categorized as 'genetic storage collection' or 'manage for stability' for management beginning in Year 1. See Chapter 5 for details on the new management designations of each population unit.

Of the 10 populations included in this category in UA3, six received management this year, two are gone, and two have management changes. See UA3 table below for details.

Management for stability
Populations were designated as 'manage for stability' in UA3 based on threats and the number of individuals in the population. Many of these populations were just a few plants found in highly degraded habitats, and many of the populations had not been monitored for at least several years. Most of the populations were monitored this year, and it was found that fourteen of the 57 populations designated 'manage for stability' in UA3 are now gone. Of the 43 extant populations, 36 (84%) received some level of management other than just monitoring (fence construction, weeding, collections).

Threat control
Threat control actions included weeding around plants in high fire threat areas and maintaining exclosures as pig free. All threat control actions designated in UA3 were conducted this year.

Trigger Action Description	Trigger Action	Taxon	Status
Achatinella mustelina collections/ management actions			
Collect for captive propagation, Achatinella mustelina. Collect from any additional unique ESUs (3).	collect for captive propagation	Achmus	All known and potential Achatinella mustelina sites were surveyed in UA2, and genetic sampling was conducted on snails at all new sites. No new ESUs were found. Therefore, no new collections took place.
Collect for genetic analysis, Achatinella mustelina, 2 populations	collect for genetic analysis	Achmus	No new populations are known. Analysis done on all known populations in UA2.
Genetic analysis for 3 populations, Achatinella mustelina. Includes sampling and genetic testing.	genetic analysis	Achmus	All new populations were sampled in UA2, and no additional populations are known. Therefore no sampling took place.
Survey for manageable populations at new ESUs (3 populations).	surveys	Achmus	There are no new ESUs where surveys could take place.
Construct exclosure, Achatinella mustelina, 2 sites to be identified during UA3.	construct exclosure	Achmus	Based on discussion at the May 12, 2004 snail meeting, exclosures will not be built in the near future. Ungulate fences will be erected at all managed sites and rats controlled.
Manage for stability, Achatinella mustelina. 3 identified populations from UA2 (Kahanahaiki to Pahole, Ohikilolo, Schofield West Range [Haleauau]).	manage for stability	Achmus	The exclosures at Pahole and Kahanahaiki were visited and maintained regularly. Mark-recapture counts were done in June/July 2004. Rat traps and baits were checked and restocked monthly. The West Range ESU (ESU C) was monitored in June 2004, and potential sites were scoped for an ungulate exclosure in either Haleauau or Manuwai.
Manage for stability, Achatinella mustelina, 2 sites from the 8 surveyed sites in UA2. Select sites based on landownership and threats.	manage for stability	Achmus	Based on discussion at the May 12, 2004 snail meeting, exclosures will not be built in the near future until the design can be refined. Ungulate fences will be erected at all managed sites and rats controlled. Sites for ungulate exclosures were scoped in East Makaleha and Puu Hapapa in summer 2004.
Small fence construction			
Small-scale fencing, Alsinidendron obovatum, Keawapilau.	Fence	Alsobo	Wild plants are dead. This area is also inside the State's proposed Kapuna fence.
Small-scale fencing, Alsinidendron obovatum, West Makaleha	Fence	Alsobo	Fence was scoped December 10, 2003. This fence will not be built because the population is not immediately threatened by ungulates. A fence was built around the recently discovered North West Makaleha population where ungulates are a threat.
Small-scale fencing, Cyanea longiflora, Makaha and Waianae Kai.	Fence	Cyalon	Fence scoped November 2003. The fence will be built once a departmental permit is received from the State of Hawaii. The permit is currently in process.
Small-scale fencing, Delissea subcordata, Huliwai.	Fence	Delsub	The area was was surveyed in July 2003 as part of UA2. The plants are gone, therefore no fence will be constructed.
Small-scale fencing, Hesperomannia arbuscula, Waianae Kai.	Fence	Hesarb	A small fence was scoped in spring 2004, and the Genetic Safety Net biologist will build a fence in the near future.
Small-scale fencing, Hesperomannia arbuscula, Makaha.	Fence	Hesarb	A fence was scoped in August 2003. The fence will be constructed once a departmental permit is received from the State of Hawaii. The permit is currently in process.

Trigger Action Description	Trigger Action	Taxon	Status
Small-scale fencing, Hibiscus brackenridgei subsp. mokuleianus, Kaimuhole and Palikea Gulch	Fence	Hibbramok	Plants at three sites. One site was visited in September 2003 and the other sites were visited in April 2004. Fence options will be reconsidered when the Dole MOU is finalized.
Small-scale fencing, Hibiscus brackenridgei subsp. mokuleianus, Kaumoku Nui.	Fence	Hibbramok	Fence options will be reconsidered based on upcoming surveys.
Small-scale fencing, Hibiscus brackenridgei subsp. mokuleianus, Kihakapu.	Fence	Hibbramok	Fence options will be reconsidered based on upcoming surveys.
Small-scale fencing, Neraudia angulata var. angulata, Waianae Kai Mauka.	Fence	Nerang	Small fence scoped on November 12, 2003. Proposed 240 m fence at one location (around 9 plants). Two other potential locations were scoped on November 24, 2003. A larger fence to encompass both sites was scoped in January 2004. A permit application will be submitted to the State for fence construction this year.
Small-scale fencing, Neraudia angulata var. angulata, Waianae Kai Makai.	Fence	Nerang	Fences scoped October 29, 2003. The more mauka location (WAI-B) had 45 mature, 35 juveniles, and 10-30 seedlings. Population seemed stable. One cutting was made, but it was not successful. The more makai location (WAI-D) had lots of goat sign, and only one plant, on a cliff.
Small-scale fencing, Phyllostegia kaalaensis, Palikea Gulch.	Fence	Phykaa	The plants are gone, but there is stock from these plants, which will be used for a Makaha reintroduction.
Small-scale fencing, Phyllostegia kaalaensis, Waianae Kai	Fence	Phykaa	Plants dead. No fence. NRS have stock from this plant.
Small-scale fencing, Plantago princeps var. princeps, Waiawa (Koolaus).	Fence	Plapripri	JL surveyed site 10/22/2003. Not a lot of pig activity in the area, so JL thinks no fence is needed.
Small-scale fencing, Schidea kaalae, South Branch of South Ekahanui.	Fence	Schkaa	Fenced scoped in February 2004. Fence constructed in May 2004.
Rare plant surveys			
Survey for historical populations in E. Makaleha, Makaha (valley bottom) and Pualii, Cenchrus agrimonioides	surveys	Cenagragr	Cenchrus surveys have been conducted.
Resurvey for Ekahanui population, and other potential habitat, Chamaesyce herbstii	surveys	Chaher	The Nature Conservancy has conducted annual surveys in this area and no new plants have been found. Joel Lau has also spent numerous days surveying in South Ekahanui.
Survey for additional individuals along Kamaileunu Ridge, Dubautia herbstobatae	surveys	Dubher	Joel Lau surveyed this location recently and the plants are gone.
Survey for populations of Neraudia angulata (all varieties) prior to initiating in situ management. Reevaluate reintroduction sources if no new populations found.	surveys	Nerang	Waianae Kai Mauka and Makai surveyed in November and December 2003.
Survey for Phyllostegia kaalaensis in the TNC preserve at Honouliuli.	surveys	Phykaa	Surveys scheduled for fall 2004.

Trigger Action Description	Trigger Action	Taxon	Status
Survey at Puu Kanehoa, Sanicula mariversa	surveys	Sanmar	Surveys were conducted in this area in 2002.
Survey for additional populations (includes Koolau sites), Schiedea kaalae	surveys	Schkaa	While working with the GSN biologist, Joel Lau discovered a new population in Kahana in March 2004.
Genetic storage collection			
Alectryon macrococcus, Kapuna. Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ).	genetic storage-living collection	Alemacmac	No collections have been made.
Alectryon macrococcus, Pahole. Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ).	genetic storage-living collection	Alemacmac	No collections have been made.
Alectryon macrococcus, Makua. Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ).	genetic storage-living collection	Alemacmac	Fruit has been collected and plants were reintroduced into Kahanahaiki using stock from this site. Air-layers set up on trees in January 2004, but none of them took.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Cenchrus agrimonioides - Makaha and Waianae Kai.	genetic storage-living collection	Cenagragr	Seeds and cuttings were collected from this population in July 2002 and June 2003.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Chamaesyce celastroides, East Kahanahaiki.	genetic storage-living collection	Chacelkae	Plants burned in the July 2003 fire, and 3 of the tagged plants died. Plants were monitored in July 2004, and inflorescences bagged for seed collection.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Flueggea neowawrea -Central and East Makaleha	genetic storage-living collection	Fluneo	Two cuttings collected from these trees in February 2004 are in the Army greenhouse.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Flueggea neowawrea -Mohiakea	genetic storage-living collection	Fluneo	Tree is dead. NRS do not have stock from this tree.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Flueggea neowawrea -Kauhiuhi	genetic storage-living collection	Fluneo	Air-layers set up on trees in January 2004, and are currently growing in the Army greenhouse.

Trigger Action Description	Trigger Action	Taxon	Status
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Flueggea neowawrea -Mikilua	genetic storage-living collection	Fluneo	No collections have been made.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Flueggea neowawrea -Nanakuli (south branch	genetic storage-living collection	Fluneo	No collections have been made.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Flueggea neowawrea -Halona.	genetic storage-living collection	Fluneo	DP and Julie Rivers from the Navy air-layered the trees in December 2003. Air-layers are currently growing in the Army greenhouse.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Flueggea neowawrea- North Kaluaa	genetic storage-living collection	Fluneo	This plant is dead.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Hedyotis degeneri, Kahanahaiki	genetic storage-living collection	Heddeg	Mature fruit were collected for storage in January 2004.
Hedyotis degeneri, East branch of East Makaleha. Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ).	genetic storage-living collection	Heddeg	Got representation (cutttings and seeds) from plants in the West Central Makaleha populations (LEH-A and LEH-B) in November 2003, July 2004, and August 2004. Seeds went to storage at Lyon Arboretum and cuttings are being grown at the Army nursery.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Hedyotis parvula, Ohikilolo Mauka	genetic storage-living collection	Hedpar	Seeds collected for storage in 2002 and 2003. Plants were monitored in 2004.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Lipochaeta tenuifolia - Ohikilolo Makai.	genetic storage-living collection	Lipten	Plants from cuttings in the greenhouse, to be used for seed production for storage testing and seed storage.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Neraudia angulata - Puu Kaua.	genetic storage-living collection	Nerang	No collections have been made.

Trigger Action Description	Trigger Action	Taxon	Status
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Neraudia angulata - Halona	genetic storage-living collection	Nerang	No collections have been made.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Nototrichium humile - Makua (east rim)	genetic storage-living collection	Nothum	NRS have surveyed the area and this plant has not been found.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Nototrichium humile - Nanakuli.	genetic storage-living collection	Nothum	No colllections have been made.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Nototrichium humile - Kolekole (east side)	genetic storage-living collection	Nothum	No collections have been made.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Nototrichium humile - Puu Kaua	genetic storage-living collection	Nothum	No collections have been made.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Nototrichium humile - Kealia	genetic storage-living collection	Nothum	No collections have been made.
Nototrichium humile - Keawapilau. Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ).	genetic storage-living collection	Nothum	Cuttings collected in January 2004, and all plants are in storage as living collections at the Army greenhouse.
Plantago princeps princeps - Pahole. Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ).	genetic storage-living collection	Plapripri	Plants were monitored in June 2004 but no collections were made.
Plantago princeps princeps - Ohikilolo. Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ).	genetic storage-living collection	Plapripri	Plants visited May 2004 and seeds and cuttings collected for storage.

Trigger Action Description	Trigger Action	Taxon	Status
Plantago princeps princeps - North Branch of North Palawai. Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ).	genetic storage-living collection	Plapripri	JL visited this site in October 2003. No collections were made. Joel Lau found the old Steve Perlman location in December 2003. Most of the plants appeared to be dead, but seeds were collected from the old stalk of one plant.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Pritchardia kaalae, Waianae Kai	genetic storage-living collection	Prikaa	Fruits collected in 2002, young plants are growing in the nursery.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Pritchardia kaalae, Makaha.	genetic storage-living collection	Prikaa	No collections have been made.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Sanicula mariversa - Keaau	genetic storage-living collection	Sanmar	Seeds were collected in June 2003 and June 2004 and sent to Lyon Arboretum for storage.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Schiedea kaalae - Maakua.	genetic storage-living collection	Schkaa	Plants were visited November 24, 2003 and cuttings were collected and are growing in Lyon Arboretum's greenhouse.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Schiedea kaalae - Makaua	genetic storage-living collection	Schkaa	Genetic safety net taxon, Susan Ching has taken cuttings, and plants are growing at Lyon Arboretum.
Collect seeds or cuttings from each individual, to establish representation in living collection (ex situ or inter situ), Tetramolopium filiforme - Puhawai (Puu Kumakalii)	genetic storage-living collection	Tetfil	Cuttings are growing in the greenhouse. Plants are used for seed production for storage.
Collect seeds or cuttings from each individuals to establish representation in living collection (ex situ or inter situ), Viola chamissoniana - Puu Hapapa	genetic storage-living collection	Viochacha	Plants monitored and seeds/cuttings collected in 2002. Cuttings now growing in the greenhouse. It is difficult to acquire seeds from this species. NRS will investigate in vitro storage as an alternative to seed storage.
Genetic storage testing			
Implement seed storage testing, Alectryon macrococcus.	storage testing	Alemacmac	Seeds are very large and would need to be sent to NSSL for testing. Seed collection is difficult because trees are difficult to access and generally don't produce many viable fruits. Seeds were collected in Makaha this year for testing.
Alvin would like to do additional seed storage testing for Cenchrus agrimonioides.	storage testing	Cenagragr	Seeds were collected in October 2000 and May 2004 and taken to Lyon for storage testing.

Trigger Action Description	Trigger Action	Taxon	Status
Implement genetic storage testing, Chamaesyce celastroides kaenana	storage testing	Chacelkae	Some testing has been done. Seeds were collected in November 2001 for storage testing. Immature fruits were bagged in August 2004 for seed collection.
Implement genetic storage testing, Chamaesyce herbstii	storage testing	Chaher	Seeds dehise at maturity, and are very difficult to collect. Seeds were collected in January 2001 for storage testing, and more collection will be attempted this year.
Implement genetic storage testing, Cyanea grimesiana obatae	storage testing	Cyagrioba	Initial germination testing has been conducted using seed collected in December 2000.
Implement genetic storage testing, Cyanea longiflora	storage testing	Cyalon	No storage testing has been done. There are currently many seeds in storage.
Implement genetic storage testing, Cyanea superba superba	storage testing	Cyasupsup	Extensive storage testing has been done. Seeds store well for up to two years. There are currently thousands of seeds in storage.
Implement genetic storage testing, Cyrtandra dentata	storage testing	Cyrden	Seeds were taken to Lyon Arboretum for storage testing in October 2003, March 2004, and July 2004. Seeds store well for at least six months.
Implement genetic storage testing, Dubautia herbstobatae	storage testing	Dubher	Seeds were taken to Lyon Arboretum for storage testing in 1999.
Implement genetic storage testing, Flueggea neowawraea	storage testing	Fluneo	Few trees produce viable fruit, so collecting enough seed for testing is very difficult. Approximately 25 same-aged mature seeds are needed for storage testing. Seeds were collected in 2002 for storage testing.
Collect for and investigate in vitro storage, Hesperomannia arbuscula	storage testing	Hesarb	Seeds were collected in July 2004 and taken to the micropropagation laboratory.
Implement genetic storage testing, Hesperomannia arbuscula	storage testing	Hesarb	Seeds have low viability, so all seeds received have been used for immediate germination testing.
Take approximately 200 seeds of Hibbra to Alvin for seed storage testing	storage testing	Hibbramok	Plants are very prolific seed producers. Germination requires seed scarification. Seeds were taken to Lyon Arboretum for testing in April 2000, and spring 2004.
Implement genetic storage testing if germination technique testing is successful, Lipochaeta tenuifolia	storage testing	Lipten	Seeds were collected for storage testing in 2000, 2001 and 2004. Initial germination rates were low. Plants are currently being grown for seed production for germination testing.
Implement genetic storage testing, Neraudia angulata	storage testing	Nerang	Seeds were collected for storage testing in 2003 and 2004.
Collect Nototrichium humile seeds, up to 800 same-aged mature, to send to AY who will forward them to the Baskins for testing.	storage testing	Nothum	More germination and storage testing needs to be done. Preliminary tests yielded only 1% germination from seeds collected in 2000.
Implement seed storage testing, Phyllostegia kaalaensis	storage testing	Phykaa	Preliminary germination trials were not successful. Plants are currently being grown for seed production for storage testing.
Need to collect seeds for storage testing, Plantago princeps	storage testing	Plapripri	Seeds were collected for storage testing in 2000. More collections and more testing need to be done.
Implement genetic storage testing if current testing inconclusive, Sanicula mariversa.	storage testing	Sanmar	Germination tests have been conducted, but seeds don't germinate well. More tests on seed dormancy need to be done.

Trigger Action Description	Trigger Action	Taxon	Status
Implement genetic storage testing, Schiedea kaalae	storage testing	Schkaa	Some storage testing has been done, but more is needed. Many seeds were collected in 2004 for storage and testing.
Implement genetic storage testing, Schiedea nuttallii	storage testing	Schnut	Many seeds have been collected for storage. Initial germination tests have been done but no storage testing.
Implement genetic storage testing, Viola chamissoniana	storage testing	Viochacha	Seed collection is difficult because plants produce few seeds and are found in remote areas on steep cliffs. Initial seed storage trials have been conducted. NRS will attempt to store tissue in micropropagation.
Management as a propagule source			
Manage as a propagule source, Alectryon macrococcus var. macrococcus, Kahanahaiki.	manage as a propagule source	Alemacmac	This population is in a fence, and weeding is conducted in the area.
Manage as a propagule source, Cyanea grimesiana ssp. obatae, South Kaluaa.	manage as a propagule source	Cyagrioba	A small fence was scoped around the remaining plant in April 2004 and constructed in May 2004.
Manage as a propagule source, Delissea subcordata, Kaawa.	manage as a propagule source	Delsub	Joel Lau surveyed the area in summer 2003 and this population is gone.
Manage as a propagule source, Delissea subcordata, South Mohiakea.	manage as a propagule source	Delsub	Plants in a small fence. Seeds in storage at Lyon Arboretum. Plants monitored in June 2004.
Manage as a propagule source, Delissea subcordata, Palawai.	manage as a propagule source	Delsub	Small fence scoped January 15, 2004, and fence constructed January 22, 2004. Plants monitored April 2004. Fruit collected for storage in July 2004.
Manage as a propagule source, Flueggea neowawraea, Makaha and Waianae Kai.	manage as a propagule source	Fluneo	All six plants were visited and monitored in November 2003. Air-layers were set up on two of the trees, and collected in July 2004.
Manage as a propagule source, Hibiscus brackenridgei subsp. mokuleianus, Kihakapu.	manage as a propagule source	Hibbramok	Joel Lau surveyed the area in April 2004. Many new plants were found, but no collections will be made until it is determined where the 'manage for stability' site will be.
Manage as a propagule source, Schiedea kaalae, Huliwai.	manage as a propagule source	Schkaa	Plants are gone. Joel Lau couldn't find this population and believes it is extirpated. One plant was removed from the wild and is growing in the greenhouse. Seeds are being collected from the greenhouse plant for storage and reintroduction into Kahanahaiki.
Manage as a propagule source, Schiedea kaalae, North Palawai.	manage as a propagule source	Schkaa	Plants are in a fence. Seeds collected for storage in April 2004.
Manage for stability, Viola chamissoniana ssp. chamissoniana, Halona.	manage as a propagule source	Viochacha	More plants were discovered at this site, so it is no longer 'manage for stability' in urgent actions.
Management for stability			
Alsobo, new population in W. Makaleha	manage for stability (baseline)	Alsobo	A small fence was constructed in February 2004. Seeds were collected for storage and greenhouse stock in March 2004. Population is now 21 mature, 12 immature.
Manage for stability, Alsinidendron obovatum, West Makaleha	manage for stability (baseline)	Alsobo	Seeds are in storage at Lyon Arboretum. Seeds will be pulled out of storage and grown in the greenhouse for outplanting in 2005. Plants were monitored and seeds were collected in April 2004.

Trigger Action Description	Trigger Action	Taxon	Status
Manage for stability, Alsinidendron obovatum, Kahanahaiki	manage for stability (baseline)	Alsobo	Wild plants are dead. A reintroduction from wild stock is being maintained instead of managing wild plants. Seeds from the reintroduced plants are in storage.
Manage for stability, Alsinidendron obovatum, Keawapilau	manage for stability (baseline)	Alsobo	Wild plants are dead. Stock collected by Dr. Steve Weller is in storage and propagation.
Manage for stability, Alsinidendron obovatum, Pahole	manage for stability (baseline)	Alsobo	Wild plants are dead. A reintroduction from Pahole stock is being maintained. Some seeds from Pahole are in storage at Lyon Arboretum.
Manage for stability, Chamaesyce herbstii, South Branch of South Ekahanui	manage for stability (baseline)	Chaher	The plants at this site died. If new plants are found in this area, they will be managed.
Manage for stability, Cyanea grimesiana ssp. obatae, Pahole	manage for stability (baseline)	Cyagrioba	This population is in a fence. Talbert collected mature fruit in November 2003 for storage at Lyon Arboretum.
Manage for stability, Cyanea grimesiana ssp. obatae, West Makaleha	manage for stability (baseline)	Cyagrioba	This population is in a fence. Plants monitored in September 2003. Fruit was not collected this year.
Manage for stability, Cyanea grimesiana ssp. obatae, Palikea (South Palawai)	manage for stability (baseline)	Cyagrioba	The population is in a fence. Fruit were collected in 2002 and seeds are in storage at Lyon Arboretum.
Manage for stability, Cyanea grimesiana ssp. obatae, North Branch of South Ekahanui	manage for stability (baseline)	Cyagrioba	The plants at this site are dead. An outplanting of mixed Kaluaa and Ekahanui stock is being maintained in Ekahanui. Fruit will be collected this year from the outplanted individuals.
Manage for stability, Cyanea grimesiana ssp. obatae, Palikea Gulch	manage for stability (baseline)	Cyagrioba	This plant is still immature, so its identity has not been confirmed. It is in a small fence.
Manage for stability, Cyanea longiflora, West Makaleha	manage for stability (baseline)	Cyalon	Fruit collected for storage in July 2003.
Manage for stability, Cyanea longiflora, Makaha and Waianae Kai	manage for stability (baseline)	Cyalon	Fruit was collected in early August 2003, and taken to Lyon Arboretum for seed storage. Two plants from this population burned in late August 2003. A fence was scoped in September 2003 and will be constructed once a permit is obtained. The permit application is currently in process.
Manage for stability, Cyanea superba ssp. superba, Kahanahaiki	manage for stability (baseline)	Cyasupsup	Plants are dead. Outplantings using stock from this population are being maintained in Kahanahaiki.
Manage for stability, Delissea subcordata, Kahanahaiki	manage for stability (baseline)	Delsub	This plant is in a fence, and weeded around. Seeds from this plant are in storage at Lyon Arboretum. The population has been augmented with stock from Kapuna.
Manage for stability, Delissea subcordata, Ekahanui	manage for stability (baseline)	Delsub	Part of this population is in the large Ekahanui fence. Small fences were constructed around the other 4 plants in May 2004.
Manage for stability, Delissea subcordata, Kapuna and Keawapilau	manage for stability (baseline)	Delsub	Known Kapuna plants have all died. Joel Lau discovered a new plant in July 2004.
Manage for stability, Delissea subcordata, Pahole	manage for stability (baseline)	Delsub	This population is in a fence. Talbert monitored this population in June 2003 and collected seeds for storage.
Manage for stability, Delissea subcordata, Kaluaa	manage for stability (baseline)	Delsub	This population is in a fence. Plants were monitored in July 2004.

Trigger Action Description	Trigger Action	Taxon	Status
Manage for stability, Delissea subcordata, Palikea Gulch	manage for stability (baseline)	Delsub	The one plant at this site was monitored July 2003. The other site has not been monitored.
Manage for stability, Delissea subcordata, Huliwai. Includes 2 days botanist time.	manage for stability (baseline)	Delsub	Joel Lau surveyed this site in 2003, and the plants are gone.
Manage for stability, Dubautia herbstobatae, Waianae Kai	manage for stability (baseline)	Dubher	The area was resurveyed in June 2004 and plants were seen. The plants are inaccessible, hundreds of feet from the top and hundreds of feet from the bottom of a vertical cliff. Management or collection would be extremely difficult.
Manage for stability, Dubautia herbstobatae, Kamaileunu.	manage for stability (baseline)	Dubher	Population may be gone, but stock from the wild plant is growing in the Army greenhouse.
Manage for stability, Flueggea neowawraea, Kahanahaiki to Kapuna	manage for stability (baseline)	Fluneo	December 2003, plants were air-layered and insecticide was applied. Air-layers already conducted on one of the plants, cuttings are in the greenhouse. Air-layers were monitored in January 2004 and July 2004.
Manage for stability, Flueggea neowawraea, Mt. Kaala NAR	manage for stability (baseline)	Fluneo	Kaawa tree airlayered January 2004. Cuttings taken in June 2004.
Manage for stability, Flueggea neowawraea, North West Makaleha.	manage for stability (baseline)	Fluneo	Air-layers were set up on this plant in November 2003, but none of the air-layers formed roots.
Manage for stability, Flueggea neowawraea, Ohikilolo (Lower Makua)	manage for stability (baseline)	Fluneo	Air-layers set up on trees in January 2004, but they were attacked by twig borer and died.
Manage for stability, Flueggea neowawraea, West Makaleha	manage for stability (baseline)	Fluneo	Seeds were germinated in micropropagation and many plants are now growing at the Army nursery in Wahiawa. Joel Lau found a new plant at this site in November 2003, and cuttings were collected and air-layers were set up.
Manage for stability, Hesperomannia arbuscula, Kapuna	manage for stability (baseline)	Hesarb	Plants air-layered in April 2004. Area weeded in May 2004.
Manage for stability, Hesperomannia arbuscula, Makaha.	manage for stability (baseline)	Hesarb	Air-layering done by Greg Koob, but none were successful. A fence will be built around this population soon, the permit application is currently in process.
Manage for stability, Hesperomannia arbuscula, North Palawai	manage for stability (baseline)	Hesarb	Joel Lau surveyed area in September 2003 and found a new population. A fence was constructed around the new population in January 2004. The plants were air-layered and the area weeded in April 2004, and seeds were collected in July 2004.
Manage for stability, Hesperomannia arbuscula, Waianae Kai	manage for stability (baseline)	Hesarb	Air-layering done by Greg Koob, and one plant is now growing at the Pahole nursery. A fence will be built around this population by the State of Hawaii.
Manage for stability, Hesperomannia arbuscula, Kaaikukai	manage for stability (baseline)	Hesarb	Joel Lau visited this site in December 2003. The plants are gone.
Manage for stability, Hibiscus brackenridgei subsp. mokuleianus, Makua	manage for stability (baseline)	Hibbramok	Good representation of this population in storage. Plants were monitored in January 2004 and there has been recruitment since last year. Weeding is conducted around this population at least once per quarter.
Maintain Hibiscus brackenridgei subsp. mokuleianus reintroduction, Kaluakauila.	manage for stability	Hibbramok	Some of the plants burned in summer 2003. Outplanting was monitored in February 2004. More plants were outplanted in March 2004.

Trigger Action Description	Trigger Action	Taxon	Status
Manage for stability, Hibiscus brackenridgei subsp. mokuleianus, Haili to Kawaiu.	manage for stability (baseline)	Hibbramok	Joel Lau surveyed the Kealia and Kawaiu sites in April 2004, and cuttings were collected and are now growing in the Army greenhouse.
Manage for stability, Hibiscus brackenridgei subsp. mokuleianus, Kaimuhole and Palikea Gulch.	manage for stability (baseline)	Hibbramok	Joel Lau conducted surveys in the area in April 2004. A site for management still needs to be selected.
Manage for stability, Hibiscus brackenridgei subsp. mokuleianus, Kaumoku Nui.	manage for stability (baseline)	Hibbramok	Joel Lau conducted surveys in the area in April 2004. A site for management still needs to be selected.
Manage for stability, Neraudia angulata var. angulata, Waianae Kai Makai.	manage for stability (baseline)	Nerang	Site visited October 29, 2003. The more mauka location (WAI-B) had 45 mature, 35 juveniles, and 10-30 seedlings. Population seemed stable. One cutting was made. The more makai location had lots of goat sign, and only one plant, on a cliff. Fences were scoped at both locations.
Manage for stability, Neraudia angulata, Manuwai	manage for stability (baseline)	Nerang	Cuttings were collected from these plants in July 2003 and 2 were successful. The site was visited again in June 2004 and cuttings were collected from the two remaining plants.
Manage for stability, Neraudia angulata var. angulata, Waianae Kai Mauka.	manage for stability (baseline)	Nerang	Two populations are known from the area. One was visited in November 2003 and the other in Janauary 2004, and fences were scoped.
Manage for stability, Neraudia angulata var. dentata. Kapuna.	manage for stability (baseline)	Nerang	Plant monitored in January 2004, and weeding was done in the area.
Manage for stability, Phyllostegia kaalaensis, Kapuna.	manage for stability (baseline)	Phykaa	This population is gone.
Manage for stability, Phyllostegia kaalaensis, Keawapilau.	manage for stability (baseline)	Phykaa	This population is gone. A reintroduction was done using stock from this site. The reintroduction fence was built and plants outplanted into the fence in February 2004.
Manage for stability, Phyllostegia kaalaensis, Pahole.	manage for stability (baseline)	Phykaa	The area where the last known plants were seen was surveyed in March 2004. This population is gone. Cuttings are being grown at the Pahole greenhouse, and they will be used to reintroduce plants into the area.
Manage for stability, Phyllostegia kaalaensis, Palikea Gulch.	manage for stability (baseline)	Phykaa	This population is gone, but there is stock at the Army greenhouse.
Manage for stability, Phyllostegia kaalaensis, Waianae Kai.	manage for stability (baseline)	Phykaa	This population is gone, but there is stock at the Army greenhouse.
Manage for stability, Plantago princeps var. princeps, Waiawa.	manage for stability (baseline)	Plapripri	Joel Lau visited this site on October 22, 2003 and counted 16 mature and 17 immature plants and many seedlings. Seeds were collected from 12 plants for storage.
Manage for stability, Sanicular mariversa, Puu Kawiwi.	manage for stability (baseline)	Sanmar	Kawiwi genetic storage plants site visited June 2004, all plants immature so no collections were made. Kamaileunu 'manage for stability' site visited June 2004, seeds collected from 14 plants and sent to Lyon for storage. Fences were scoped at both sites.
Manage for stability, Schiedea kaalae, North Branch of South Ekahanui.	manage for stability (baseline)	Schkaa	Small fence scoped April 2004 and constructed May 2004. Seeds collected for storage in June 2004.
Manage for stability, Schiedea kaalae, South Branch of South Ekahanui.	manage for stability (baseline)	Schkaa	Plants in a small fence.

Trigger Action Description	Trigger Action	Taxon	Status
Manage for stability, Schiedea kaalae, Pahole.	manage for stability (baseline)	Schkaa	Talbert monitored the two remaining plants in spring 2004.
Manage for stability, Schiedea kaalae, North Kaluaa.	manage for stability (baseline)	Schkaa	This population is gone.
Manage new plant found in Mohiakea, Schiedea kaalae.	manage for stability	Schkaa	Seedlings from this plant are in the greenhouse. Small fence constructed around the plant April 2004.
Manage for stability, Schiedea nuttallii, Kahanahaiki.	manage for stability (baseline)	Schnut	Plants monitored March 2004, and cuttings were collected for the Army greenhouse. Seeds were collected for storage in 2002, 2003, and 2004.
Manage for stability, Schiedea nuttallii, Kapuna-Keawapilau Ridge.	manage for stability (baseline)	Schnut	Cuttings were taken in February 2004 and and July 2004 are growing in the Army nursery. Plants were monitored and weeding was conducted in the area in July 2004.
Manage for stability, Schiedea nuttallii, Pahole.	manage for stability (baseline)	Schnut	Weeded around this population March 2004. Plants monitored in July 2004.
Threat management			
Continue weed control around Chamaesyce celastroides var. kaenana, Kaena and Keawaula.	threat control	Chacelkae	Ongoing. Weed control around the Chamaesyce population is conducted monthly.
Continue weed control around Cyanea superba subsp. superba reintroduction, Pahole.	threat control	Cyasupsup	Weed control takes place each quarter.
Continue weed control around Hibiscus brackenridgei subsp. mokuleianus, Lower Ohikilolo.	threat control	Hibbramok	Weeding takes place at least once each quarter.
Control ungulates at Mt Kaala NAR to protect Lipochaeta tenuifolia.	threat control	Lipten	A hunt was conducted in June 2004 and September 2004.
Continue Panicum maximum control at Kaluakauila MU.	threat control	multiple	Grass was sprayed on November 24, 2003. Several attempts to control the grass were made in the spring of 2004 but wet weather prohibited the use of herbicides.
Maintain Kaluakauila exclosure as pig free.	threat control	multiple	Fence damaged by rock falls in early 2004, but the fence has been repaired and is pig free.

3.0 *ACHATINELLA MUSTELINA* MANAGEMENT

Achatinella mustelina *MIP requirements*

The Final Makua Implementation Plan 2003 (final MIP) contains a stabilization plan for *A. mustelina*. The strategy for management outlined in this stabilization plan was based on unpublished genetics studies that were underway at the University of Hawaii (Holland and Hadfield 2003). Since the Implementation Plan was finalized, these genetic studies were published (Holland and Hadfield 2002). The final results in this publication differ from the unpublished results used to build the stabilization plan for *A. mustelina*. Both studies are based on the concept of Ecologically Significant Units or ESUs. Each ESU is considered a genetically distinct group. In order to reach stability for *A. mustelina* the Army needs to ensure that threats at each of these ESUs are managed. In the unpublished paper, eight ESUs were identified but in the published paper there were only six. This discrepancy was discussed at a snail subcommittee meeting of the Makua Implementation Team on 12 May 2004 and the group was in agreement that the published paper should be the basis for the stabilization plan. This means that the Army's requirement is to manage the six ESUs identified in Holland 2002. The Army will still manage two sites within the geographically large ESUs (ESU B and ESU D) as stated in the final stabilization plan for *A. mustelina* in order to represent the extreme ends of the ranges for these ESUs. The revised stabilization plan for *A. mustelina* reflecting ESU changes is below.

***Achatinella* Stabilization Plan Summary**

Long Term Goals:

- Manage snail populations at 8 field locations to encompass the extant range of the species and to include all 6 genetically defined evolutionarily significant units (ESUs).
- Achieve at least 300 snails per population.
- Maintain captive populations for each of the 6 recognized ESUs.
    - Control all threats at each managed field location.

Table 3.1 Field Sites for Stabilization Efforts

New ESU	Old ESU	Site No.	Location	# of Snails in the Final MIP	Final MakualP Year 1 Recommended Actions	Revised Year 1 Recommended Actions
A	A	1	Kahanahaiki	55	Manage for stability (choose between Kahanahaiki and Pahole)	Manage for stability (together with Pahole)
A	A	2	Pahole	50+	Manage for stability (choose between Kahanahaiki and Pahole)	Manage for stability (together with Kahanahaiki)
A	A	3	Kapuna	~25	None	None
B	B	4	Ohikilolo	300+	Manage for stability; Collect for captive propagation	Manage for stability
B	B	5	Central Makaleha (culvert 39)	81	Select one of 3 candidate sites for management (site # 5, 6 or 7)	None
B	B	6	East Makaleha (culvert 45)	29	Select one of 3 candidate sites for management (site # 5, 6 or 7)	None
B	B	7	East Makaleha (culvert 67)	40	Select one of 3 candidate sites for management (site # 5, 6 or 7)	None
B	N/A	N/A	East Makaleha (culvert 69)	83	None	Manage for stability
C	C	8	Schofield West Range/ Haleauau	18	Manage for stability; Collect for captive propagation	Manage for stability
C	D	9	Alaiheihe	25	Survey; Collect for captive propagation	None
C	E	10	Palikea Gulch	7	Survey; Collect for captive propagation	None
C	N/A		Manuwai Gulch	?	None	Survey for substantial population for management. If found abandon Hale`au`au.
D	F	11	Waianae Kai (2 sites)	12	Survey for manageable population	None
D	F	12	Waianae Kai	20	Survey for manageable population	None
D	F	14	Puu Hapapa	36	None	None
D	F	15	Schofield South Range	32	Select one of 2 candidate sites for management (site # 15 or 16)	None
D	F	16	Kaluaa and Waieli	50	Survey for manageable population; Select one of 2 candidate sites for management (site # 15 or 16)	Manage for stability
D	N/A	19	Makaha	17	Determine management after genetics analysis is completed	Manage for stability

New ESU	Old ESU	Site No.	Location	# of Snails in the Final MIP	Final MakuaIP Year 1 Recommended Actions	Revised Year 1 Recommended Actions
D	N/A	20	Mohiakea	10+	Determine management after genetics analysis is completed	None
D	N/A	21	Puu Kumakalii	~20	None	None
D	N/A	22	Central and North Kaluaa	5 (seen incidentally)	Determine management after genetics analysis is completed	None
E	G	17	Puu Kaua (Ekahanui)	12	Survey for manageable population; Collect for captive propagation	Manage for stability
E	N/A	23	Huliwai	30+	Determine management after genetics analysis is completed	None
F	H	18	Puu Palikea	~40	Manage for stability; Collect for captive propagation	Manage for stability

3.1 Captive Propagation

One of the requirements outlined in the MIP stabilization plan is to represent in captive propagation snails from each of the six ESUs and from the two extra sites in ESU-B and ESU-D. All but one site is represented and the snails are prospering at Dr. Hadfield's laboratory at the University of Hawai`i. Detailed snail captive propagation data are included in Attachment 1. In reviewing these data it appears that eight lab populations from 7 field sites that are designated as manage for stability are still growing in the laboratory. The MIP stabilization plan states that lab populations should be refreshed with wild stock if the lab population remains small or declines in numbers. In addition, it states that lab populations should be refreshed every two years and lab-reared snails rotated back out into the wild. NRS have concerns about the potential drain on the field population and the potential for lab borne pathogens to harm the wild population.

3.2 ESU Updates

3.2.a ESU A (Pahole to Kahanahaiki)

Table 3.2 Number of snails counted from ESU A

Pop Ref Code	No. Snails as of 8/04	Size Classes			Pigs/ Goats	Weeds	Rats	*Euglandina*
		Lg	Med	Sml				
MMR-A Kahanahaiki Exclosure	70	50	20		X	X	X	X
MMR-B Pahole Exclosure	39	39			X	X	X	X
MMR-C Maile Flats	157	117	32	8	X	X	X	X
TOTAL	**266**	**206**	**52**	**8**				

This table shows the number of snails, size classes, and threats to the snails in ESU A. Shaded boxes indicate that the threat is being controlled, X's indicate that the threat is present. In some cases the threat may be present but not actively preying on *A. mustelina*.

Management for ESU A is well underway. This ESU encompasses a relatively flat forest area in the uppermost reaches of Kahanahaiki Valley. This area is dominated by *Acacia koa* and *Metrosideros polymorpha*. *Nestigis sandwicensis* is a common canopy tree in this area and is favored by *A. mustelina*. Two exclosures were constructed to protect snails from rats and *Euglandina rosea*. The numbers of snails in these exclosures from recent observations are shown above as MMR-A and MMR-B. MMR-C is the area between the two existing exclosures called "maile flats". *A. mustelina* from ESU-A are represented at the U.H. Tree Snail Laboratory.

3.2.a.1 MMR-A (Kahanahaiki Exclosure)

For a detailed description of the Kahanahaiki snail exclosure, see PCSU Report 2003. NRS continue to maintain and monitor the Kahanahaiki exclosure by re-stocking salt troughs, ensuring the electrical barrier is functioning and conducting rat control outside the exclosure. Rat control is conducted just outside the perimeter because rat damage on *N. sandwicensis* fruit has been observed inside the exclosure in past years. Bait is not placed within the exclosure because NRS do not want to provide any attractant that may encourage rats to cross the barrier. Rat control has been conducted regularly since 2001 and a total of six bait station and 12 snap traps are deployed.

Table 3.3 Kahanahaiki Snail Enclosure Rat Information

Year	Rats Snapped	% Take	Bait Taken	Bait Available
2001	1			
2002	3	84%	404	479
2003	5	72%	647	896
2004	11	75%	533	706

The Kahanahaiki exclosure design has some flaws. The exclosure is not impenetrable to rats but does seem to be keeping out *Euglandina rosea*. The current design requires significant overstory clearing along the perimeter of the exclosure, which has created a drier environment within the exclosure. NRS have discovered *A. mustelina* in the salt trough of the snail exclosure; it is unclear if these snails were trying to enter or exit the exclosure. The electrical barrier is often not functioning properly because of rain or shorts in the system and requires monthly monitoring. NRS will investigate exclosure design modifications to address these issues before constructing any new exclosures.

NRS attempt to conduct an *A. mustelina* census each summer within the exclosure. This year a mark-recapture study was conducted inside the exclosure. On the 6 May 2004 survey, 68 snails were counted and marked. On the re-capture survey of 14 July 2004, 70 snails were counted, only 37 of which were observed to have marks from the original count. This potentially indicates a much larger number of snails in the exclosure than were counted, but because it is likely that the paint used to mark the snails wore off before the second count, further studies need to be done. At this time, NRS are only comfortable saying there are 70 snails in the exclosure.

3.2.a.2 PAH-A (Pahole Exclosure)

For a detailed description of the Pahole snail exclosure, see PCSU Report 2003. The Pahole snail exclosure is located on the Pahole side of the boundary between MakuaMilitary Reservation and the State of Hawai`i's Pahole Natural Area Reserve. This site protects what remains of the population, which University of Hawai`i researchers have been studying for over 20 years. On 27 May 2004, a total of 39 *A. mustelina* were counted. *Euglandina rosea* has penetrated the exclosure barriers in the past killing *A. mustelina*. Significant predation was documented and live *E. rosea* were found within the exclosure. Over the past year NRS have been assisting the State of Hawai`i with maintenance of this exclosure. No additional surveys have been conducted at this site.

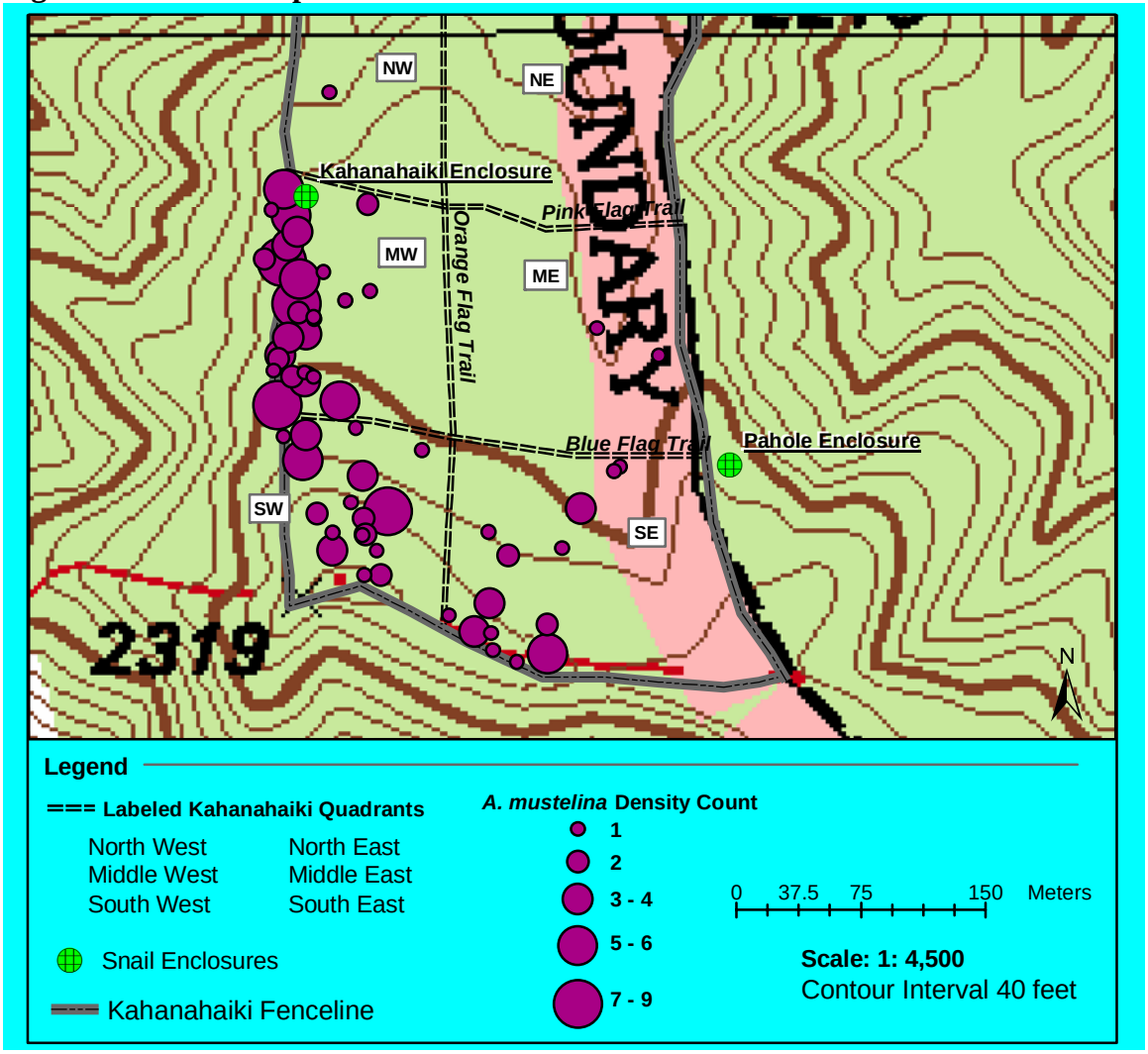
3.2.a.3 MMR-C (Maile Flats)

NRS conducted a thorough survey of the Maile Flats area this summer to determine if there are any large concentrations of snails outside the existing exclosures. NRS surveyed each of six quadrants that were installed for facilitating weed control efforts in the area. The results of this survey are described below and displayed spatially on the map (Figure 5.5).

A. mustelina is most dense in the area just outside the Kahanahaiki snail exclosure and to the south into the Southeast and Southwest quadrants. One hundred and thirty-three person hours were spent searching trees in the Maile Flats area for live *A. mustelina*. Another 8 hours were spent conducting ground searches for evidence of predation in order to determine what threat control is needed. No evidence of recent rat or *E. rosea* predation was observed. However, evidence of significant historical *E. rosea* predation was found, mainly within small, scattered patches of *Pisonia sandwicensis*. Over 50 old, empty *A. mustelina* shells of varying size classes and a number of old, empty *E. rosea* shells were found centered within these *P. sandwicensis* patches. Perhaps *A. mustelina* is easier for *E. rosea* to track within these patches because of the large leaf size of these plants. Or perhaps *A. mustelina* reached high densities on *Pisonia*

sandwicensis. Further study of this unique situation could provide insight into *E. rosea* feeding strategy and may help in determining where *Achatinella* are most susceptible to predation.

Figure 3.1 ESU A/ Population MMR C



One live *E. rosea* was exterminated in the Middlewest quadrant near the Kahanahaiki snail exclosure. There is some concern among NRS that rat control designed to take predatory pressure off *A. mustelina*, may also relieve pressure on *E. rosea* and at the same time may serve as an *E. rosea* attractant. Further investigation should be done to ensure that by trying to control one predator we are not inadvertently increasing the numbers of the other.

The results of this survey show that *A. mustelina* is still abundant in areas outside the MMR-A and PAH-A exclosures. NRS will continue to monitor the high-density areas within the Southeast, Southwest and Middlewest quadrants for evidence of predation. NRS will respond by installing a rat predator control grid if evidence of rat predation is observed. NRS recently made contact with a graduate student from the University of Hawai`i who is interested in studying *E. rosea*. We will encourage him to follow-up on the observations that were made while

conducting these surveys and to develop control techniques for *E. rosea* that may be implemented on a large-scale.

3.2.b ESU B1 (Ohikilolo)

ESU B is very large. Based on Holland's 2002 genetic studies it stretches from East Makaleha to Ohikilolo Ridge. Because of this large range, two sites have been chosen within the ESU for management. These two sites are at the extreme ends of the ESU perimeter; they are the East Branch of East Makaleha (B2) and Ohikilolo (B1). The habitat present at these two sites is very different. See 3.2.c. ESU B2 for a description of the E. Makaleha site. Most of the snails found on Ohikilolo ridge are located within the Ohikilolo Forest Patch. This forest area is dominated by *Acacia koa* and *Metrosideros polymorpha*. *Myrsine lessertiana* is also a common canopy tree on Ohikilolo and is favored by *A. mustelina*. *M. lessertiana* underwent a dieback 3-5 years ago and is still recovering. Other common native trees at Ohikilolo preferred by *A. mustelina* are *Melicope spp*. and *Freycinetia arborea*. The number of snails and threats at each of these sites are presented in the tables below. *A. mustelina* from ESU-B1 are represented at the U.H. Tree Snail Laboratory. Rat control on Ohikilolo has always shown a pattern of high rat bait take. This is mainly because we only visit the site once every three months via helicopter because of the remote nature of Ohikilolo. This high-take pattern should be considered when designing and expanding rat baiting grids in order to compensate for the long period of time between visits.

Table 3.4 Number of Snails Counted at Ohikilolo

Pop Ref Code	No. Snails	Size Classes			Pigs/ Goats	Weeds	Rats	*Euglandina*
		Lg	Med	Sml				
MMR-E Ohikilolo Mauka	77	62	8	7	X	X	X	
MMR-F Ohikilolo Makai	210	166	22	22	X	X	X	
MMR-G Alemac Site	24	20	4		X	X	X	
MMR-H Ohikilolo Koi`ahi Prikaa Reintro Site	16	9	7		X	X	X	?
MMR-I Hedpar MMR-B	2	2			X	X	X	X
TOTAL	**329**	**259**	**41**	**29**				

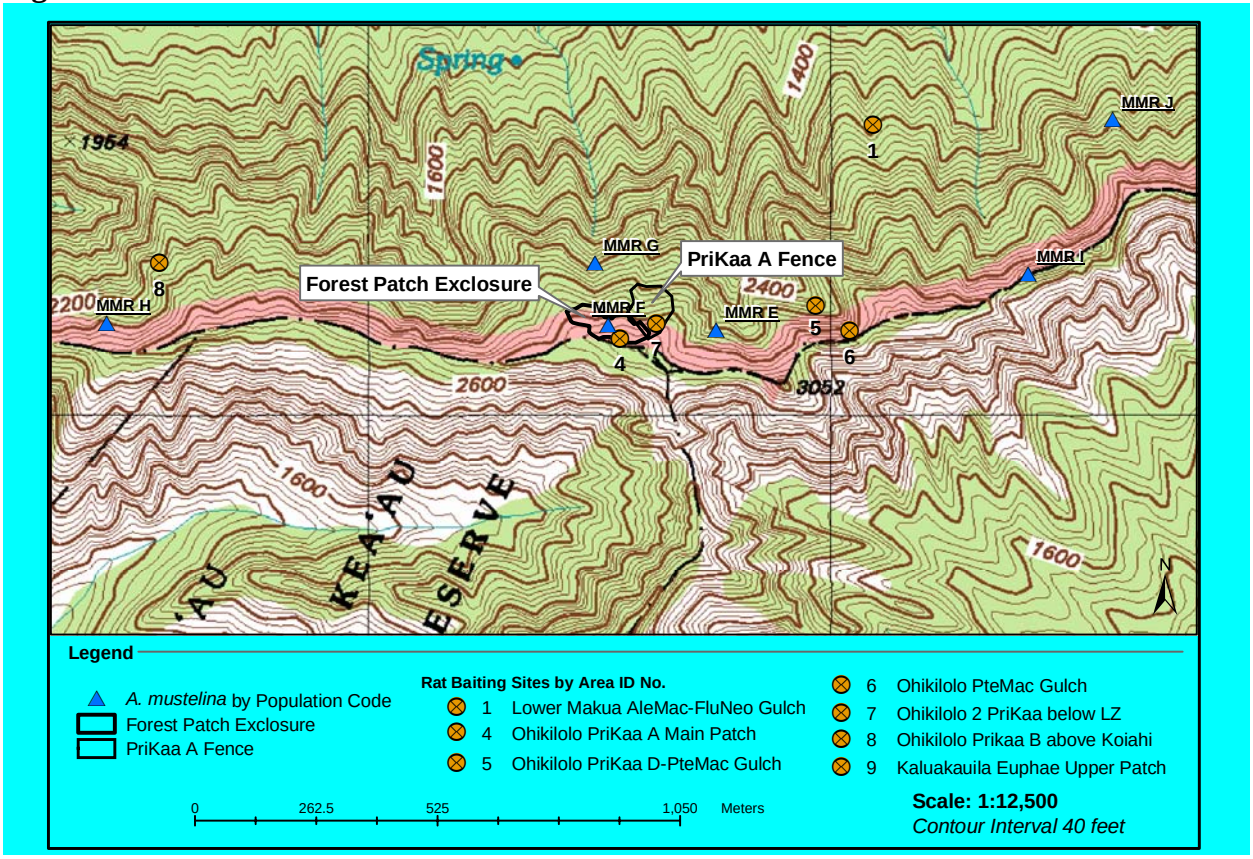
This table shows the number of snails, size classes, and threats to the snails in ESU B1. Shaded boxes indicate that the threat is being controlled, X's indicate that the threat is present. In some cases the threat may be present but not actively preying on *A. mustelina*.

3.2.b.1 MMR-E (Ohikilolo Mauka)

The Ohikilolo Mauka population encompasses the full area in the main forest patch "mauka" of the landing zone. NRS observed significant rat predation at this site and began controlling rats in 1999. The rat control currently being conducted is centered on a high-density snail area and the rare plant *Pteralyxia macrocarpa*. There are a total of six bait stations in this area. *E. rosea* has never been observed at this site. Extensive surveys were conducted in August of 2004 and many snails were discovered outside the existing grid. NRS will continue to monitor for evidence of rat predation and will expand rat baiting based on the August 2004 data. Currently this site is protected from pigs because of the steep cliffs that surround the site. Goats within Makuahave almost been completely removed. Goat numbers are very low and remaining herds reside in

other parts of the valley. No evidence of goat browse has been observed in the last two years. Weed control at this site is extensive and on-going.

Figure 3.2 ESU B1



3.2.b.2 MMR-F (Ohikilolo Makai)

The Ohikilolo Makai site consists of the main forest patch "makai" of the landing zone. The core of the *A. mustelina* population on Ohikilolo ridge is located here. NRS have observed significant rat damage to *Prichardia kaalae* fruit near Ohikilolo Makai snails and are currently baiting to protect this fruit year-round. Prior to this summer, no evidence of rat predation on snails had ever been observed at this site. Hence, rat control was never initiated at Ohikilolo Makai. However, comprehensive snail monitoring was conducted at Ohikilolo Makai this summer and eight rat-predated shells were observed at one site. All the predated shells were estimated to be between three and six years old. With this new information, NRS will reconsider the best rat control/monitoring approach for this site. No evidence of *Euglandina rosea* has ever been observed at this site. NRS will continue to monitor for *E. rosea* in Ohikilolo Makai. Care should be taken to ensure that all field gear that has the potential to transport *E. rosea* to the site is strictly inspected. This site is completely protected from ungulates by fencing. Extensive canopy and understory weed control efforts are underway.

3.2.b.3 MMR-G (*Alectryon macrococcus* Site)

MMR-G is located just below the Ohikilolo makai forest patch at the 2,700 ft. elevation. The endangered plant *Alectryon macrococcus* var. *macrococcus* is also located at this site and most of the *A. mustelina* found were observed on these plants. NRS have not observed rat damage to *A. mustelina* at this site although NRS are certain that rats are present in the area. Neither has NRS observed *E. rosea* at this site. NRS will continue to monitor for any signs of predation. Currently this site is protected from pigs by the steep cliffs that surround the site. Threat from goats is minimal as there are few left in Mākua, and those left are found in other parts of the valley. Although some weed control has been conducted at this site, extensive weed control will be more difficult than at the Mauka and Makai sites because of the steep terrain and high density of weed cover.

3.2.b.4 MMR-H (Ohikilolo Koiahi *Pritchardia kaalae* Reintroduction Site)

MMR-H is located at 2200 ft., just below the junction of Ohikilolo and Koiahi ridges. This forest was dominated by *Myrsine lessertiana*, which experienced a large dieback over the last five years. NRS outplanted the endangered plant *Prichardia kaalae* into this site and have conducted weed control in combination with this effort. Observations indicate that *M. lessertiana* is making a comeback as numerous juveniles are now seen in areas previously dominated by this taxon. NRS have not observed rat damage to *A. mustelina* at this site although NRS are certain that rats are present in the area. NRS will conduct ground searches for *E. rosea* shells at this site in order to determine if it is present. Currently MMR-H is protected from pigs because of the steep cliffs that surround the site. The goats within Makua have almost been completely removed and pose a very low threat to the site.

3.2.b.5 MMR-I (*Hedyotis parvula* MMR-B)

Only two individual *A. mustelina* have been observed at MMR-I, elevation 2,700 feet. They were found in tiny forest pockets on steep cliffs by NRS on rappel. The small forest pockets are dominated by *Metrosideros tremuloides*. This site does not have much management potential as this terrain is too steep and remote to conduct meaningful management. In addition, *Schinus terebinthifolius* is abundant within most small forest pockets in this habitat type. Rats and *E. rosea* are both present at this site, but because of the terrain no ground searches have been conducted for predated shells. The *A. mustelina* habitat at this site has certainly benefited from goat control.

3.2.c ESU B2 (East Branch of East Makaleha)

Table 3.5 Number of Snails Counted in East Branch of East Makaleha

Pop Ref Code	No. Snails as of 6/04	Size Classes			Pigs/ Goats	Weeds	Rats	*Euglandina*
		Lg	Med	Sml				
LEH-C (culvert 69)	83	83			X		X	?
LEH-D (culvert 73)	19	10	3	6	X		X	?
TOTAL	**102**	**93**	**3**	**6**				

This table shows the number of snails, size classes, and threats to the snails in ESU B2. Shaded boxes indicate that the threat is being controlled, X's indicate that the threat is present. In some cases the threat may be present but not actively preying on *A. mustelina*.

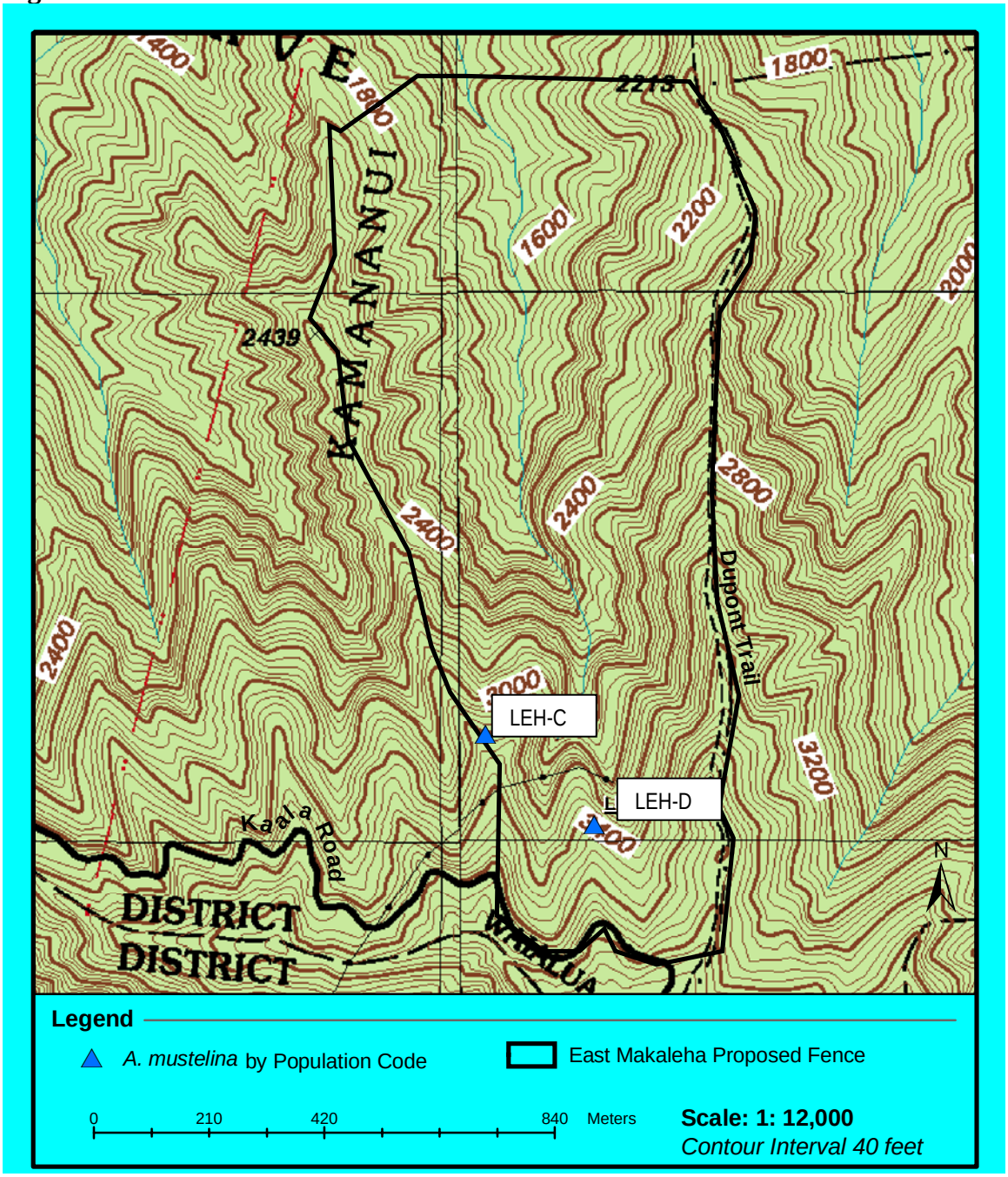
3.2.c.1 Culvert 69

Culvert 69 is off of the Mt. KaalaAccess Road. The forest is fairly intact wet forest dominated by *Metrosideros polymorpha* and *Dicranopteris linearis*. *A. mustelina* is found along the crest of the ridge that starts at culvert 69. The ridge crest is moderately steep. It is narrow in most spots, being less than 10 meters wide. The ridge quickly becomes steep off both sides. Very few weedy plant species are found along the section of ridge where *A. mustelina* is found, between 3,000 and 3,400 ft. Little effort has been spent looking for evidence of *E. rosea* and rat predation, but in the limited time spent no evidence was found. NRS will survey the eastern boundary ridge along the Dupont trail within this branch of East Makaleha to determine the presence and abundance of snails there. NRS will expand management of this area by first developing fencing plans. *A. mustelina* from ESU-B2 are represented at the U.H. Tree Snail Laboratory.

3.2.c.2 Culvert 73

Culvert 73 is off of the Mt. Kaala Access Road. The forest is fairly intact wet forest dominated by *Metrosideros polymorpha* and *Dicranopteris linearis*. *A. mustelina* is found along the crest of the ridge that starts at culvert 73. This ridge has similar characteristics as the ridge off of culvert 69. Very few alien plant species are found along the section of ridge where *A. mustelina* is found, between 3,000 and 3,400 ft. Little effort has been spent in the area looking for evidence of *E. rosea* and rat predation, but in the limited time spent no evidence was found. Again NRS will place priority on developing fencing plans for this area and continue to survey to determine abundance and distribution of *A. mustelina* in the area.

Figure 3.3 ESU B2



3.2.d ESU C

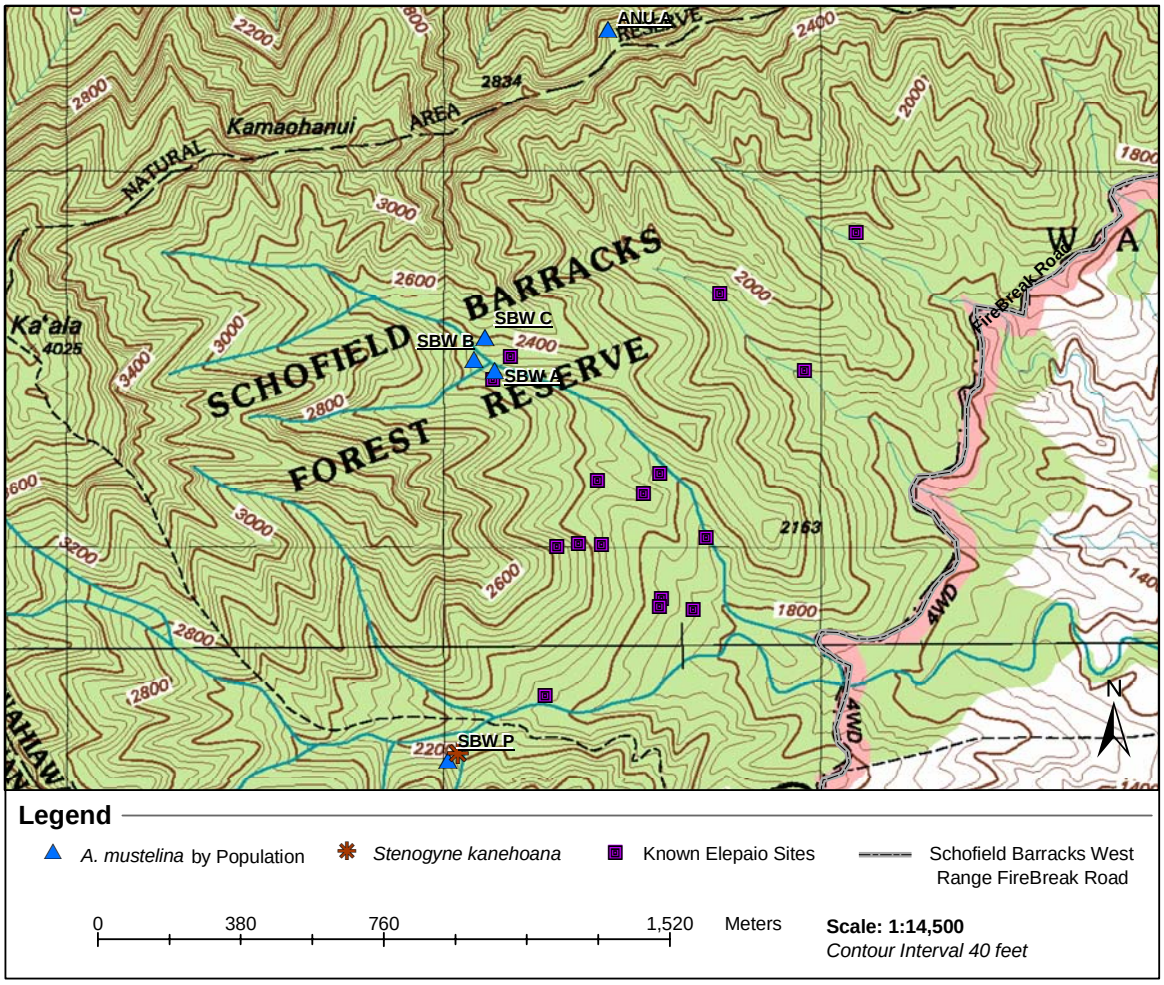
Table 3.6 Number of Snails Counted in ESU C

Pop Ref Code	No. Snails as of 7/04	Size Classes			Pigs/ Goats	Weeds	Rats	*Euglandina*
		Lg	Med	Sml				
SBW-A North Haleauau, Hame Ridge	13	13			X	X	X	X
SBW-B North Haleauau, one ridge north of Hame	7	7			X	X	X	X
SBW-C North Haleauau, just above *Pouteria* pair territory	10	7	3		X	X	X	X
SBW-P Stekaa site	4	2	1	1	X	X	X	X
ANU-A Manuwai Gulch	1	1			X	X	X	X
TOTAL	**31**	**30**	**4**	**1**				

This table shows the number of snails, size classes, and threats to the snails in ESU C. Shaded boxes indicate that the threat is being controlled, X's indicate that the threat is present. In some cases the threat may be present but not actively preying on *A. mustelina*.

Management for ESU C is challenging. The numbers of snails found at any one site within the ESU are few and the habitat quality is marginal. Access issues related to steep terrain and Schofield Barracks West Range compound these challenges. ESU-C was not managed prior to the MIP. Originally, the SBW-A, B and C sites were going to be combined into one site for management. Unfortunately, this site is difficult to access because of its location above the Schofield Barracks West Range (SBW) live-fire training area. At the May 2004 MIT snail subcommittee meeting a decision was made to survey the upper reaches of Manuwai gulch to find a manageable population, as this area is already slated for large-scale fencing and unfortunately all appropriate habitat was surveyed and only one snail was found. Other proposals for management are discussed below. There are other sites in ESU-C not shown on the table above that could be revisited, considering current management challenges. *A. mustelina* from ESU-C are represented at the UH Tree Snail Laboratory.

Figure 3.4 ESU C



3.2.d.1 Schofield Barracks West Range-A, B, C, and P

These four sites will be discussed collectively because their situations are similar and related. All of these sites are located in North Hale`au`au gulch between 2,500 and 2,600 ft in elevation. The habitat is infested with pigs. This area is off-limits to hunters, therefore the pig population is growing un-checked. There are no fences installed here. The high pig numbers facilitate the spread of *Psidium cattleianum*, which is a dominant canopy tree in the area. Native forest areas have a very tall canopy in Hale`au`au, which is dominated by *Metrosideros polymorpha*. The subcanopy is composed of *Antidesma platyphyllum*, *Melicope spp*., *Cheirodendron platyphyllum* and *Elaeocarpus bifidus*. This area was proposed for management because the terrain is relatively flat in portions of this ESU and suitable for constructing snail exclosures similar to those in ESU-A. Since these exclosures require intense maintenance, Hale`au`au may not be suitable because of access restrictions. This being said, if management of *A. mustelina* overlapped with management of other species in SBW, then adequate access may be possible to obtain. The O`ahu Biological Opinion (O`ahu BO) mandates that two species must be managed within SBW, *Stenogyne kanehoana* and O`ahu `Elepaio. In this last year, one new *A. mustelina*

site was discovered in the south fork of Hale`au`au in a spot where the other two O`ahu BO taxa are present. This is referred to in the table above as SBW-P. If substantial numbers of *A. mustelina* are found at the SBW-P site, rat baiting could be conducted in conjunction with O`ahu `Elepaio predator control and a fence could be constructed to protect all three species together. Additional surveys in the vicinity of the *S. kanehoana* in South Hale`au`au for *A. mustelina* are recommended. If substantial numbers of *A. mustelina* are found, NRS will collect genetic material so an ESU determination can be made.

3.2.d.2 ANU-A (Manuwai)

Manuwai is one of the gulches in Lower Mt. KaalaNatural Area Reserve (NAR). Lower Mt. KaalaNAR as a whole is characterized by very steep-walled gulches, which limit management options. There are plans for a fence in Manuwai in order to protect some rare plant populations found there. NRS theorized that *A. mustelina* could be managed in combination with these plants in one large fenced unit, however, based on the poor numbers of snails discovered during the survey conducted this year, NRS are re-evaluating again where and how to conduct management for *A. mustelina* in ESU-C. Therefore, the lone snail was not sampled to determine its ESU status. Other sites in Lower Mt. KaalaNAR are available for management. Surveys will be conducted in other gulches within this portion of ESU-C in order to determine if there are populations located in moderate terrain, within a healthy native forest and in areas that overlap with other species the Army must manage.

3.2.e ESU-D1 North Kaluaa and Puu Hapapa

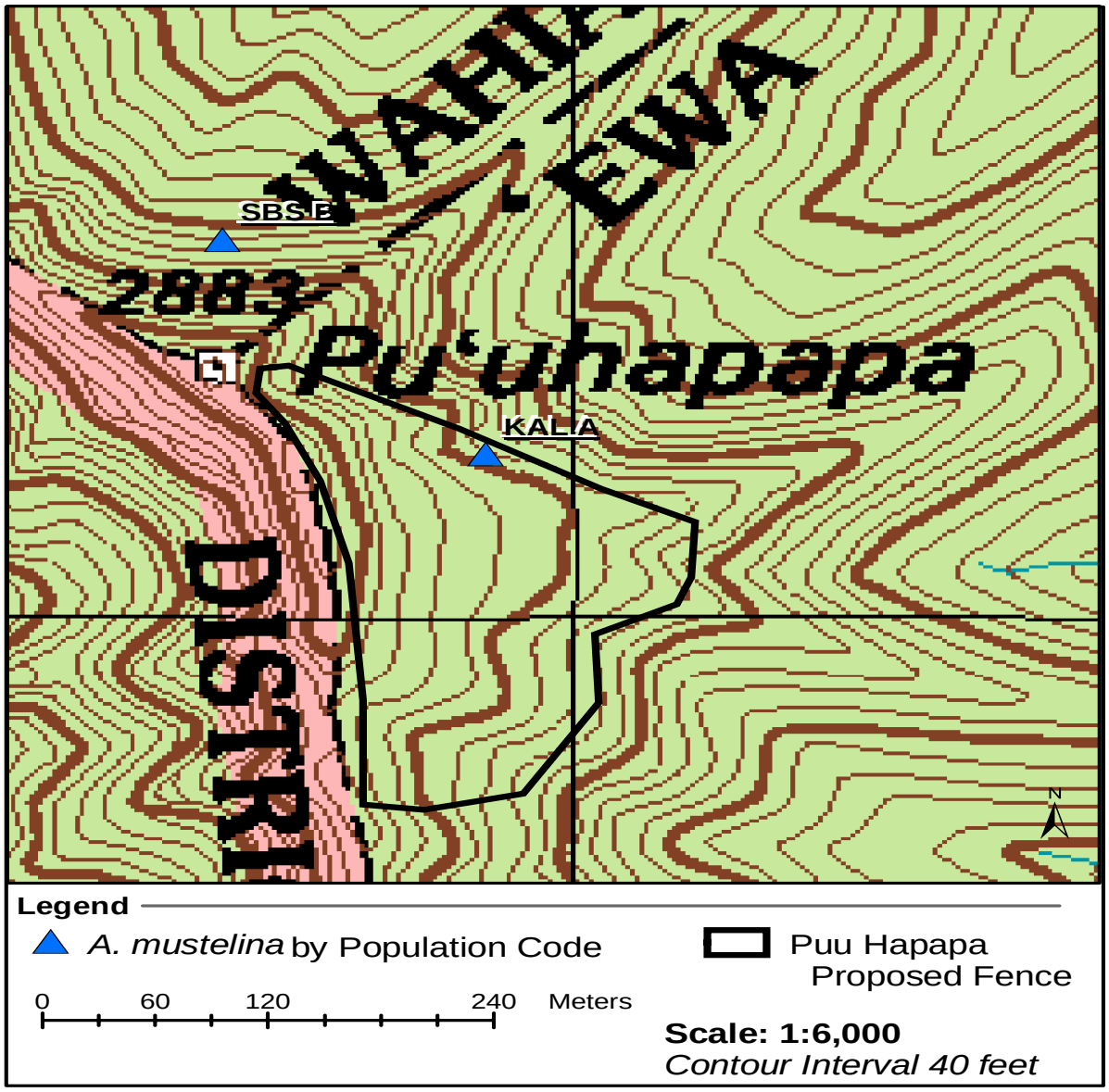
Table 3.7 Number of Snails Counted in ESU D1

Pop Ref Code	No. Snails as of 8/04	Size Classes			Pigs/ Goats	Weeds	Rats	*Euglandina*
		Lg	Med	Sml				
KAL-A Kaluaa and Waieli	481	158	237	86	X	X	X	X
SBS-B Puu Hapapa	196	131	44	21	X	X	X	X
TOTAL	**677**	**289**	**281**	**107**				

This table shows the number of snails, size classes, and threats to the snails in ESU D1. Shaded boxes indicate that the threat is being controlled, X's indicate that the threat is present. In some cases the threat may be present but not actively preying on *A. mustelina*.

ESU D encompasses a large geographic area. For management purposes it has been split into two portions. D1 includes Puu Hapapa and Kaluaa, and D2 includes Makaha. Management for ESU D1 is promising. The numbers of snails found at both sites is substantial and habitat quality is good. The two sites are continuous and encompass most of the Puu Hapapa summit. Rat baiting is already being conducted at both sites and plans are being developed to protect the ESU from pigs. Weed control is also conducted at both sites. The native species in this ESU preferred by *A. mustelina* include *Freycinetia arborea* and *Myrsine lessertiana*. The native forest canopy is primarily *Metrosideros polymorpha*. Slow growing *Freycinetia arborea* is extremely susceptible to pig damage as it grows low to the ground. ESU D1 was managed prior to the MIP and the number of snails in the area reflects this. *A. mustelina* from ESU-D1 are represented at the UH Tree Snail Laboratory.

Figure 3.5 ESU D1



3.2.e.1 KAL-A, Kaluaa and Waieli (Land of 10,000 Snails)

NRS and TNC conducted a joint survey of this site. The total reflected in the table above is the result and shows that this site is one of the most robust in the Wai`anae Mountains. The Nature Conservancy (TNC) has been working here for the last three years, as it is located within the Honouliuli Preserve. They have been administering rat bait to protect snails from rat predation and have been controlling pig populations in the area. TNC stocks 16 bait boxes each month and checks five snap traps near the core of the population. This year the Army funded a full-time field position to work on species covered in Army consultations located on Honouliuli Preserve. This staff person has been assisting with the rat baiting and ungulate control efforts at the Kaluaa and Waieli *A. mustelina* site. TNC obtained grant money to obtain fence materials to construct a

fence to protect this site. NRS will assist TNC with this fencing effort. NRS will work with TNC staff to cooperatively maintain the rat bait stations and expand the rat-baiting grid if necessary.

3.2.e.2 Schofield Barracks South Range-B Puu Hapapa

North Waieli gulch is situated within Schofield Barracks South Range (SBS). A portion of Puu Hapapa, which is the peak at the top of Wai`eli gulch, is also a part of SBS. This portion of Puu Hapapa is referred to as SBS-B. NRS have been controlling rats using diphacinone bait atop Puu Hapapa since 2000. This year a total of 172 bait blocks were put out in 8 stations. Rat control also protects two other species of native snails that are found in overlapping habitat at this site. These taxa are *Laminella sanguinea* and *Amastra micans*. On a recent survey to Puu Hapapa NRS counted 196 *A. mustelina* in an area less than 10 acres in size. This portion of Puu Hapapa is very steep, which renders management efforts challenging. For safety, NRS work while on rappel in some areas. Nonetheless, NRS would like to expand the fencing project planned for KAL-A to include as much of SBS-B as possible. Weed control is underway at Puu Hapapa and should directly improve the quality of habitat for *A. mustelina* in the area.

3.2.f ESU-D2 Makaha

Table 3.8 Number of Snails Counted in ESU D2

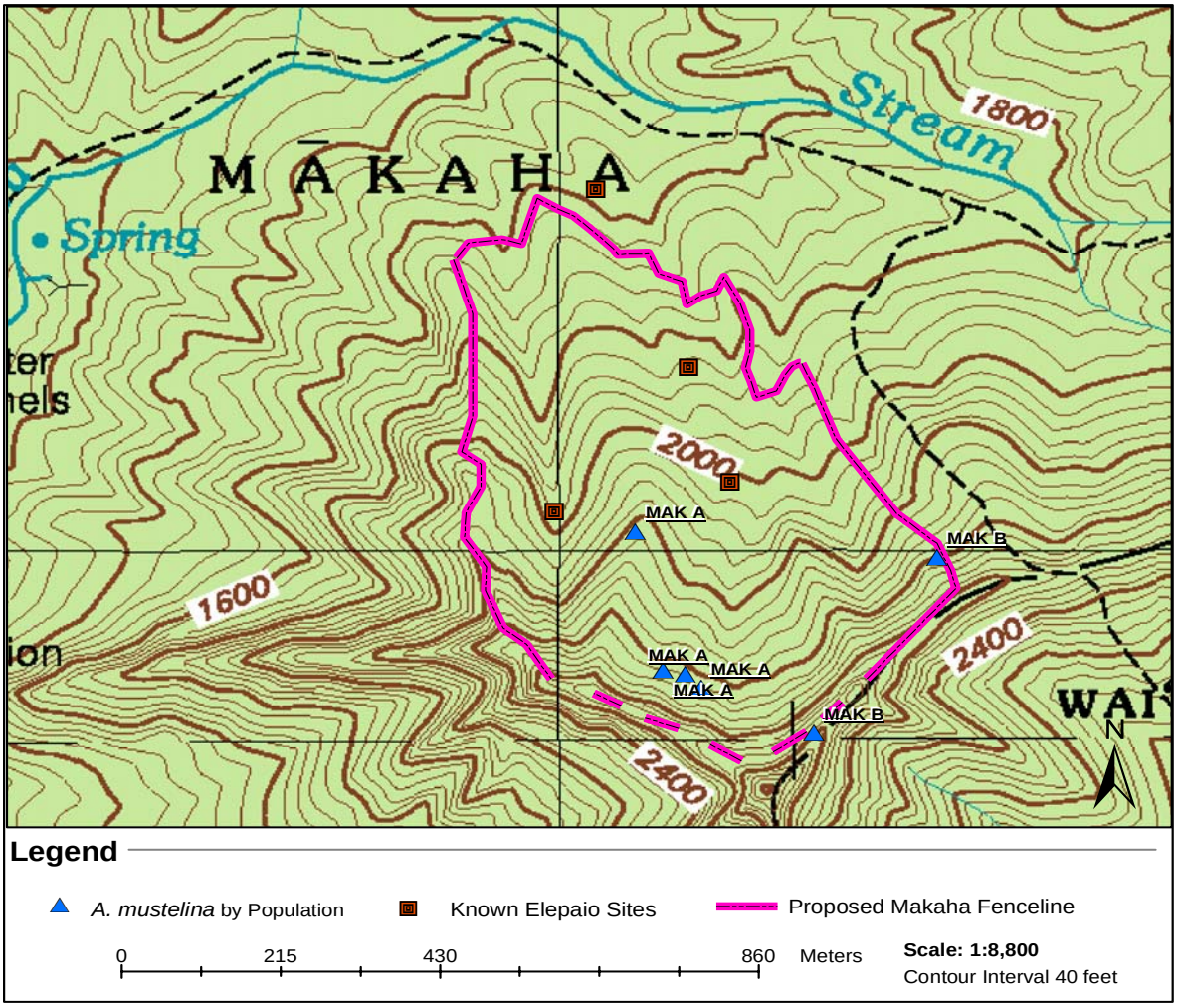
Pop Ref Code	No. Snails as of 7/04	Size Classes			Pigs/ Goats	Weeds	Rats	*Euglandina*
		Lg	Med	Sml				
MAK-A (Isolau ridge)	53	53			X	X	X	X
MAK-B (Kumaipo ridge crest)	4	3	1		X	X	X	X
TOTAL	**57**	**56**	**1**					

This table shows the number of snails, size classes, and threats to the snails in ESU D2. Shaded boxes indicate that the threat is being controlled, X's indicate that the threat is present. In some cases the threat may be present but not actively preying on *A. mustelina*.

Management of ESU D2 has been limited thus far. Comprehensive surveys have yet to be conducted in Makaha. In the lower elevation gulches within Makaha (MAK-A), the native canopy is a mix of *Diospyros spp*., *Antidesma platyphyllum*, *Nestigis sandwicensis* and *Pisonia spp*. The forest canopy near the Kumaipo ridge crest (MAK-B) is dominated by *Acacia koa* and *Metrosideros polymorpha*. The numbers of snails at MAK-A is an old number and needs to be updated. The MAK-B number represents an incidental observation made along a portion of the proposed fence line near the Kumaipo ridge crest. NRS need to conduct methodical surveys to identify hot spots, look for evidence of predation and develop management plans. At this point, most of the staff time spent in Makaha has been planning a large-scale fence project. MAK-A and MAK-B are both located within the proposed fence project. Ungulates are currently having a significant negative impact on the forest within Makaha. NRS have determined the best fence route, flagged the line, determined where strategic fencing is necessary and put together supporting paperwork for the project. The fence will protect 100 acres of mesic forest, most of which is suitable habitat for *A. mustelina*. The fence construction has been funded this year and construction is expected to begin in late Fiscal year 2005. Extensive weed control is required in order to improve the condition of this forest area. The most abundant canopy weeds are *Psidium*

cattleianum and *Schinus terebinthifolius*. The Board of Water Supply has yet to authorize the use of pesticides in Makaha Valley but the issue is being considered. BWS conducts rat baiting between January and June, during the O`ahu `Elepaio nesting season. This rat control probably benefits the snails found within those `Elepaio territories, if there are any. *A. mustelina* from ESU-D2 are represented at the UH Tree Snail Laboratory.

Figure 3.6 ESU D2



3.2.g ESU-E Puu Kaua/Ekahanui

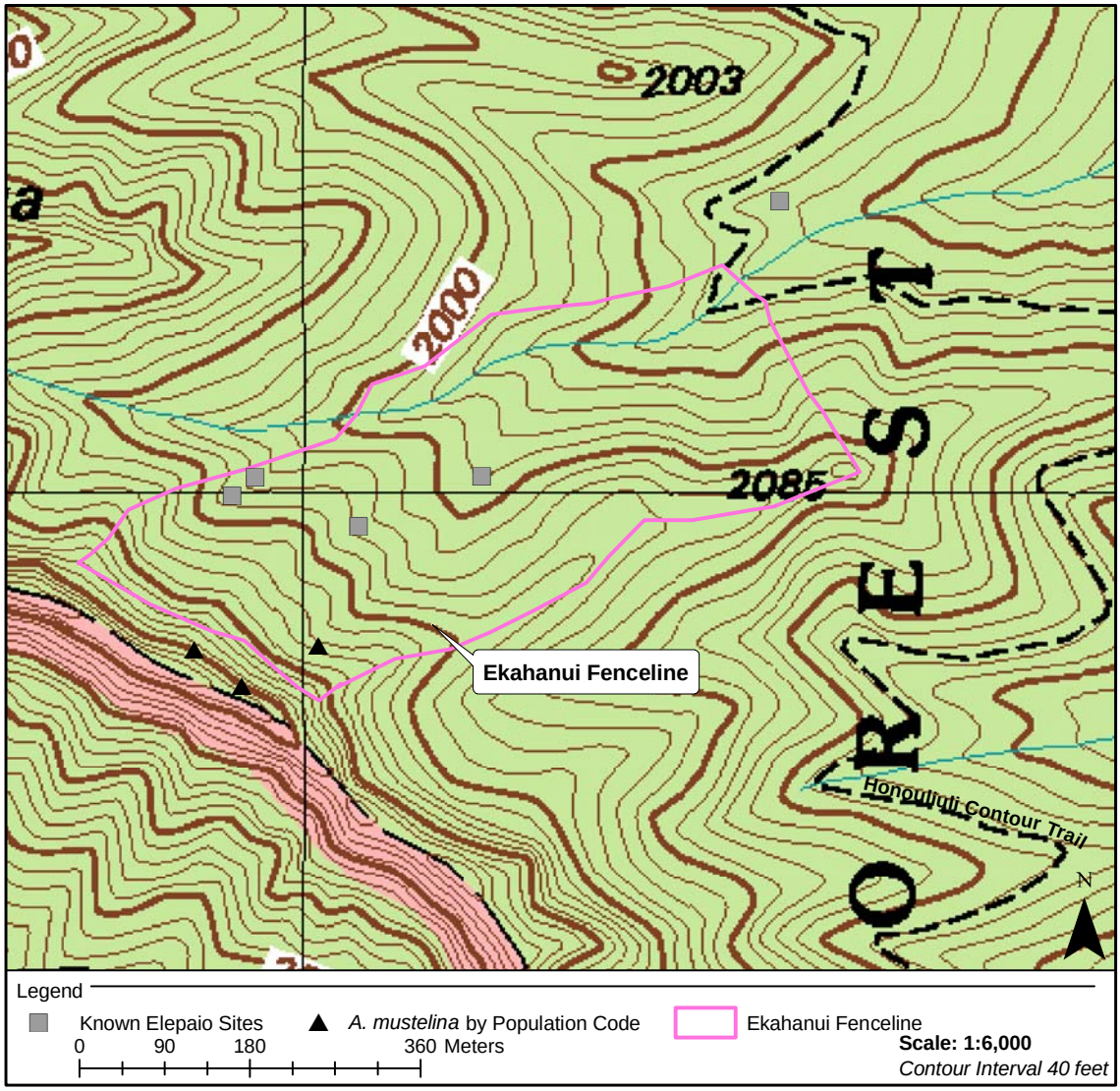
Table 3.9 Number of Snails Counted in ESU E

Pop Ref Code	No. Snails	Size Classes			Pigs/ Goats	Weeds	Rats	*Euglandina*
		Lg	Med	Sml				
EKA-A (Mamane Ridge)	25	25			X	X	X	X
EKA-B (Plapri EKA-A site)	29	27	2		X	X	X	X
EKA-E (Amastra site)	5	5						
TOTAL	**59**	**55**	**2**	**2**				

This table shows the number of snails, size classes, and threats to the snails in ESU E. Shaded boxes indicate that the threat is being controlled, X's indicate that the threat is present. In some cases the threat may be present but not actively preying on *A. mustelina*.

Management for ESU E has been limited thus far. This ESU encompasses a few large concentrations of snails within the Ekahanui drainage and along the ridge crest above the drainage. The ridge crest forest type is comprised mainly of wet forest species including *Metrosideros polymorpha*, *Metrosideros tremuloides*, *Melicope peduncularis*, and *Dicranopteris linearis*. Most of the snails found in this area are on Myrsine lessertiana. Both EKA-A and EKA-B are situated in this type of ridge crest vegetation. The Ekahanui gulch area is a mix of alien and native forest patches. The native vegetation in areas within Ekahanui that have high concentrations of *A. mustelina* consist of *Freycinetia arborea, Diospyros hillebrandii* and *Antidesma platyphyllum*. The management of this ESU has been limited so far as NRS are still getting oriented to the area. The Nature Conservancy is currently conducting rat control in the vicinity of an *Amastra spirazona* population. *Achatinella mustelina* do occur in the same habitat (EKA-E). Only two bait stations are currently deployed. In addition, rat control is conducted during the nesting season in the vicinity of `Elepaio and this baiting may benefit *A. mustelina* if there are snails nearby. NRS will assist TNC in these efforts. NRS should expand this grid based on comprehensive survey results. An ungulate exclosure that protects approximately 50 acres of forest already exists in the southern fork of Ekahanui, however, only EKA-A and EKA-E are located within this fence. The Army staff person working full-time with TNC is developing plans for additional fencing to protect the remaining portions of Ekahanui gulch and all the snails in EKA-B. Ten snails were collected from the Mamane Ridge site for captive propagation and are doing well at the UH Tree Snail Laboratory (see Attachment 1: Captive snail propagation data). Site KAL-B, located at a population of the endangered plant *Plantago princeps* needs further survey. A comprehensive *A. mustelina* survey should be conducted with knowledgeable TNC staff across Ekahanui in order to determine where the areas of highest density exist, look for evidence of predation and determine management needs.

Figure 3.7 ESU E



3.2.h ESU-F Puu Palikea

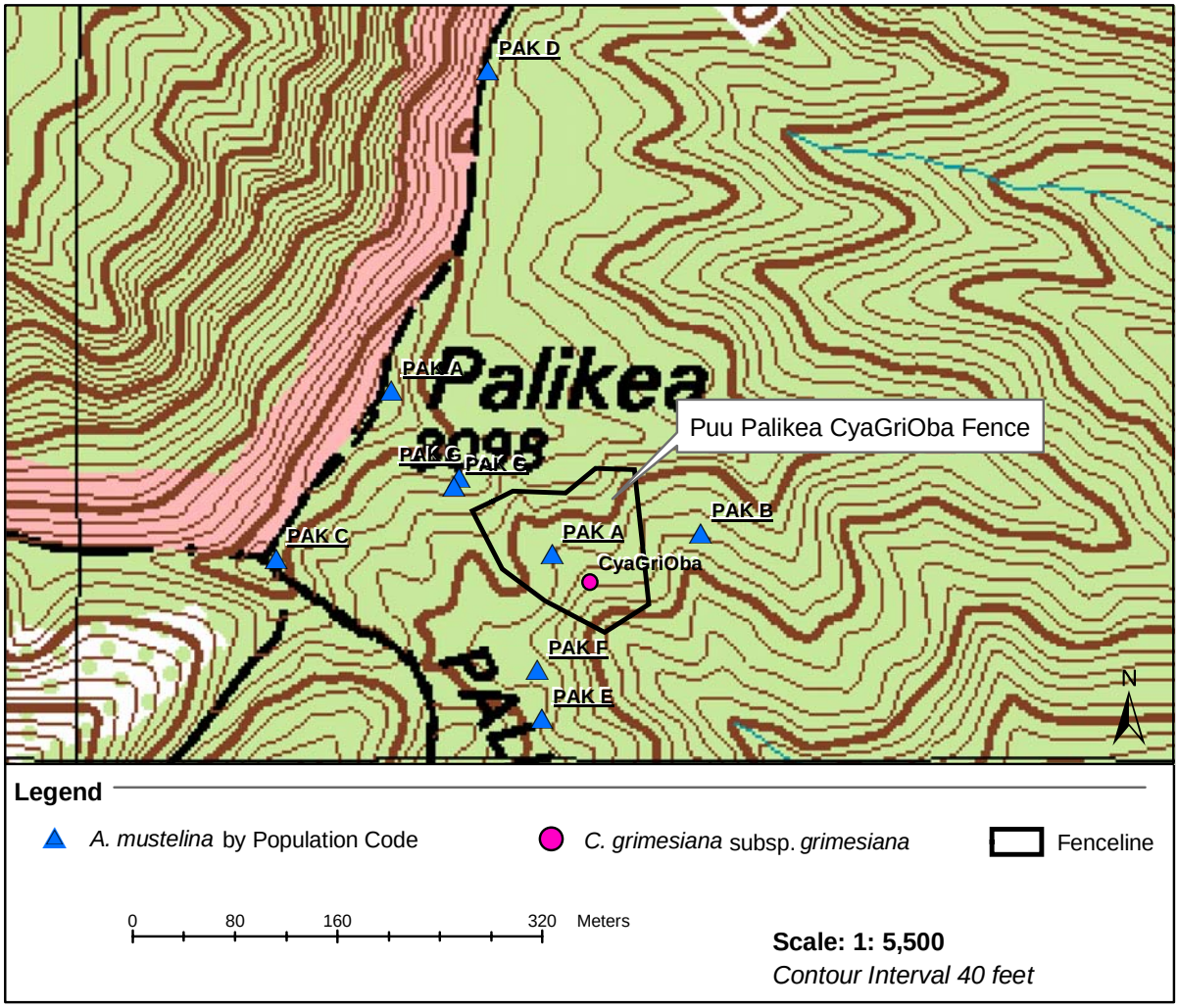
Table 3.10 Numbers of Snails Counted in ESU F

Pop Ref Code	No. Snails as of 8/04	Size Classes			Pigs/ Goats	Weeds	Rats	*Euglandina*
		Lg	Med	Sml				
PAK-A Puu Palikea Ohia spot	9	5	2	2	X	X	X	X
PAK-B `Ie`ie Patch	13	11	1	1	X	X	X	X
PAK-C Steps spot	19	14	3	2	X	X	X	X
PAK-D Joel Lau's site	11	8	2	1	X	X	X	X
PAK-E Exogau site	6	4	1	1	X	X	X	X
PAK-F Dodvis Site	5	3	2		X	X	X	X
PAK-G Hame and Alani site just above Cyagri fence	22	13	6	3	X	X	X	X
TOTAL	**85**	**58**	**17**	**10**				

This table shows the number of snails, size classes, and threats to the snails in ESU F. Shaded boxes indicate that the threat is being controlled, X's indicate that the threat is present. In some cases the threat may be present but not actively preying on *A. mustelina*.

Management conducted to protect ESU F has been limited thus far. Surveys to locate areas of high snail density were recently conducted in order to determine threats and plan management. The snails known from this ESU are scattered in distribution and are shown on the map below. At total of 85 snails were counted in the Puu Palikea vicinity during two days of survey. The habitat quality is good although introduced conifers dominate a large portion of the forest. The native forest in the area is dominated by *Metrosideros polymorpha*. The native plant species at Palikea that *A. mustelina* prefer as host trees include *Metrosideros polymorpha*, *Coprosma foliosa*, *Antidesma platyphyllum* and *Melicope o`ahuensis*. TNC and the Army constructed a fence that is approximately 2.5 acres in size in 1999 to protect an endangered plant, *Cyanea grimesiana* ssp. *obatae*. At this point there are no known *A. mustelina* found within this exclosure but NRS have yet to survey the entire potential habitat within the fence. Weed control is conducted by TNC and the Army liaison to TNC within the exclosure perimeter on a regular basis. Of the 85 snails seen during the recent survey, only 11 were found at an outlier location to the north. Expanding the fence unit at Puu Palikea will protect habitat for the other 74 snails. NRS will make this a high priority action for this ESU. In addition some rat control is underway around the PAK-A, PAK-B and PAK-C snail locations and in the vicinity of the *Cyanea grimesiana* ssp. *obatae*. NRS will work with TNC to expand this predator control effort. *Achatinella concavospira* was also found during the recent survey and will benefit from any management in the Puu Palikea area. Snails collected from this ESU are represented at the UH Tree Snail Laboratory.

Figure 3.8 ESU F

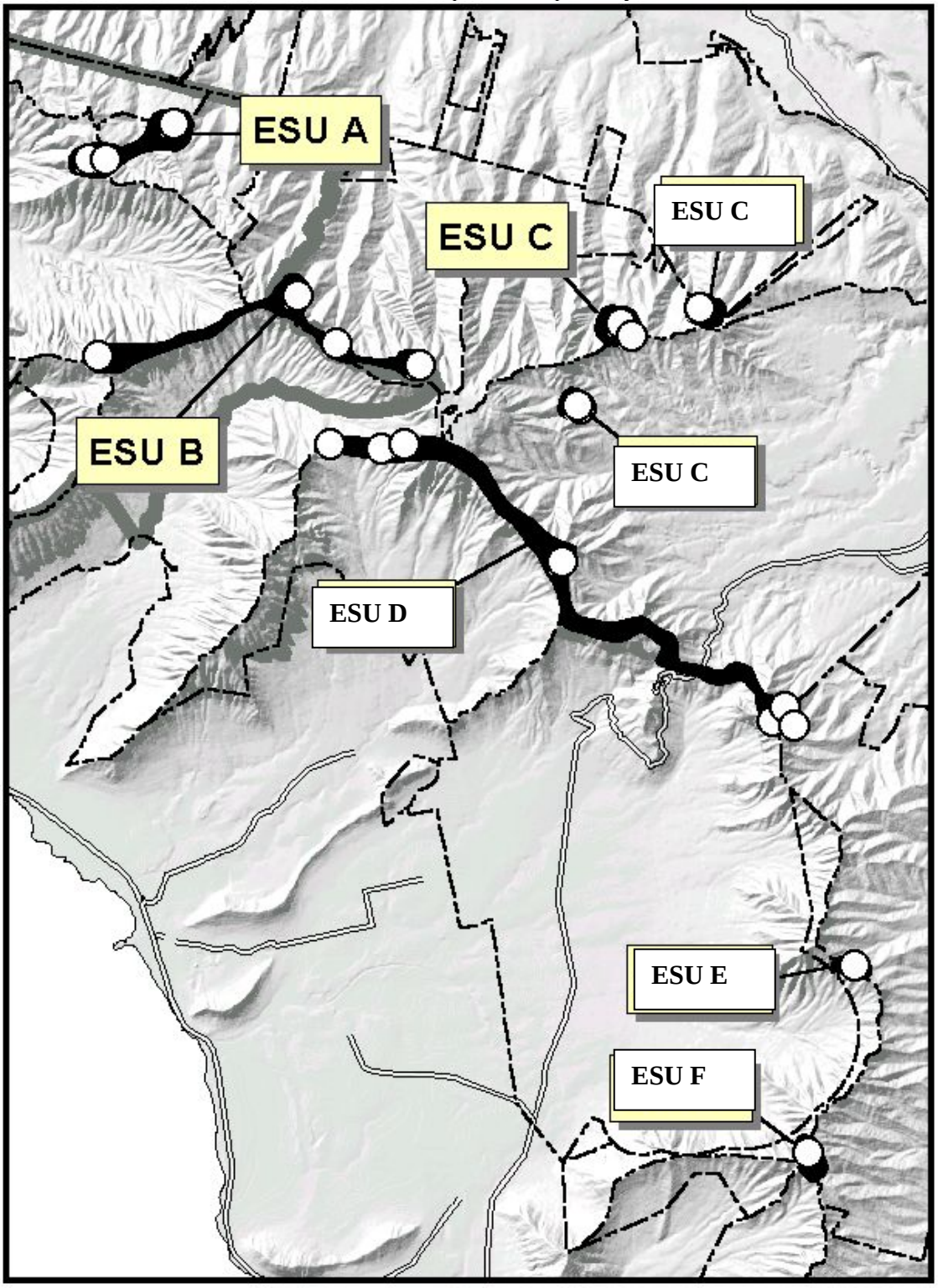


Attachment 1: Captive Snail Propagation Data

Species	Population	ESU	# *juv*	# *sub*	# *adult*	# Individuals
A. mustelina	10,000 snails	D1	*8*	*22*	*0*	**30**
	Ala'ihe'ihe Gulch	C	*14*	*4*	*4*	**22**
	Bornhorst		*1*	*1*	*1*	**3**
	Ekahanui - Hono'uli'uli	E	*24*	*2*	*3*	**29**
	Ka'ala S-ridge	B2	*23*	*0*	*6*	**29**
	Makaha	D2	*16*	*0*	*8*	**24**
	Ohikilolo - Makai	B1	*27*	*0*	*4*	**31**
	Ohikilolo - Mauka	B1	*20*	*5*	*0*	**25**
	Palehua	F	*3*	*0*	*4*	**8**
	Palikea Gulch	C	*20*	*1*	*8*	**29**
	Peacock Flats	A	*8*	*11*	*4*	**23**
	Recombined		*0*	*3*	*0*	**3**
	Schofield		*1*	*4*	*1*	**6**
	Schofield South Range	D2	*18*	*7*	*3*	**28**
	Schofield West Range	C	*15*	*1*	*9*	**25**
	TOTAL					**315**

Number of snails as of April, 2004

Attachment 2. Grouping of 18 *A. mustelina* sampling sites into 6 ESU's. ESU's A through F show the relative positions of each in the Waianae Mountains of western Oahu. The threshold of genetic distance separating the ESUs was set at 1%. Each population within a given ESU has a pairwise genetic distance to all other populations with the same ESU of 1% or less. Note that the exact shape and extent of each ESU is unknown and therefore the contours depicted are partially theoretical.



4.0 ‘ELEPAIO MANAGEMENT

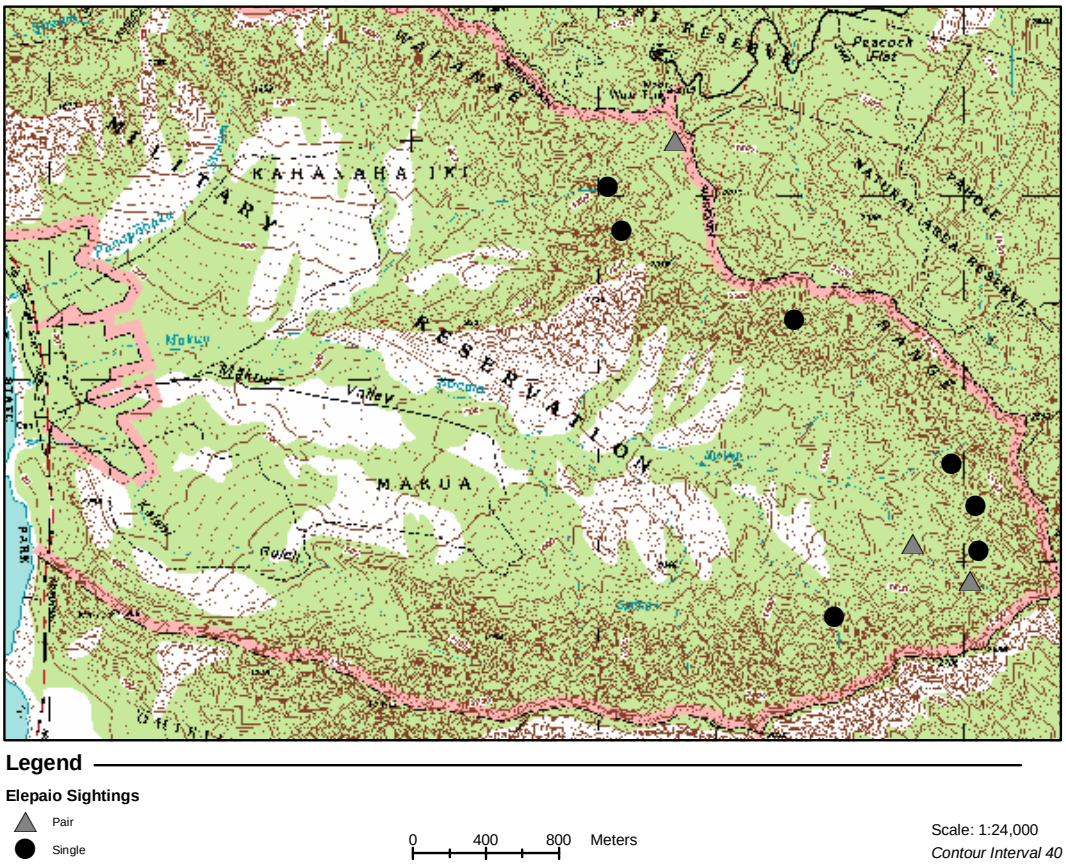
The initial Biological Opinion (BO) that triggered the development of the Makua Implementation Plan (MIP) was issued in 1999. At that time, the Oahu ‘Elepaio (*Chasiempsis sandwicensis* ssp. *ibidis*) was not listed as an endangered species. The 1999 BO included recommendations related to `Elepaio. These included conducting complete surveys of the action area for `Elepaio presence, monitoring of all known `Elepaio within Makua Military Reservation (MMR) and predator control around nesting pairs within MMR. In 2000, the U.S. Fish and Wildlife Service (USFWS) granted the Oahu `Elepaio endangered species status under the federal Endangered Species Act and designated critical habitat on Oahu for the `Elepaio in 2001. In the *Supplement to the Biological Opinion and Conference Opinion for Proposed Critical Habitat for Routine Military Training at Makua Military Reservation* issued in 2001, the recommendations from the 1999 BO became requirements. The sections below outline the status of the required actions from MMR Section 7 Consultations since 1999.

Current Status of ‘Elepaio in MMR

1. Surveys

Thorough surveys for `Elepaio have been conducted in MMR. The only area that requires additional survey is the East Rim Ungulate Control Area (UCA) below the cliffs. The best way to access this area is via the Lower Makua MU. Access to this MU has been hampered by helicopter restrictions imposed by the Army’s Safety Office following a helicopter crash last year and new permissions required for work in UXO areas. When appropriate permissions are acquired, more surveys of this area will be conducted as a priority action. Currently at MMR, `Elepaio are known from Kahanahaiki and Lower Makua MUs and the East Rim Ungulate Control Area (UCA). `Elepaio were known to exist in Kaluakauila in 1999 but have disappeared from this area since. A total of 13 `Elepaio currently exist within MMR. Of these birds there are three pairs.

Figure 4.1 `Elepaio Distribution in Makua Military Reservation



Some of the known birds within MMR have been captured and had color-bands placed on their legs. These color bands assist NRS in monitoring. Table 4.1 lists the color bands for the birds from MMR. Seven of the known thirteen birds are banded.

Table 4.1 Bird Banding Data, Makua Military Reservation

Bird	Date Banded	Last Observed	Last Monitored	Disease	Mate Observed	Range or Gulch	Sex
ARRB	3/4/96	3/4/01	2/7/02	Y	N	Kahanahaiki	M
GBAR	3/4/96	5/26/04	5/26/04	Y	Y	Kahanahaiki	M
BABW	3/4/96	6/12/03	6/12/03	Y	Y	Kahanahaiki	F
BGAW	3/4/96	12/9/99	3/18/02	Y	N	Kahanahaiki	M
ABBB	12/11/01	5/5/04	5/5/04	N	Y	Lower Makua	M
ARGB	12/03/02	8/21/03	5/5/04	Y	Y	Lower Makua	M
AGWR	5/5/04	5/5/04	5/5/04	Y	Y	Lower Makua	F

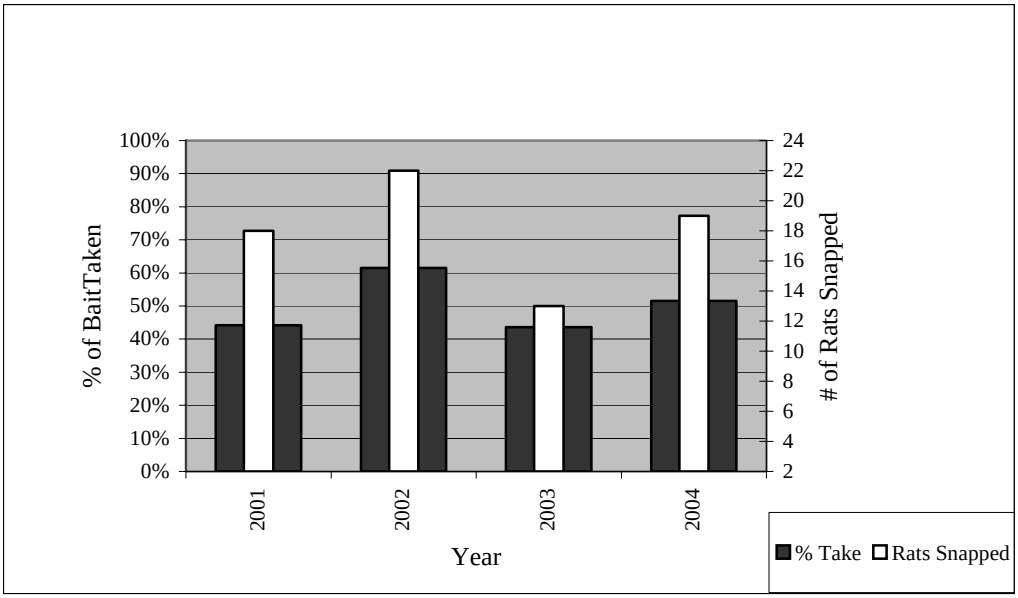
Bird column: A=Aluminum, R=Red, B=Blue, G=Green and W=White color bands.

2. Management Unit Discussions.

Lower Makua MU

Currrently, NRS know of eight `Elepaio in the Lower Makua MU. Of these birds there are two pairs. In 2001, NRS initiated predator control efforts for one pair and began control efforts after a second pair was discovered in 2002. From 24 December 2003 to 16 June 2004, NRS again implemented predator control efforts during the `Elepaio breeding season in Lower Makua. Twelve Protecta® rodent bait stations and 24 Victor® rattraps were deployed throughout both territories. A total of 633 blocks (17.95 kg) of molasses/peanut-butter flavored Ramik® Mini Bars (.005% diphacinone) were taken from bait stations. The total bait consumed was 45.9% of the total bait put into the bait stations. A total of 19 rats were caught in snap traps during the breeding season with an average of 4.8 rats per monitoring trip (4 monitoring trips). Rodent control efforts from 2001 through 2004 are shown in Figure 4.2. Nesting success of the two pairs of `Elepaio in this region is uncertain since fledglings were never observed. NRS was able to band one female of a pair on 05 May 2004 (see Table 4.1). The female was observed to have a brood patch and avian pox lesions on one wing and foot. NRS fear this infection may be lethal. After the female was released, the active nest was found. The stage of the nest was unknown due to the height of the nest. The success of the nest was uncertain since fledglings were not observed on the next visit 15 June 2004. An attempt to band the female of the second known pair was unsuccessful. No nesting attempts for this pair were observed during the four monitoring trips taken during 2004.

Figure 4.2 Lower Makua Rodent Control 2001- 2004



Kahanahaiki MU

Currrently, NRS know of four `Elepaio in the Kahanahaiki MU. Of these birds there is one pair. In 1996, three males and one female were banded. Since that time BGAW (see Table 4.1) has not been detected, and this bird is thought to be dead. ARRB was last observed in 2001. A bird

was heard in his territory in 2003, but NRS was unable to determine whether or not it had bands. The pair GBAR and BABW nested in 1996 and 1997 without successfully fledging a chick. Predator control was begun in 1998 and this pair was able to successfully fledge a chick that year. Predator control continued in 1999 and 2000, but there was no observable fledging success. In 2001 and 2002, one and two fledglings were observed respectively but NRS are unaware of where they may have gone. NRS observed the pair nesting two times in 2003. The first attempt appeared unsuccessful, but the second resulted in a fledgling. NRS attempted without success to band the fledgling. In 2004, the pair had at least two nesting attempts. The first nest was observed in the final stages of construction on 11 February. This nest appeared to have failed with no subsequent activity observed at this nest after numerous checks. A second nest was found on 26 May in the final stages of construction. Two nestlings were observed being fed in the nest by both parents on 28 June. At least one fledgling was observed on 14 July. Confirmation of both nestlings and fledglings has been difficult to ascertain because of the secretive nature of `Elepaio fledglings and the limited number of NRS visits to the area. Attempts to locate the fledgling(s) will continue.

Predator control was implemented again this year from 06 January through 01 August 2004. It entailed bi-monthly maintenance of 12 Protecta® rodent bait stations, 12 Victor® rattraps, and four Tomahawk® live traps. Prior to annual predator control in this area, a graduate student of the University of Hawaii maintained bait stations and snap traps monthly from 20 August 2003 through the start of the annual baiting season. The stations were maintained during this time to prevent predation of outplanted plant seedlings. A total of 1015 blocks (28.8 kg) of molasses/peanut-butter flavored Ramik® Mini Bars (.005% diphacinone), were taken from bait stations. The total bait consumed was 68% of the total bait put into the bait stations. A total of 17 rats were caught in snap traps, with an average of 1.4 rats caught per monitoring trip (12 monitoring trips). A mongoose, feral cat, and Erckel’s Francolin (*Francolinus erckelii*) were caught in Tomahawk® live traps in 2004. Figure 4.3 shows the results of the rodent control efforts during the 2004 breeding season. Bait take remained consistently high through most the breeding season with few rats being caught in snap traps. Predator control efforts from 1998 through 2004 during the `Elepaio breeding season are shown in Figure 4.4. The bait take this year at Kahanahaiki was almost two times as high as years previous. NRS attribute this spike in take to the extremely wet year. The abundant rainfall may have increased fruit production in the forest, thereby increasing rat numbers.

Figure 4.3 Kahanahaiki Rodent Control Results, 2004

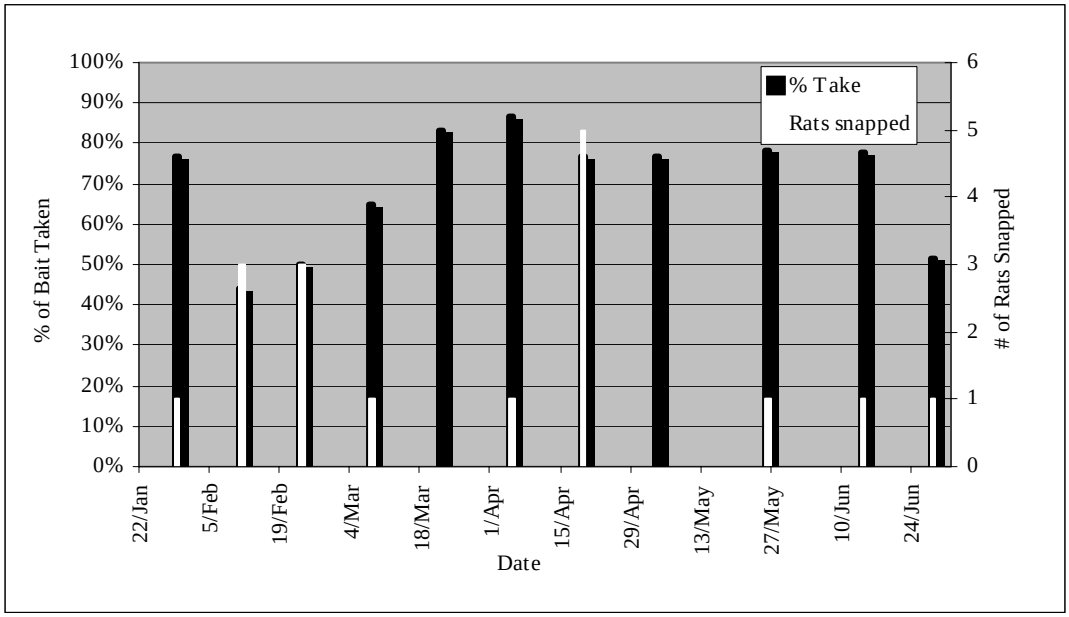
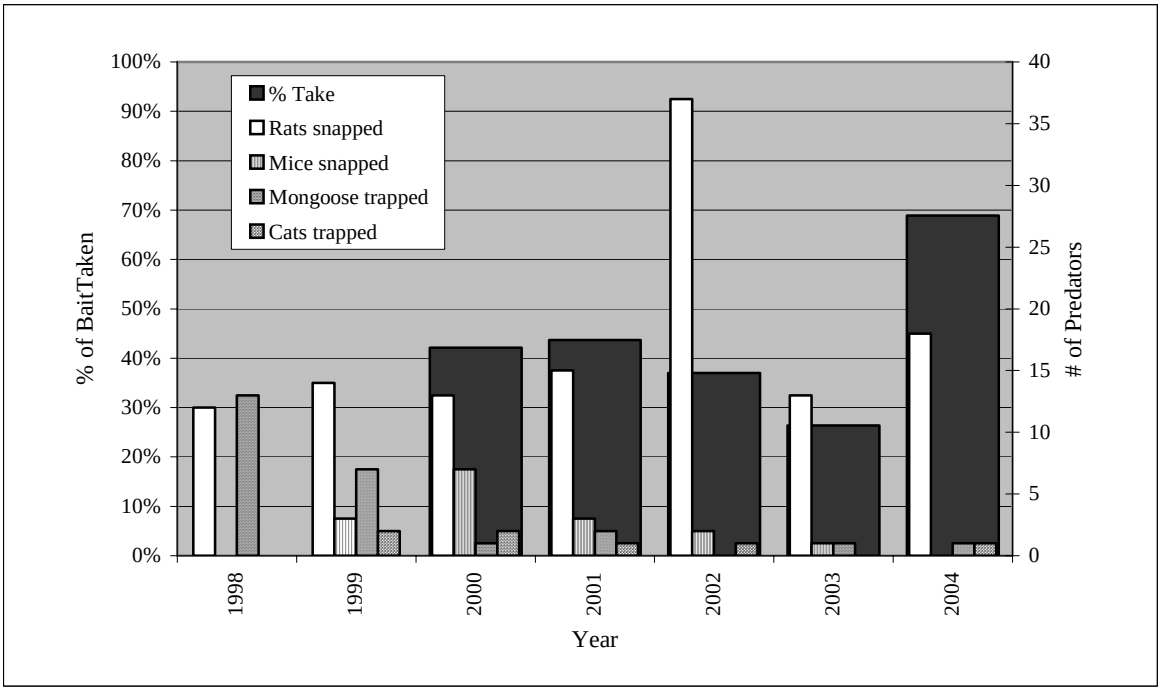


Figure 4.4 Kahanahaiki Predator Control Efforts, 1998-2004



Makua Action Area outside MMR Boundary

1. Management Unit Discussions

Pahole Natural Area Reserve

During the spring of 2004 NRS spent a couple of days surveying for `Elepaio throughout Kapuna, Keawapilau, and Pahole Gulches. Special emphasis was paid to locations of known birds in order relocate them. Playbacks were used but no birds were detected.

Makaha Management Unit

Although NRS are not working with any of the `Elepaio from the north side of Makaha Valley in the MMR Action Area, NRS have become involved in the management of some `Elepaio outside the action area on the south side of Makaha Valley. At least two pairs and three single males of `Elepaio are known from an area where a proposed fence to protect endangered plants will be constructed in the coming year. The fencing of this area is a joint project between the Honolulu Board of Water Supply (BWS) and the Army. In 2004 NRS assisted in banding three birds in order to facilitate monitoring. NRS will assist BWS with predator control operations being conducted during the breeding season for both pairs. NRS will conduct surveys to locate additional birds in the area.

Mokuleia Forest Reserve (Kuaokala)

Surveys were conducted along forested gulches within the Kuaokala area in February of 2001. During these surveys three birds were observed. Two of these birds were a mating pair. In addition one lone male was observed in 2000 below the State’s Nike Site Facility and has not been observed since. The State of Hawaii, Wildlife Program has continued monitoring these birds. In the last year none of the birds could be detected (E. Shiinoki, pers. comm., August 2004). NRS will assist DOFAW in additional surveys in Kuaokala in the up coming year and will assist DOFAW with predator control if any `Elepaio are re-discovered. The Kuaokala birds are very important to the conservation of `Elepaio in the Waianae Mountains because they represent the northwestern most birds. In addition the fire of July 2003 burned into Kuaokala in a number of places. Measures should be taken to ensure that these birds are not impacted by fires from MMR training.

Keaau Game Management Area

NRS have not conducted surveys for `Elepaio within Keaau.

5.0 RARE PLANT STABILIZATION PLAN STATUS

Example Species Status Summary

Requirements for Stability:

This section defines requirements for reaching stability for each taxon. This section has not changed from the final Makua IP.

- 3 population units (PUs)
- [25-100] reproducing individuals in each PU (justification for number of individuals; life span, life form, other factors)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon-Level Discussion

The taxon-level discussion covers three main topics related to taxon status:

1) A justification is given for which sites were chosen to be 'manage for stability'. If more than one of the 'manage for stability' PUs is in the action area, this is also justified.
2) An overview of taxon threats is discussed.
3) The prognosis for reaching stability and the challenges to reaching stability are discussed. Challenges include taxon threats, plant propagation options, and unique species traits (such as managing all three types of *Hibiscus brackenridgei* subsp. *brackenridgei*).

Example 'Taxon Status' Table

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Kahanahaiki and Pahole	Manage for stability	7	10/0	0/15	10/15
Out of AA					
Palawai	Manage for stability	New population	6/0	None	6/0
Makaha	Genetic storage	13/1	8/3	None	8/3
Kaaikukai	Genetic storage	1	0	None	0
Reintroduction					
Central and East Makaleha	Manage reintroduction for stability	N/A	N/A	0	0

This table covers the current status of *in situ* and outplanted plants. Population units are grouped into extant PUs in the action area (AA) and out of the AA, and new PUs established via reintroductions.

Population Unit: Population units were modified based on changes agreed upon by the IT at the April 2004 meeting. Where PUs were merged, the names of the former PUs were combined, i.e. the separate population units 'Kahanahaiki' and 'Pahole' are now 'Kahanahaiki and Pahole'. None of the original PUs were divided.

Management Designation: Management status is based on changes agreed upon by the IT at the April 2004 meeting, and thus may be different from the final Makua IP. All population units are either 'manage for stability' or 'genetic storage'. The 'manage as a propagule source' category has been eliminated.

No. of plants in final IP (mature/immat.): The number of individuals, as reported in the final Makua IP. In the IP, where the number of immature individuals was unknown, no information was recorded in this field. For this report, the number of immature individuals is always reported, so either the number of immature plants or a '0' is recorded. Where population units were merged, numbers were tallied. For populations discovered since the final Makua IP, 'new population' was entered into this column.

NRS monitored plants (mature/immature): The number of individuals for many of the PUs has changed from what was reported in the final Makua IP. Often those changes are due to more accurate monitoring of the population, rather than an actual change in plant numbers. Included in the 'Population Unit Level Discussion' is an explanation for any change in numbers.

Augmentation (mature/immature): The numbers of individuals NRS or partners (TNC, the State NARS staff) have outplanted into a PU. The number represents reintroductions into the PU rather than reintroductions of genetic stock from that PU. In most cases, reintroductions into a PU will be from that PU's genetic stock. Exceptions are discussed in the text.

Total number of mature/immature: The sum of the updated numbers of *in situ* plants, and the number of augmented individuals. This number shows how close each PU is to reaching the stability number of individuals. In a few cases, the final Makua IP number rather than the NRS monitored number of individuals was tallied with the augmentation number to obtain the total number of individuals. This only occurred for PUs where NRS were not able to complete a thorough monitoring of the PU, and final Makua IP numbers were believed by NRS to be a more accurate representation of the PU's current status.

Genetic storage

The status of seed storage testing and an overview of seed storage collections are discussed in this section. Other storage techniques, such as living collections in micropropagation or a greenhouse are also discussed. The relative success rates of the different techniques and general recommendations for future genetic storage efforts are given.

Example 'Genetic Storage of In-situ Plants' Table

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Kahanahaiki to Pahole	Manage for stability	10/0	5	0	2	4
Out of AA						
Palawai	Manage for stability	6/0	1	0	4	0
Makaha	Manage for stability	8/3	0	3	0	0
Kaaikukai	Genetic storage	0	1	0	0	0

This table shows the status of NRS's and NRS partners' (including TNC, BWS, and the State of Hawaii) collections. The 'Population Unit' and 'Management Designation' columns are the same as in the 'Taxon Status' table above. The number of plants represented in storage may be larger than the number of wild plants because collections from now dead wild plants are included.

Total number of *in situ* mature/immature: This column lists the number of mature *in situ* plants. This number does not include the number of outplanted individuals, because collection goals in the final Makua IP were for wild plants only. This column is generally the same as the 'NRS monitored plants' column in the table above, however, in a few cases, the final Makua IP number rather than the NRS monitored number of individuals was recorded here. This only occurred for PUs where NRS were not able to complete a thorough monitoring of the PU, and final Makua IP numbers were believed by NRS to be a more accurate representation of the PU's current status.

Number of plants with >25 seeds in storage: According to the plant stabilization plans, for taxa where seed storage is the preferred genetic storage method, up to 50 seeds should be collected from each plant for storage. Because it is in the early stages of implementation, NRS felt it was important to show all plants that were at least halfway to this goal. This column shows the number of *in situ* plants with greater than 25 seeds in storage. Plants that were collected from but have since died are also included in this tally if >25 seeds are currently in storage. This column does not show the total number of seeds in storage (in some cases thousands of seeds have been collected from one plant). Where large numbers of seeds have been collected, more information is included in the text.

In cases where collections have been made from outplanted individuals, a separate column was included in the table titled 'Number of *ex situ* or *intersitu* plants with >25 seeds in storage'. This column shows seed collections from outplanted individuals within a PU. Source stock of the outplanted individuals is discussed in the text.

Number of plants with rep.'s in microprop: The number of *in situ* plants with at least one propagule in storage in Lyon Arboretum's micropropagation facility is recorded in this column.

Number of plants with rep.'s in the nursery: All *in situ* plants that currently have at least one representative in the Army nursery or at the Pahole Nike site nursery are recorded in this column. Not all of these plants are in storage as living collections; many of them are in the nursery temporarily until they are ready for outplanting. Plants that were recently propagated and are still growing in the mist house are not yet in the nursery inventory.

Number of founders with rep.'s outplanted: This column lists the number of *in situ* plants that have representatives from their stock outplanted. Propagules collected from outplanted individuals, or progeny of outplanted individuals that are subsequently outplanted into the wild, are not included in this tally. When it is not known how many individuals served as founders for an outplanting (as is occasionally the case with outplantings conducted with NRS partner programs) '1+' is recorded in this field.

Propagation/Germination Techniques

This section is a discussion of the relative success rates of the various propagation techniques that have been tested for each taxon. These include seed germination, or vegetative propagation via cuttings, clones or air-layers. If NRS have experimented with unique propagation methods, a more detailed discussion of observations and results is included.

Unique Species Observations

Any unique features of a taxon's morphology, phenology, ecology, or pollination biology observed by NRS are discussed here. Post-fire observations for species that have been affected by fire in the last couple years are also discussed in this section.

Outplanting Issues

Observations of outplantings conducted by NRS or NRS partners are discussed here. Among the topics included are: choosing outplanting sites; the best size of plants for outplanting; outplanting success rates; post-outplanting care conducted or possibly needed for future outplantings; time to maturity and establishment of any F1 individuals.

Research Issues

For many of the taxa, stability is limited by a lack of threat controls. In many cases, NRS will support further research into discovering and implementing control methods. For example, NRS are currently supporting research into black twig borer and slug control methods. For some taxa research into pollination biology or better seed storage methods are recommended. In addition, any past or ongoing research projects are discussed, such as genetic research or pollination biology studies.

Surveys

Surveys conducted over the last two years as a part of Urgent Actions 1, 2 or 3 are discussed here, along with any surveys conducted by NRS.

Taxon Threats

Threats such as weeds, ungulates, invertebrates, fire, or trampling are discussed in this section. Problematic weed species were cited. A discussion of NRS's progress in controlling threats to the taxon was also included.

Population Unit Level Discussion

In this section, the status of the population units is discussed. This section is split into two parts. In the first part, 'Manage for Stability PUs', each 'manage for stability' PU is discussed. Any large changes in numbers of individuals from the final Makua IP are explained. NRS management efforts at the PU are discussed, including any collections, augmentations, fencing, or weeding in the vicinity of the PU. Weed control is reported as person hours spent weeding from the period between January 2003 and September 30, 2004.

In the second section 'Other PUs', all other PUs are discussed. If NRS have not visited a site in the last two years collection, there is no discussion for that PU.

Example 'Population Unit Management' Table

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Kahanahaiki to Pahole	Manage for stability	Partial	Yes	No
Out of AA				
Palawai	Manage for stability	Yes	Partial	No
Makaha	Manage for stability	No	No	No
Kaaikukai	Genetic storage	No	No	No

This table shows the status of NRS's threat control efforts at all PUs. The 'Population Unit' and 'Management Designation' columns are the same as in the 'Taxon Status' table above. If no individuals have been outplanted into the reintroduction site, as in this example (see 'Example Population Unit Status' table above), it is unlikely a site has been selected, and therefore threat information cannot be discussed. Columns are shaded if there is a threat present that warrants threat controls. 'Partial' indicates that the threat is controlled over a portion of the population unit.

Fenced: 'Yes' is entered into the column if all of the individuals in the PUs are fenced. If some of the individuals are outside of a fence, it is recorded as 'partial'.

Weeds managed: In most areas, NRS conduct weed management on a PU scale. 'Yes' is entered into this column if weed management has been conducted specifically for this taxon and around the entire PU. 'Partial' is entered into the column if weed control has been conducted around a

portion of the PU, or habitat-level weed management has been conducted in the vicinity of the PU. If more than one rare taxon is found in an area where weed control has been conducted, the time spent weeding is counted for each taxon (and thus the overall time is double-counted).

Rats controlled: This column is shaded only if rats are a documented threat to the taxon. If rat predation is observed at any single PU, the taxon as a whole is considered threatened by rats. 'Yes' is entered into this column if a rat-baiting and snap trap grid is set up around the entire PU. 'Partial' means rat control is in place for a portion of the PU, or is in place for another species in the vicinity of the PU, but the PU directly benefits from the rat control project.

5.1 *Alectryon macrococcus* var. *macrococcus*

Requirements for stability:

- 3 population units (PUs)
- 50 reproducing individuals in each PU (long-lived perennial with reproductive problems)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon-Level Discussion

Alectryon macrococcus var. *macrococcus* is diffusely distributed throughout the Waianae Mountains. The MIT chose the largest populations in the best habitats for management. Only one of the PUs is within the action area, the Kahanahaiki to Pahole to Kapuna to West Makaleha PU. This PU covers one contiguous area and thus will be treated as one effort. This year NRS conducted surveys for more individuals in Makaha PU and the Kaluaa to Waielu PU. NRS have observed little recruitment of this species in the wild. Therefore all of the 'manage for stability' PUs will be augmented once a black twig borer control method is established. This taxon will be difficult to stabilize. Trees are widely distributed. Most of the trees observed this year were in poor condition, and many were dead. All trees appeared to have been impacted by the black twig borer. No viable method for controlling the black twig borer has been found, and this invertebrate threatens all trees of this species. Few trees flower and even fewer produce fruit. Vegetative propagation can be done by air-layering, but this method is labor intensive and only about 10% of the air-layers are successful.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Kahanahaiki to West Makaleha	Manage for stability	55/4	43/4	0/6	43/10
Makua	Genetic storage	15	17/0	None	17/0
South Mohiakea	Genetic storage	16/1	15/1	None	15/1
Out of AA					
Central Kaluaa (to Central Waieli)	Manage for stability	50-55/3	50/1	None	50/1
Makaha	Manage for stability	75+/2	35/0	None	35/0
Waianae Kai	Genetic storage	16	16/0	None	16/0

Status of genetic storage

Seed collection is very difficult for this species as very few trees produce viable seeds, and seeds do not mature at the same time. In addition, seeds are vulnerable to rat and invertebrate predation. Seventy-two seeds were collected from one prolifically fruiting tree in Makaha this year and taken to Lyon Arboretum for seed storage testing. Unfortunately, most seeds appeared to have been eaten by the larvae of an unidentified insect. The seeds showed signs of predation and most floated in water, which suggests they are not viable. Because seed storage is difficult, NRS have been experimenting with other methods of propagation for storage of *Alectryon*. Micropropagation is not a good storage method for this taxon because it is not possible to subculture plants, and because plants soon become too large to store in vials.

Genetic Storage of *In-situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ Immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Kahanahaiki to West Makaleha	Manage for stability	43/4	0	0	0	0
Makua	Genetic storage	17/0	0	0	0	0
South Mohiakea	Genetic storage	15/1	0	0	1	0
Out of AA						
Central Kaluaa (to Central Waieli)	Manage for stability	50/1	0	0	0	0
Makaha	Manage for stability	35/0	0	0	0	0
Waianae Kai	Genetic storage	16/0	0	0	0	0

Propagation/germination techniques

Propagation from seeds has not been successful, so grafting, air-layers, cutting, and micropropagation have been attempted. This year, multiple attempts were made to graft tip cuttings onto an *ex-situ* tree using material collected from MMR stock. Grafts were also attempted using tip material collected from the same tree. None of these preliminary grafting trials were successful. NRS installed several air-layers on this tree this past year. Several have produced roots and have been collected from the tree. In addition, one air-layer was successful this year on a tree in Mohiakea. Only about 10% of the air-layers are successful, in part because they get attacked by black twig borers. NRS will attempt to refine this technique on other trees in the coming year. Cuttings from this taxon have not been successful. Seeds have been successfully started in micropropagation, and have been grown in the greenhouse and outplanted.

Unique Taxon Observations

This taxon has both small (1 cm diameter) and large (5 cm diameter) fruited trees. The Makua populations are small-fruited and more closely resemble the Kauai trees. The Kaluaa and Waieli trees have very large fruit (5 cm). This taxon does not produce many fruit. Even within one population of mature trees, not all of the trees produce fruit. NRS have observed many dead trees in the last couple years, suggesting a recent large-scale decline. It is important to get genetic representation from all of the PUs as soon as possible because this taxon is in rapid decline.

Outplanting Issues

Because there is low recruitment, all of the 'manage for stability' PUs will be augmented once black twig borer controls are in place. Augmentations will be done using stock from all of the Waianae Mountains. The Kahanahaiki to West Makaleha PU was augmented at a site in Kahanahaiki in December 2002 using stock from the Makua PU. The plants were drenched with the systemic insecticide Merit twice in the year after planting. This treatment interval was not sufficient and plants were attacked by black twig borers. Since then, the plants have been treated four times per year. This interval of insecticide application may be more effective at keeping the plants free of black twig borer. Eight of nine plants have survived, though few are healthy. NRS will continue to treat these outplants quarterly in the coming year.

Research Issues

In order for this species to become stable in situ, a sustainable method for controlling black twig borer will need to be found. NRS submitted a research application with USGS to fund black twig borer research projects. NRS is also working with the University of Hawaii to fund a research project. Research should also be conducted on seed viability. Seeds were sent to the National Seed Storage Laboratory (NSSL) this year for storage testing in liquid nitrogen. Unfortunately the initial germination tests found that none of the seeds were viable, so no storage testing could be conducted. This year's seed collection had heavy insect predation. Research should be conducted on pollinators, and whether the plants are cross-pollinating or self pollinating. *Inter-situ* sites such as Botanical Gardens should be considered as potential sites for conducting research.

Surveys

No Urgent Action surveys were conducted for this taxon. Incidental observations were made by the HINHP contract botanist while on surveys for other species. In addition, NRS surveyed for *A. macrococcus* in Makaha and Kaluaa and Waieli this year, but did not find any new trees.

Taxon Threats

The most serious threat to *A. macrococcus* is the black twig borer. All trees of this taxon are being affected by the black twig borer to some degree. NRS have attempted controlling the black twig borer on *in situ* trees by using microinjections of the insecticide Avid, but this was not

successful. Greenhouse experiments are underway attempting to separate the effects of the black twig borer from the effects the fungus it carries. A researcher from the University of Hawaii, Jenny Davidson, is currently culturing fungus from infected twigs of *A. macrococcus* collected in Kahanahaiki. Once the culture is separated, some trees will be inoculated with the fungus culture, while other trees will have simulated black twig borer damage. Greenhouse staff will monitor the trees and report results.

Rats and invertebrates prey on the seeds of this taxon and reduce seed viability and germination. NRS have rat bait stations around trees in Makaha and Central Kaluaa (the baits are in conjunction with ‘Elepaio management).

Population Unit Level Discussion:

Manage for Stability PUs:

Kahanahaiki to West Makaleha: Many areas in this PU were monitored in 2004, but not all trees in this PU were revisited. This number reflects NRS’s most current count, which is not a complete count of the PU. Few of the trees have been observed flowering and fewer have been observed with mature fruit. Most of the trees show significant damage from the black twig borer. All of the Pahole trees, but none of the Kahanahaiki or West Makaleha trees, in this PU are fenced. The Kahanahaiki and West Makaleha trees are scheduled for fencing in year 1 and year 2 of the MIP, respectively.

The two mature trees in Kahanahaiki are in moderate health. NRS revisited three mature trees in the East Rim MU in April of 2004. They were in moderate health and had no flowers or fruits. NRS has just recently begun to work with this species in Pahole. In Pahole there are approximately 7 mature trees, all fenced, and no juveniles or seedlings are known (T. Takahama, pers. comm.). NARS staff know of more sites, but report that there are presently no healthy reproductive trees in Pahole. Most trees are in poor condition. NRS will monitor trees for threats and fruit production and consider trying to collect from these trees for storage. In West Makaleha there is a more robust population of *Alectryon* with 36 matures and four immature trees. NRS monitored these plants in the last year. NRS are in discussion with NARS biologists regarding the construction of a large-scale fence in this area, currently scheduled for year 2 of the MIP. NRS will continue to monitor these plants in the coming year.

This PU was augmented in 2002 with stock from Makua. Eight of the original nine plants are still alive, though few are healthy. NRS will continue to monitor the plants and drench them quarterly with Merit. NRS spent 8 hours weeding around these plants this year. Target weeds included *Oplismenus hirtellus, Paspalum conjugatum, Psidium guajava,* and *Grevillea robusta.*

Central Kaluaa to Central Waieli: NRS conducted status surveys in the Central and South branches of Kaluaa this year. Locations reported by TNC staff were revisited and new areas surveyed. A total of 32 mature trees and two seedlings were observed. Currently, 16 mature trees and two seedlings are known within the Kaluaa fence. There are additional areas to search and NRS believes that more individuals will be discovered. Most individuals were in poor health

and no fruit or flowers were observed. Many recently dead trees were observed. NRS will continue to search for and monitor individuals.

A formal survey of Waieli has not been conducted, however, in the years following 2000, six individuals were observed in Waieli by TNC, NRS, and HINHP staff. NRS will conduct surveys in South Waieli in late 2004.

Makaha: NRS presently know of about 15 plants in Makaha and believe that there are more to be found. Unfortunately, many of these trees are in poor condition, and many dead trees were seen as well. NRS will continue to search for additional trees and monitor known individuals in the coming year. NRS scoped a large-scale fence in Makaha this year that will protect 12 of the trees in this PU from ungulates. Once the proposed Makaha fence is constructed, extensive surveys and monitoring of this taxon in the fenced area will take place. One of the most prolifically fruiting trees NRS has ever seen is located in Makaha. NRS visited this individual in July 2004 and collected 72 mature fruit. This collection is significant because it is large enough to perform storage testing on. However, when this collection was submitted to the Lyon Arboretum for storage testing it was discovered that almost all of the seeds or embryos had invertebrate predation. This year NRS will bag immature fruit to exclude invertebrates and hopefully increase seed viability. In addition, some immature fruit will be collected and taken to Lyon Arboretum's micropropagation laboratory to determine if better seed viability can be achieved than with mature fruit.

Other PUs:

Makua: Plants were monitored in 2002 and 2004. The four trees on Ohikilolo were monitored in the last year and cuttings were brought to the Army Nursery. The cuttings were not successful. In the coming year, NRS will air-layer these trees as they are declining rapidly. NRS have chainsaw cleared and applied the herbicide Garlon to *Schinus terebinthifolius* trees around the *A. macrococcus* trees at this site.

South Mohiakea: A recent thorough count of this population has not been done, but one tree was observed dead last year. NRS continues to find rat predated fruit around these trees, however, controlling rats with bait requires frequent re-stocking and this is not feasible given access restrictions. Three air-layers were put onto one tree in May 2003. Two of the air-layers died, but one had grown roots and was collected in May 2004 (see Figure 5.1 below). This air-layer is now established at the Army Nursery in a 3-gallon pot and is over 2 meters tall.

Figure 5.1 *Alectryon macrococcus* Air-layer

Inter-situ sites: Trees were outplanted at Waimea Botanical Garden this year. NRS assist Waimea staff with monitoring the trees and drenching them with Merit quarterly. The trees appear to be healthy.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Kahanahaiki to West Makaleha	Manage for stability	Partial	Partial	No
Makua	Genetic storage	Yes	Partial	Partial
South Mohiakea	Genetic storage	No	No	No
Out of AA				
Central Kaluaa (to Central Waieli)	Manage for stability	Partial	No	Partial
Makaha	Manage for stability	No	No	Partial
Waianae Kai	Genetic storage	No	No	No

5.2 *Alsinidendron obovatum*

Requirements for Stability from MIP:

- 3 population units (PU)
- 100 reproducing individuals in each PU (short-lived perennial which is prone to large fluctuations)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

The three PUs for *A. obovatum* are composed of six sites. Only two of these six sites have extant individuals. The other fours sites are no longer extant but are represented in *ex situ* collections of seeds or plants and in some cases in reintroductions in wild areas. Since there are so few remaining populations of this taxon, NRS are managing all sites that are extant or from which there is stock available. The table below outlines the population unit boundaries as defined in the April 2004 MIT meeting. NRS are managing stock from three sites within Kahanahaiki and Pahole as one PU. Similarly, the historical Keawapilau and extant North West Makaleha populations and West Makaleha sites are treated as one PU. The West Makaleha population is small and will probably require augmentation using stock from North West Makaleha.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Kahanahaiki to Pahole	Manage for stability	0	0	65/25	65/25
Keawapilau to West Makaleha	Manage for stability	3	21/12	None	21/12
Reintroductions					
Makaha	Manage for stability	N/A	N/A	0	0

Genetic Storage

Alsinidendron obovatum is the only taxon from the MIP for which there is significant seed storage data. Since 2000, NRS have collected 327,553 seeds of Kahanahaiki to Pahole stock. Reintroduced plants have proven an excellent source of seed for storage. Also *ex situ* plants in greenhouses can be used for sources of seed. Dr. Steve Weller at U.C. Irvine has valuable stock represented in his greenhouse, which can be used in stabilizing this taxon. *A. obovatum* stores well under refrigeration and freezing. After five years of storage in refrigeration germination is over 80%. Populations of *A. obovatum* in the wild have been known to disappear for a number of years and then reappear after large rainfall events. It seems that their ability to persist in the seed bank for long periods of time maintaining viability gives them good characteristics for

successful seed storage. The results of storage trials conducted at the Lyon Arboretum are included as Appendix 1: Lyon Arboretum Seed Storage Trials. The preferred seed storage technique for *A. obovatum* is under refrigeration (4ºC) with 20% humidity (pers. comm., L. Weisenberger 2004).

Genetic Storage of *In Situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ Immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted	Number of *ex situ* or *intersitu* plants with > 25 seeds in storage
In AA							
Kahanahaiki to Pahole	Manage for stability	0	3*+	1	1+	4	48/30
Keawapilau to West Makaleha	Manage for stability	24/12	17	1	3+	0	30/1+

Propagation/Germination Techniques

A. obovatum germinates best at least six months post harvest (pers. comm. Dr. Steve Weller 2004). Germination in vermiculite and perlite and on wet paper towels is very successful. One attempt at rooting plants via cutting was made and it was successful.

Unique Species Observations

A. obovatum has been known from five locations in recent years. NRS have observed significant inter-population variation in *A. obovatum* morphology. The leaf length between populations varies from approximately two to eight centimeters. The North-West Makaleha site, which is by far the largest extant population, has the greatest intra-population leaf size variation. There are plants with both large and small leaves in this population. Another strange variation that has been observed is the age at which branching begins. Some stock begins to branch almost immediately but other stocks maintain one main growing point for a longer time and branch much later. NRS thought that these characteristics were unique to individual populations until the NW Makaleha population was found. NRS is perplexed by the presentation of both these seemingly distinct types in one population. These variable characteristics could affect the adaptive nature of any population.

Outplanting Issues

A. obovatum out-plantings have been underway since 1999. Since this time NRS have reintroduced stock from three populations. Stock from Kahanahaiki was outplanted into four sites in the Kahanahaiki MU. These sites were all founded from the lone Kahanahaiki individual plant. NRS assisted NARS with one outplanting of Pahole stock into Pahole Gulch. This site contains six, sixteen and two plants respectively from three separate founders and twenty-four plants of unknown parentage but from the same Pahole Population. NRS will continue to work

with NARS staff to equalized the founders represented at this population. One inadvertent reintroduction of West Makaleha stock was made into Kahanahaiki as part of the slug research conducted by a University of Hawaii graduate student. This West Makaleha stock was planted side by side with Kahanahaiki stock. These outplants are from an unknown number of founder plants.

These reintroductions have provided an interesting comparison of the various *A. obovatum* founders. Reintroduced Kahanahaiki material has always seemed fairly successful until NRS were able to observe the performance of the two other stocks in comparable sites. The vigor of the Kahanahaiki stock is fairly poor as compared to the Pahole and West Makaleha stocks. In the slug plots, Kahanahaiki founder plants have very few leaves and these leaves are often tattered. In these same plots the South-West Makaleha plants are growing vigorously, are fully foliated and leaves have little or no damage. In addition, the Kahanahaiki stock begins branching right away after outplanting but the West Makaleha stock has not begun branching at all. It is difficult to say what advantage any of these traits may carry but it certainly seems that, based on these observations, there is significant justification for mixing stock from 'closest neighbor' populations into sites where there are currently limited founders. NRS have not mixed stock previously because *A. obovatum* is thought to be a facultative selfer and that inbreeding depression may not affect this taxon significantly. However, considering the observations in the field, NRS will revisit our assumptions about mixing for *A. obovatum*. NRS will mix stock in order to determine whether a mixed site would produce more vigorous seedlings. NRS will mix Pahole stock with Kahanahaiki stock to begin. Stock is available from at least three founders from Pahole gulch.

This year NRS coordinated with Dr. Steven Weller at U.C. Irvine to acquire seed stock grown from a historical Pahole Gulch population of *A. obovatum* and from the Keawapilau historical population. Dr. Weller isolated his greenhouse plants from these populations in order to collect pure seed from them. This seed is in propagation in the Army greenhouse and plants that germinate will be used in MIP augmentations/reintroductions. Since the seed of *A. obovatum* are viable for long periods of time, NRS will pursue collecting seeds from Bishop Museum specimens for propagation.

Research Issues

Slug predation of seedlings is a concern for *A. obovatum,* along with a number of other MIP taxa. A graduate student from the University of Hawaii, Ms. Stephanie Joe, is conducting research on this topic in Kahanahaiki with the support of NRS. She is trying to quantify the effect of introduced slugs on *A. obovatum* as a representative of the native Hawaiian plants in the family Caryophyllaceae. NRS supported her with the set-up of her plots and committed one staff person per week to assist in recording data. She has completed her field research and is currently analyzing her data. Preliminary results show that slugs are responsible for about one-third of *A. obovatum* mortality in the seedling stage (pers. Comm. S. Joe). The plants that were used in this study were immature (>10 centimeters) therefore the impacts from slugs may likely be even greater than 33% for seedlings (<10 centimeters).

Surveys

Additional surveys were contracted after the MIP was finalized for *A. obovatum* because of its severe rarity. Historical sites were re-visited and new terrain was covered. Survey work was contracted to the Hawaii Natural Heritage Program's Botanist, Joel Lau. Mr. Lau discovered one new substantial population in North West Makaleha. The closest historical population nearby is the Keawapilau ridge site. In addition, surveys were conducted in the Palehua area in the Southern Waianaes to attempt to re-locate this population but no *A. obovatum* was found.

Taxon Threats

A major threat to *A. obovatum* is predation of seedlings by introduced slugs species. As sited above, research is underway to determine the significance of this threat. This research will provide the support necessary to obtain permission to use slug bait around susceptible species. Rats are cited as a potential threat to this taxon but NRS have never observed any predation to *A. obovatum* plants or reproductive structures. NRS will continue to monitor for any evidence of rat predation at *A. obovatum* populations and respond accordingly. Some of the weed species present at *A. obovatum* populations that are difficult to control include *Rubus argutus* and *Erigeron karvinskianus.* NRS are working to develop effective control techniques for these taxa. Of course feral pigs and goats negatively affect this taxon and its habitat. Control of feral ungulates is essential in managing this taxon effectively.

Population Unit Level Discussion

Manage for Stability PUs:

Kahanahaiki to Pahole: The wild populations in Kahanahaiki and Pahole were gone from the wild by 2001. NRS and NARS staff have visited all of the former wild populations in the past year to check for new seedlings, but none were found. The number of mature plants still remaining in Kahanahaiki from past outplantings is 64. These 64 all come from the lone founder in the Kahanahaiki population. Only one F1 generation plant has ever made it to maturity at a sub-site within Kahanahaiki called "Ethan's". "Ethan's" is also the only site within Kahanahaiki that has immature F1 plants. A possible explanation for this site performing better than the other four within Kahanahaiki is that it is drier and may support fewer slugs (pers comm. S. Joe). The Pahole reintroduction site, which uses Pahole founders, is doing extremely well in comparison to all the Kahanahaiki sites. The Pahole reintroduction site was established in the winter of 2003 and at last monitoring in the summer of 2004 had 18 F1 immature *A. obovatum* and 200+ seedlings. Over the last year, 27.5 hours of weed control effort have been spent controlling a number of weeds including *Psidium cattleianum, Clidemia hirta* and *Rubus rosifolius* around *A. obovatum* reintroduction sites within Kahanahaiki.

Keawapilau to West Makaleha: The Keawapilau wild plants died in 2000. Joel Lau discovered a new population in North West Makaleha in November 2003. It is in the Pahole NAR outside of the large proposed Upper Kapuna fence, so a small fence was constructed around these plants in February 2004. Since that time grass control has been conducted within the fence and along its

perimeter. *Melinus minutiflora* is present in the understory throughout the exclosure. Over the last year, eight person hours have been spent controlling *M. minutiflora* and *Psidium cattleianum* at the NW Makaleha PU. NRS have collected seeds from the NW Makaleha plants and they are in storage. Some of this stock will also be used to re-establish the Keawapilau site. The completion of the Upper Kapuna Management Unit is critical to the stabilization of this PU.

NRS staff visits the three plants at the West Makaleha site regularly, and several seed collections have been made, most recently in June 2004. There were three seedlings present at the site in June 2004. NRS have monitored seedlings through maturity at this population. This site was slated for a small-scale fence but the plants are located on a cliff and there are no direct ungulate impacts to the plants. Pigs severely impact the habitat around this PU and therefore it will be included in a larger fence. PU-level weed control has been conducted around the West Makaleha site. Over the last year, four person hours have been spent controlling a number of weeds including, *Psidium cattleianum* and *Clidemia hirta* around this site. In addition, *Erigeron karvinskianus* and *Rubus argutus* are present at this site. Both these taxa are difficult to control but control techniques developed at Ohikilolo MU will be employed in the future. There is an existing pig exclosure that was constructed to protect *Cyanea grimesiana* ssp. *obatae* near the *A. obovatum* PU. NRS has withdrawn West Makaleha seed from storage to plant within this exclosure. 162.5 hours of weed control have been spent within the *C. grimesiana* exclosure over the past 1.5 years in preparation for a future *A. obovatum* augmentation.

Makaha: Funding has been committed this year to construct a 100-acre pig and goat-proof fence this year, which contains appropriate habitat for *A. obovatum* reintroductions. Management emphasis for this taxon has been on extant populations and historical locations from Kahanahaiki to West Makaleha but once the fence in Makaha is complete and ungulate free, NRS will select and prepare sites for reintroduction.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Kahanahaiki to Pahole	Manage for stability	Yes	Partial	No
Keawapilau to West Makaleha	Manage for stability	Yes	Partial	No
Reintroductions				
Makaha	Manage for stability	No	No	No

5.3 *Cenchrus agrimonioides* var. *agrimonioides*

Requirements for Stability

- 3 population units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon-Level Discussion

The largest populations in the best habitat were chosen for management. Huliwai was not included as 'manage for stability' even though it has more individuals than the Makaha and Waianae Kai PU because the habitat is very degraded. Only the Kahanahaiki and Pahole PU is in the action area. This PU has stable numbers, and plants of all size classes are present. The Waianae Kai portion of the Makaha and Waianae Kai PU is along the ridge, near a popular trail. Stock from the Waianae Kai plants will be reintroduced into the fenced unit in Makaha when the fence is complete. Management of this taxon is going well. It is relatively easy to grow plants from seed, and managed populations recruit well. Reintroductions show a 'J'-shaped curve, with high numbers of seedlings seasonally, and a progressively larger number of plants moving into larger size classes each year.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Kahanahaiki and Pahole	Manage for stability	28/9	66/23	182/57	248/80
Out of AA					
Makaha and Waianae Kai	Manage for stability	9/3	9/2	None	9/2
Central Ekahanui	Manage for stability	20	30/3	None	30/3
South Huliwai	Genetic storage	27	18/0	None	18/0

Genetic Storage

Seeds have been collected from the Kahanahaiki and Pahole PU, and from the Ekahanui PU, for storage. Seed storage testing was done at Lyon Arboretum on 10 seeds in each of three treatments. Refrigeration at 24°C at 20% relative humidity was recommended as the best storage technique. There are currently 138 seeds from six wild plants in storage from Kahanahaiki and Pahole, and eight seeds from one wild plant in storage from Ekahanui. In order to allow as many seeds as possible to germinate in the field, cuttings have been taken from all PUs and brought to the Army nursery to be used for seed production for storage. There are 18 cuttings from 9 plants from the Kahanahaiki to Pahole PU. The Makaha and Waianae Kai population is fully

represented as all the mature plants and one juvenile have representatives in the greenhouse. The second juvenile in this PU was not cloned as it was too small. There are five cuttings from five plants from the Central Ekahanui PU in the greenhouse. Cuttings were collected in September from South Huliwai PU, and will soon be potted.

Genetic Storage from *In-situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Kahanahaiki and Pahole	Manage for stability	66/23	2	0	9	29
Out of AA						
Makaha and Waianae Kai	Manage for stability	9/2	0	0	10	0
Central Ekahanui	Manage for stability	30/3	0	0	5	8
South Huliwai	Genetic storage	18/0	0	0	0	0

Propagation/Germination Techniques

Plants can be grown from seed, and NRS have grown plants from seed to be used in outplantings. Germination testing done at Lyon Arboretum of fresh seeds sown on agar showed a 60% germination rate. It is also very easy to grow plants from cuttings from runners, or from divisions cut off of the root ball. NRS prefer to grow plants from cuttings or divisions for three reasons: 1) a larger seed bank remains in the field, 2) it is much faster to get a mature plant from a cutting or division (approx. 3 months) than from seed (approx. 6 months), and 3) this technique produces clonal stock from wild plants that have not been effected by any selective pressures that may impact greenhouse-germinated plants.

Unique Species Observations

There are no unique observations for this taxon.

Outplanting Issues

Stock from Kahanahaiki was outplanted into two sites in Kahanahaiki. One outplanting of Kahanahaiki stock has been planted into Pahole. Two outplantings have been planted in Kaluaa. More outplantings are planned for this year.

One of the Kahanahaiki outplantings and the Pahole outplanting have shown impressive recruitment. The other Kahanahaiki outplanting was planted beneath strawberry guava trees due to a miscommunication about the outplanting site, and the plants have not done well. NRS will not continue to manage the second Kahanahaiki outplanting. Plants outplanted into sunny gaps

are more rigorous and have high reproductive rates than plants outplanted in the shade. Alien grasses should be controlled in the proximity of the proposed reintroduction sites prior to outplanting. Grass control becomes difficult once *C. agrimonoides* is outplanted because it is susceptible to the herbicides used to control grasses, such as Fusilade.

Research Issues

None at this time.

Surveys

No surveys for this taxon were conducted as part of Urgent Actions. The State NARS biologist rediscovered a population in Pahole this year. In addition, NRS discovered a new population in Kahanahaiki while conducting other resource management projects.

Taxon Threats

The State NARS biologist, Talbert Takahama, has noted seed predation of this taxon. Mr. Takahama collected seeds from the ground and compared them to seeds on the plant, and found that most of the seeds on the ground were empty capsules. During drought conditions in 2001, rats ate stems of this taxon but did not kill any of the plants. NRS have not observed any other rat damage to this taxon. Presumably the rats were searching for water, as it was a very dry year and other species that aren't usually eaten by rats were predated. This taxon grows in areas where alien grasses are prevalent. This makes it difficult to use spray herbicides like Fusilade because the herbicide will kill *Cenchrus* as well as the target grasses.

Population Unit Level Discussion

Manage for Stability PUs:

Kahanahaiki and Pahole: This is a large PU. There are four main sites in Kahanahaiki, three *in situ* and one reintroduction, and two *in situ* sites and one reintroduction in Pahole. Three of the Kahanahaiki sites are located inside the Kahanahaiki fence, and the fourth has just one individual and is outside the fence. The plant outside the fence is both represented in reintroductions inside the fence, and scheduled to be fenced in year 1 of the MIP. Approximately 100 meters separate the three subgroups within the exclosure. See the below map for details. NRS visited one of the *in situ* sites in Pahole this year, and monitored the reintroduction.

Kahanahaiki site 1 (MMR-A): There has been a general increase in the number of plants of all size classes at this site since the fence was installed in 1997. There are currently 7 mature, 1 immature, and 54 seedlings at this site. NRS spent two hours controlling weeds around these plants this year. NRS will continue to collect cuttings to supplement the existing Kahanahaiki augmentation in the coming year.

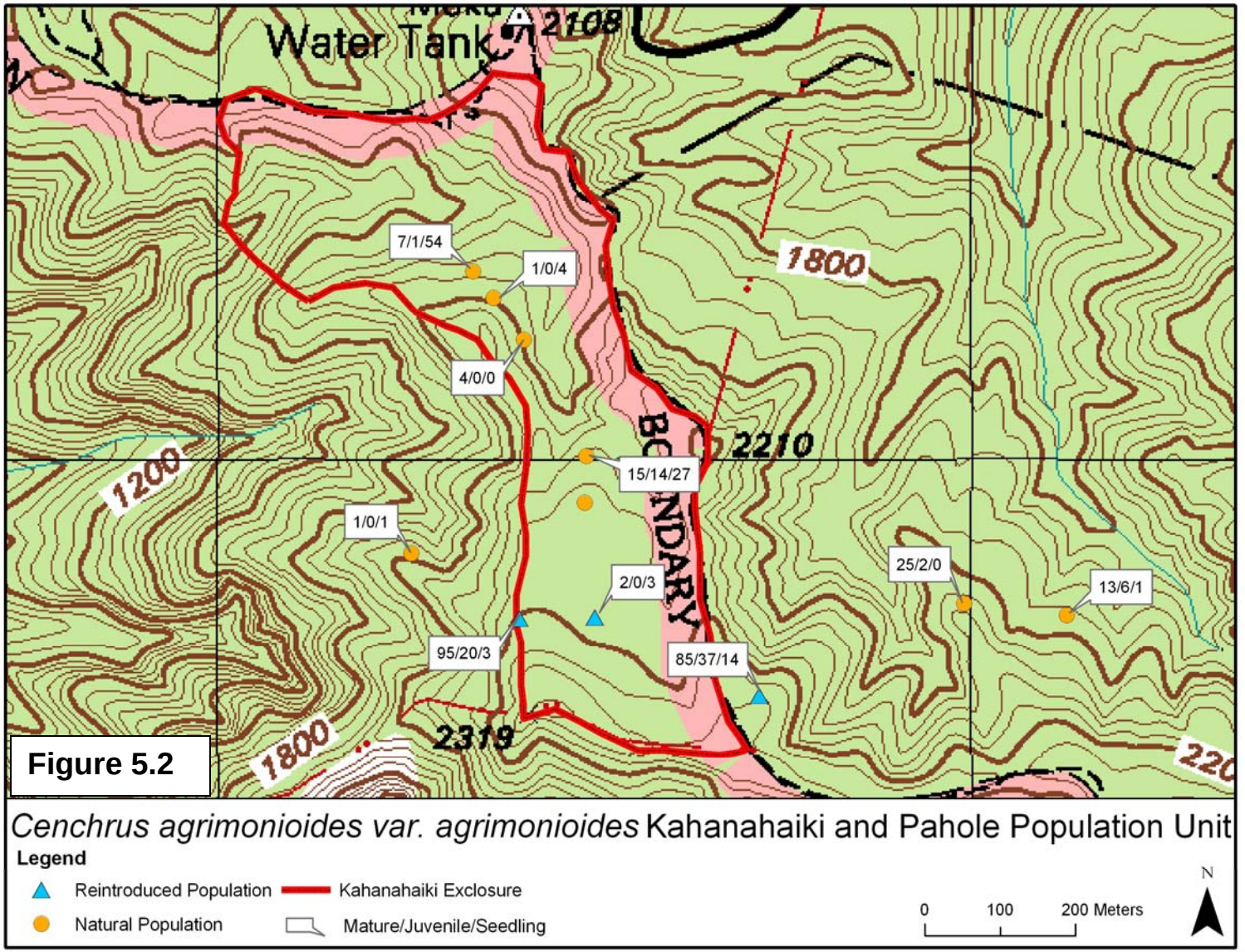

Water Tank
2108
1800
7/1/54
1/0/4
4/0/0
BOUNDARY
2210
15/14/27
1200
1/0/1
2/0/3
25/2/0
13/6/1
95/20/3
85/37/14
1800
2319
220
Cenchrus agrimonioides var. agrimonioides Kahanahaiki and Pahole Population Unit
Legend
Reintroduced Population
Kahanahaiki Exclosure
Natural Population
Mature/Juvenile/Seedling
0
100
200 Meters
N

Figure 5.2

Kahanahaiki site 2 (MMR-B): This site has one mature individual. It is not protected by fencing and may still be disturbed by ungulates, though no sign was observed in the last year. Snares are in place to protect the area. This area is proposed to be fenced in year 1 of the MIP. Several seedlings have been observed at this site over the past few years, however none has survived to become a juvenile plant. A single seedling was found at this site when it was monitored in the last year. In the coming year, propagules from this individual will be grown to supplement the reintroductions in Kahanahaiki and Pahole. This plant is represented by reintroductions inside the fence exclosure.

Kahanahaiki site 3 (MMR-C): This site has about twenty mature plants, and has increased in numbers for the past few years. The site is protected from pigs, and NRS conducted grass control around these plants in the last year to help to limit competition. NRS will continue to collect propagules in the coming year to supplement the reintroductions in Kahanahaiki and Pahole.

Kahanahaiki site 4: This is an augmentation site located just inside the fence near the Makua Rim. NRS spent 153.5 hours weeding in the general vicinity of these plants this year, and 31 hours controlling the nearby *Casuarina equisitifolia* population. Thirty-two plants were planted here in December 2000 and 11 more were added in January 2002. This summer, 95 mature, 20 immature, and 3 seedlings were counted. NRS expect this trend in recruitment to continue. In the next year, NRS will supplement this reintroduction with un-represented and under-represented stock from the wild populations.

There are also a 5 mature plants and 4 seedlings that were found in two new locations in Kahanahaiki in 2003. These plants will be collected from and represented in the existing augmentations. *Psidium cattleianum* and *Clidemia hirta* control was conducted around these plants this year.

The second augmentation site in Kahanahaiki was abandoned by NRS in 2002. The stock from this augmentation is represented elsewhere.

Pahole: At the *in situ* site visited by NRS in July 2004, thirteen mature plants, six immature and one seedling were counted. NRS did not have time to completely monitor the site, and it is likely there are more individuals. NRS collected seeds from this site this year, and spent two days weeding. There are significant weed threats at this site including encroaching *Melinus minutiflora* and *Psidium cattleianum*. NRS discussed these weed issues with the NARS biologist and have developed a plan to implement weed control for the area. NRS coordinated with the State NARS biologist to visit the second *in situ* site in Pahole recently, but the trip was cancelled due to bad weather. Another trip to this site is planned for the upcoming months. Seed collected from the two Pahole *in situ* sites will be propagated in the greenhouse and outplanted into a new reintroduction site in Pahole.

NRS outplanted 60 *C. agrimonioides* into Pahole in December 2000. In December 2003 the reintroduction was augmented with 35 more plants. This reintroduction has flourished. There are presently 114 seedlings and 37 immature plants at the site. These are all plants that have

germinated on-site. NRS will continue to balance founders at this site and conduct monitoring and weed control twice a year. This year, NRS spent 17.5 hours weeding at this site.

Makaha and Waianae Kai: The Waianae Kai portion of this PU is along a hiking trail, and these plants are not proposed for fencing. The Makaha portion of this PU will be fenced in the second Makaha subunit, proposed for fencing in year 5 of the MIP. The large Waianae Kai fire last September burned up to the ridge crest, but did not burn any of these plants. However, the fire significantly changed the habitat along the ridge-top. In June 2003, NRS counted nine mature plants, two juveniles and one seedling. Cuttings were taken from all the mature plants and one juvenile and were brought to the Army nursery for propagation. Plants grown from these propagules will be used to produce seed in the greenhouse for storage and will be reintroduced into a fenced unit in Makaha when the fence is complete. NRS will continue to monitor this population and will continue collections to ensure good ex-situ representation.

Central Ekahanui: There are a total of 30 mature and 3 immature individuals at this site. The plants are currently not protected from browsing by ungulates, but this population will be included in the upcoming Ekahanui fence expansion, scheduled for year 3 of the MIP. NRS spent 2 hours weeding *Psidium cattleianum* and *Grevillea robusta* at this site this year.

South Huliwai: NRS visited this site in September 2004 and collected cuttings. The cuttings will be grown in the greenhouse for seed production for storage. Stock from this collection may be used to augment the Ekahanui population once the habitat is protected. NRS spent 2.5 hours weeding *Clidemia hirta* and *Psidium cattleianum* at this site this year.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Kahanahaiki and Pahole	Manage for stability	Partial	Partial	No
Out of AA				
Makaha and Waianae Kai	Manage for stability	No	Partial	No
Central Ekahanui	Manage for stability	No	Partial	No
South Huliwai	Genetic storage	No	Partial	No

5.4 *Chamaesyce celastroides* var. *kaenana*

Requirements for Stability from MIP:

- 3 population units (PU)
- 25 reproducing individuals in each population (long-lived perennial)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon-Level Discussion

The three populations that were designated as manage for stability PUs are located in the most manageable terrain. The other PUs are located on cliffs or in very degraded habitat. *C. celastroides* var. *kaenana* as a taxon has stable numbers but all threats are not controlled and genetic collection is not complete. Three populations with >25 individuals exist at the Waianae Kai, Kaena to Keawaula (Kaena), and Makua PUs. Only one of these is located within the Makua Action Area. Complete genetic storage for these three PUs will be a priority as this is also a stability goal. Four populations, not three, were designated as 'manage for stability' at the MIT meeting in April 2004 because it was determined that the Waianae Kai PU could be monitored but not managed. All of the plants in this PU are found on the inaccessible cliffs of Kamaileunu ridge. NRS will continue to monitor this population once annually for threats and to confirm its' stability. Based on the improved status of this taxon, NRS plan to focus efforts primarily on the 'manage for stability' PUs shown in the table below. NRS will ensure that complete genetic storage collections are made from these PUs where possible. See individual sections below for a more detailed PU discussion and for clarification on site locations, see the map of the PUs in Makua Military Reservation.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitoring number (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Makua	Manage for stability	36/4	57/55	None	57/55
Kaluakauila	Genetic storage	17/1	12/7	None	12/7
North Kahanahaiki	Genetic storage	218	177/0	None	177/0
Puaakanoa	Genetic storage	147/10	145/10	None	145/10
East Kahanahaiki	None	2	2/0	None	2/0
Out of AA					
Kaena (East of Alau)	Manage for stability	21/5	21/4	None	21/4
Kaena and Keawaula (Kaena)	Manage for stability	300-450	300/0	None	300/0
Waianae Kai	Manage for stability	48-58	33/0	None	33/0
Kaena and Keawaula (Keawaula)	None	69/6	24/1	None	24/1

Genetic Storage

C. celastroides var. *kaenana* was only discovered in MMR 2000. The large Makua PU was discovered in 2001. Since 2001, NRS have been developing collection methods at the Makua PU. *C. celastroides* seeds violently dehisce upon maturity. Therefore, NRS crafted lightweight crinoline bags that cover the small branches. The light material is important because the branches of *C. celastroides* are very fragile. It allows for aeration if it rains so the seeds don't rot or begin to germinate. The bags are placed over immature fruit in mid-summer and seeds are collected in late summer or early fall. Since this technique was developed NRS have acquired one substantial collection from the Makua PU. A sufficient number of seeds were collected in the summer of 2003 to submit them to Lyon Arboretum for storage but no trials have been conducted yet because a bulk collection for this purpose has yet to be submitted. Initial germination results from the 2003 collections were 60, 52 and 72% germination for three seed lots of 25 seeds each. NRS will try to acquire a bulk collection of seed over the next year. NRS will continue to collect seeds from the populations within MMR that are threatened by fire and put them into storage, assuming the seeds store well and will collect for genetic storage from all populations which are designated manage for stability. NRS will approach the State for permission to collect from offsite populations on their land once preferred seed storage methods are determined.

This summer NRS applied the bagging technique more widely; unrepresented individuals within the Makua PU and fruit at other populations were bagged. At the Makua PU, all fruiting individuals with <50 seeds in storage were bagged. Collection of these bags was conducted in October. Bagging as conducted with the goal of reaching 50+ seeds from individuals. NRS are approaching bagging slowly so as to allow for additional on-site recruitment. At East Kahanahaiki only one plant has fruit this year and it was bagged. At Punapohaku bags were placed on nine accessible plants.

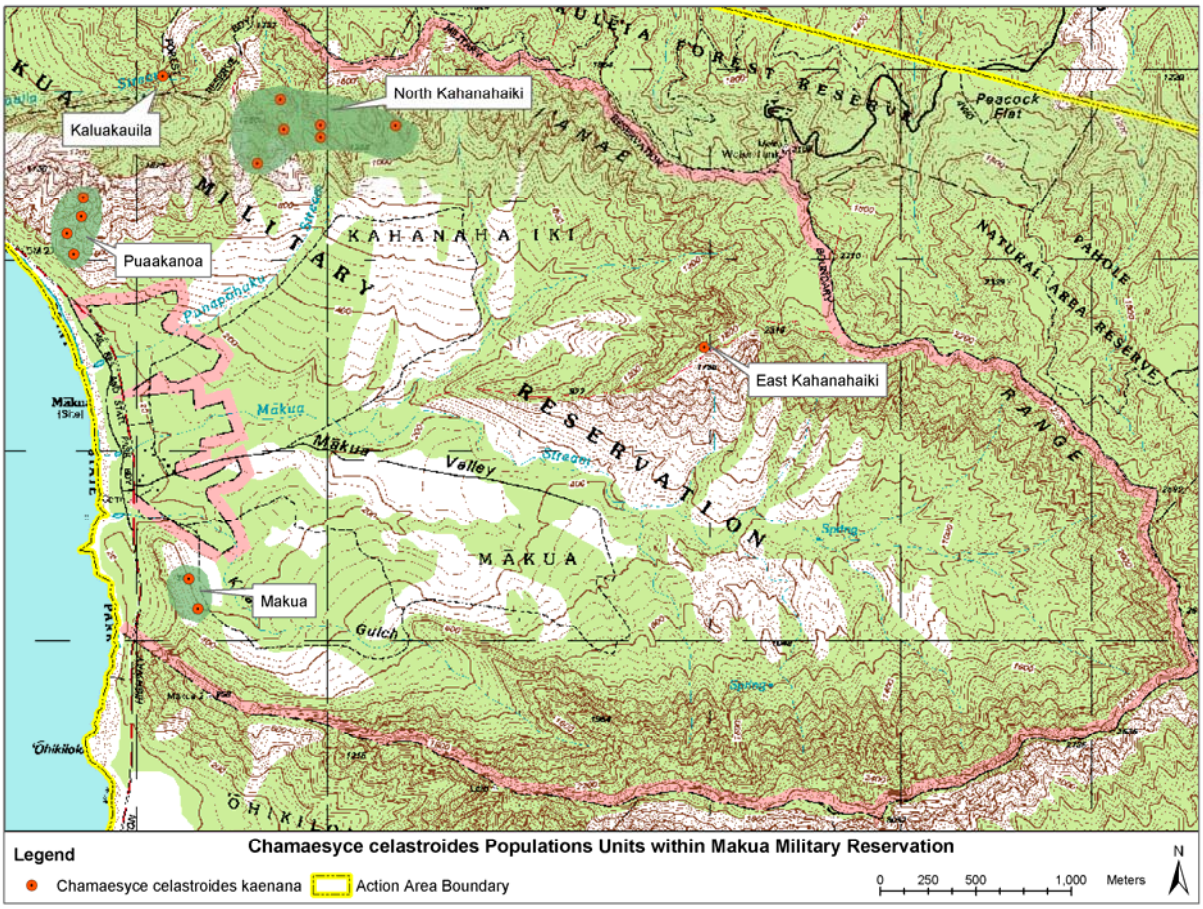
Genetic Storage of *In Situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of plants with rep.'s outplanted
In AA						
Makua	Manage for stability	57/55	15	0	3	0
Kaluakauila	Genetic storage	12/7	0	0	0	0
North Kahanahaiki	Genetic storage	177/0	2	0	0	0
Puaakanoa	Genetic storage	145/10	0	0	0	0
East Kahanahaiki	Genetic storage	2/0	0	0	0	0
Out of AA						
Kaena (East of Alau)	Manage for stability	21/4	0	0	0	0
Kaena and Keawaula (Kaena)	Manage for stability	300/0	0	0	0	0
Waianae Kai	Manage for stability	33/0	0	0	0	0
Kaena and Keawaula (Keawaula)	Genetic storage	24/1	5	0	0	0

Propagation/Germination Techniques

C. celastroides has been propagated from seeds very successfully. Germination rates over 50% have been observed. NRS has attempted to propagate *C. celastroides* from cuttings. Of approximately 40+ attempts, none have been successful. The preferred propagation technique for this taxon is germination from seed.

Figure 5.3 *Chamaesyce celastroides* var. *kaenana* populations at MMR



Unique Taxon Observations

There is some variation amongst populations of *C. celastroides* that may be dur to environmental rather than genetic variation. Plants from the Kaena to Keawaula (Kaena) PU are very prostrate which may result from the wind exposure at that site. The other populations, located on cliffs or in areas out of the wind are erect. All populations of *C. celastroides* that NRS are working to stabilize are substantial in size therefore no mixing of genetic stock is planned.

The East and North Kahanahaiki populations were impacted by the fire that occurred in the summer of 2003. NRS have established photopoints and will monitor the long-term effects of the fire on individual plant survival.

In North Kahanahaiki, within Punapohaku gulch, approximately nine *C. celastroides* var. *kaenana* were impacted by the fire of July 2003. NRS returned to evaluate impacts in July of 2004 and found that three of the nine plants were dead. These three plants were located at the base of lowest cliff within the area. This lower cliff abuts fields of *Panicum maximum,* whereas the rest of the population does not. Although six of the plants appear as if they will survive, they are not yet fully recovered. None of the six plants that were impacted by fire produced as much fruit as un-impacted plants. Two of these six plants had no fruit at all.

There are two plants in East Kahanahaiki (C-ridge). One was heavily impacted by the fire of July 2003. The other was higher on a cliff and further from alien grass fuel and was not impacted by fire. NRS returned to monitor the effects of the fire in August 2004. The lower plant was still recovering from the fire and had only a few live branches and no sign of reproduction. In contrast, the upper plant was covered with flowers and immature fruit. NRS believe that it will take at least another year if not two for the lower plant to fully recover from the effects of the fire.

Based on these observations it appears that *C. celastroides* can withstand fires that are not burning intensely but rather are carrying through light fuels. This is not surprising considering the number of fires that have burned through these populations in the past and they still persist. However, fire stress appears to have a negative impact on fruit production and intense fires will lead to mortality. The effect on seedlings and seed germination is unknown but would likely be negative. NRS will continue to monitor these plants to determine if there are any long-term effects on the plant's health and fecundity.

Outplanting Issues

Germination and progression through age classes to maturity is occurring naturally at the PUs that NRS are managing toward stability. Currently there is no need to out-plant into these populations. NRS conducted limited outplanting of this taxon at Makua Range Control. NRS have secured plants from the Makua PU stock at the Makua Range Control Building where they are protected from fires. This planting is used in part for educational purposes and as a back-up ex-situ site. NRS will continue to maintain this planting and supplement it with any new founders from the wild population.

Research Issues

NRS will continue to monitor the long-term effect of fire on this taxon.

Surveys

Just before the MIP was finalized in May of 2003, NRS and the Hawaii Natural Heritage Program discovered more populations of *C. celastroides* var. *kaenana* in MMR.

Taxon Threats

For *C. celastroides* the number one threat common to most of the extant populations is fire. This taxon grows in very dry and rocky lowland environments, which are now dominated by alien grasses. *Panicum maximum* is the most significant grass affecting *C. celastroides*. Not only does this grass compete for light, space and nutrients with *C. celastroides* but also it carries fires through the populations. Also this taxon as a whole exists in very degraded habitat that has been affected by human uses of the land for many years. This being said, NRS have seen rapid positive responses to intense weed control where it has been conducted.

Population Unit Level Discussion

Manage for Stability PUs:

Makua: The number of individuals in the final Makua IP was the number Joel Lau counted when the population was discovered in 2001. Since that time, extensive fuel and weed management have been done at this site, and the population is doing extremely well. In addition to the 57 mature and 55 immature plants, 104 seedlings were counted this year and this number is a large increase since 2001.

Management around the Makua PU of *C. celastroides* var. *kaenana* is unique among the many weed control projects performed by NRS because it is focused primarily on firebreak construction and maintenance and secondarily on native habitat management. A sea of the invasive grass, *P. maximum*, and the invasive tree, *L. leucocephala* surrounds this PU. There are two groups of *C. celastroides* in this PU. The upper and lower groups of the *C. celastroides* population are only 15m outside the Makua firebreak road (See figure 2-4). In order to reduce this risk of fire at the Makua PU, NRS constructed 30m firebreaks around the populations. This resulted in the creation of a 1.8 acre fuel break around the Upper *Chamaesyce* Patch, and a 1.7 acre break around the Lower *Chamaesyce* Patch. In the last year, NRS spent 313.5 hours maintaining and extending the fuel breaks around this PU.

The effort expended this year is a significant reduction in number of hours as compared to the first year that control was conducted in this PU. Figure 2-5 below shows the reduction in effort for weed control in the Lower Ohikilolo MU over time and the change in weed control emphasis over time. Initially most weed control work was with grasses but now much more time is spent on removing *Leucaena leucocephala* and *Acacia farnesiana*. Less time is needed to keep the grass controlled within the patches than was required at the outset so more time is available for controlling other ecosystem weed threats. Note that this graph includes time spent conducting weed control at the *Hibiscus* population also located in this same MU.

Figure 5.4 Increase of Lower Ohikilolo *C. celastroides* Fire Breaks

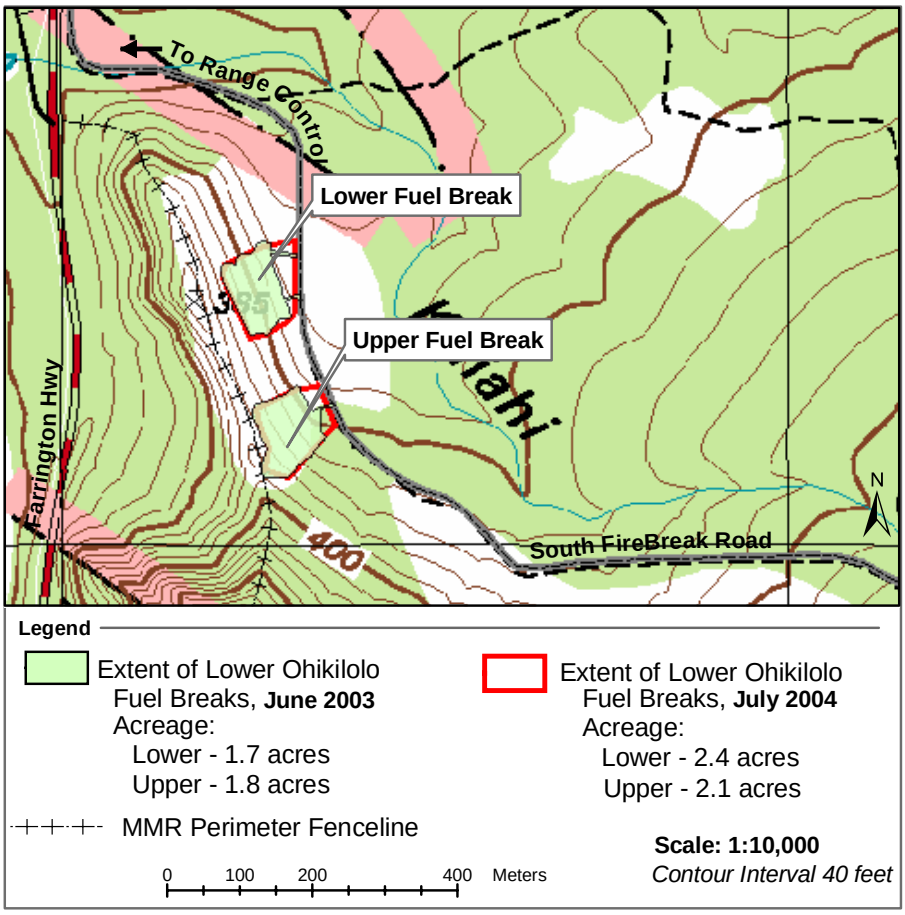


Figure 5.5 Lower Ohikilolo: Change in Effort Over Time

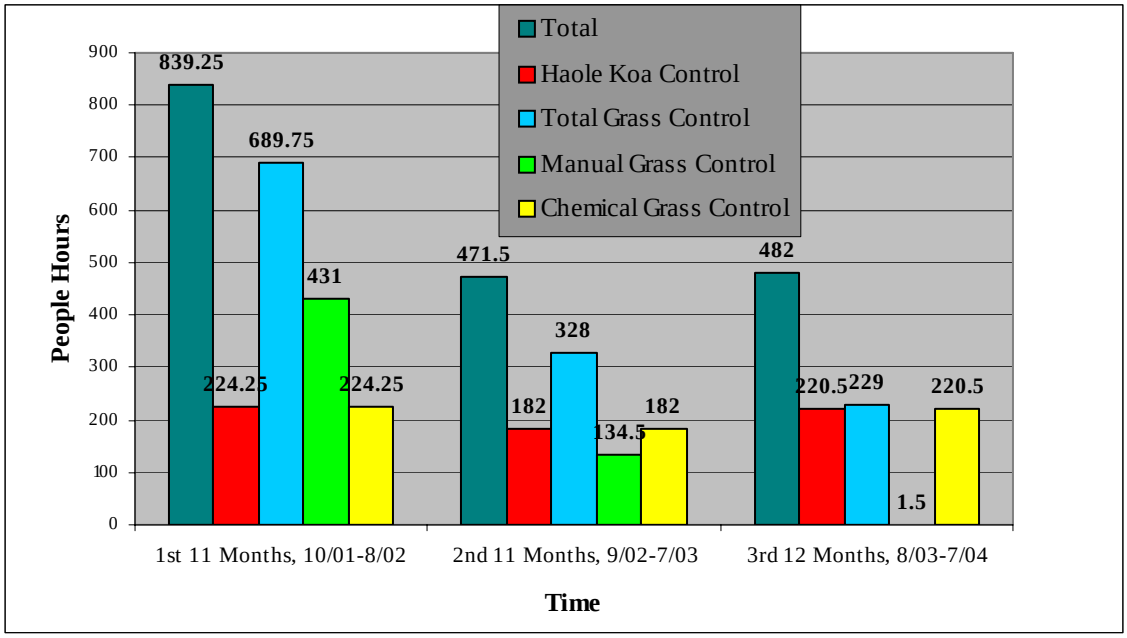


Figure 5.6 Upper *Chamaesyce* Photopoint Series: July 2002

July 2003

July 2004

Kaena and Keawaula (Kaena): This 0.9-acre population of 300+ mature plants, protected within a State Natural Area Reserve, is located in a predominantly native coastal habitat. There is substantial on-site recruitment; the population is littered with juvenile and seedling plants. The size and density of this PU makes monitoring the population structure each year an overwhelming and potentially damaging task. To avoid damaging plants, NRS will not conduct a census of this population each year as the number is well over the target number of 25 mature individuals. NRS will work with State of Hawaii NARS staff to determine the best monitoring and collection approach for this PU. NRS have not yet collected seeds for genetic storage from this PU because there is such a substantial wild population but this summer, the State borrowed some bags to put them out at Kaena.

Over the last year, 252 hours of weed control effort have been spent controlling a number of weeds including *L. leucocephala*, *A. farnesiana*, and *Atriplex semibaccata*. This year the population was also treated for encroaching grass cover of *Chloris barbata* and *Panicum maximum*. Levels of *A. semibaccata* have been significantly lower since efforts to control this weed were initiated in 2002. NRS control this herbaceous weed by handpulling. While large plants with long taproots and spreading branches covering 0.25 square meters were very common, now few plants this large are seen. Since beginning management, NRS noticed a distinct increase in *Chloris barbata* and *Panicum maximum* grass. It appears that *C. barbata* is spreading into areas cleared of other weeds by NRS. This year, NRS have determined through trials that *C. barbata* can be controlled with Fusilade II with little impact on non-grass native

vegetation in the area. Special attention will be paid to native grasses in the control area. An informal trial using Fusilade II on *P. maximum* showed that this herbicide did not kill the grass completely, but did set it back significantly. During the *C. barbata* spray effort this year, *P. maximum* was also treated as NRS feel that immediate attention must be given to this grass, even if only to set it back temporarily. Results from this spraying may show that the herbicide is effective as it is possible that during the trial, the grass was sprayed at a growth stage unresponsive to the herbicide. NRS will continue to monitor efficacy of treating *P. maximum* with Fusilade II at Ka`ena Pt. This year mature plants and seedlings of the incipient invasive weed *Achyranthes aspera* were found within the *C. celastroides* population. All plants found were pulled and bagged, or treated with Garlon 4, 20%. NRS hope to eradicate this weed in the population and will continue to sweep for plants in known sites and map areas where new plants are found.

Waianae Kai: The number of individuals included in the final Makua IP represents a tally of Joel Lau's observations in this area between 1991 and 2001. Just over 30 plants were counted during surveys by NRS in Waianae Kai in 2002. A large fire occurred in Waianae Kai in 2003, but this PU has not been revisited since to determine if any plants were impacted. Since this fire the State of Hawaii installed a fuel break in order to prevent wildfires from reaching the Forest Reserve. The Waianae Kai PU is slated for monitoring but not management because all of the plants in this PU are found on the inaccessible cliffs of Kamaileunu ridge. Currently the Waianae Kai population is located in very open portions of these cliffs where weeds are not a threat. Perhaps this PU will maintain its' stability, even without active management for a long time. Genetic storage collections from this PU will be very difficult if not impossible to acquire. NRS will make it a priority to monitor this PU to confirm its' stability and determine if the fire affected any plants.

Kaena (East of Alau): This population was visited once in the last year. The habitat at this population is a mix of native and alien shrubs. NRS spent 11 hours in the last year weeding *Acacia farnesiana* and *Leucaena leucocephala*. Although there is no grass in the area immediately surrounding this PU, encroachment by fire prone grasses is occurring nearby. NRS will keep alien grasses from invading. This year the State of Hawaii deployed collection bags at this PU. NRS will coordinate with the State for retrieval of the seed.

Other PUs:

Kaluakauila: This population was first sighted with binoculars from across the gulch. The estimated number of individuals from that observation was reported in the final Makua IP. Since that time, the plants have been monitored and their maturity level has been assessed more accurately. No weed control has been conducted at this PU because it occurs on a cliff. NRS are finalizing a fire management plan for the Kaluakauila MU and this PU will benefit from the actions outlined in the plan.

North Kahanahaiki: The number of individuals reported in the final Makua IP was based on Joel Lau's estimate of both counted individuals, individuals sighted from helicopter and with binoculars. The plants found in North Kahanahaiki are found mainly on cliffs this is why helicopter surveys were conducted. Joel Lau's number took into account some plants that since

have been identified as hybrids of *C. celastroides* var. *kaenana* and *C. celastroides* var. *amplectans*. NRS has been back to monitor the most fire-prone part of this population. Some of the plants in this PU are inaccessible on foot because they are on large cliffs. NRS attempted to collect from the lowest portion of this PU soon after it's discovery in the summer of 2003 but the fire at MMR burned all of the collection bags. See the discussion in the *Unique Observations* section above for more discussion on the fire's impact. In July of 2004, NRS again deployed collection bags and will retrieve them in early fall. Seed will be placed in storage.

Puaakanoa: Plants were monitored in 2002 but NRS have not revisited the site. The fire of 2003 did not affect this PU because most of the plants are located on sparsely vegetated cliffs. Fire does not carry well through this type of habitat.

East Kahanahaiki: Army staff and NRS refer to this area as 'C-ridge'. One plant from the East Kahanahaiki PU was burned in the July 2003 Makua fire. The plants were monitored in August 2004 and both plants are alive, though the one impacted by the fire is still recovering, and had only a few live branches and no sign of reproduction. See the *Unique Observations* section above for more details and photographs of the damage done by the 2003 fire to this PU.

Kaena and Keawaula (Keawaula): The number of individuals in the final Makua IP was a tally of Joel Lau's observations from this area between 1991 and 2001. The number in this report represents the number of individuals monitored by NRS at two sites in Keawaula. A thorough count has not been done by NRS. Collections were acquired from this PU in the summer of 2003.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Makua	Manage for stability	Yes	Yes	No
Kaluakauila	Genetic storage	No	No	No
North Kahanahaiki	Genetic storage	No	No	No
Puaakanoa	Genetic storage	No	No	No
East Kahanahaiki	Genetic storage	No	No	No
Out of AA				
Kaena (East of Alau)	Manage for stability	No	Yes	No
Kaena and Keawaula (Kaena)	Manage for stability	No	Yes	No
Waianae Kai	Manage for stability	No	No	No
Kaena and Keawaula (Keawaula)	Genetic storage	No	No	No

5.5 *Chamaesyce herbstii*

Requirements for Stability:

- 3 population units (PUs)
- 25 reproducing individuals in each PU (long-lived perennial)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

There is only one remaining extant PU, Kapuna to Pahole. This PU is in the action area, and will be managed for stability. Historically this taxon had a northern and southern range, but there are no *in situ* plants still extant in the southern range, and no stock from the southern plants. However, it is still important not to outplant northern stock into the southern range in case new populations are found or seedlings emerge from the seed bank. Reintroductions using the northern stock will take place in West Makaleha and Central and East Makaleha once fences are constructed in those MUs, in year 2 and year 4 of the MIP, respectively. The West Makaleha reintroduction is in the action area, but is an important site because it is a historical location for this species.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Kapuna to Pahole	Manage for stability	170	52/3	52/3	52/3
Out of AA					
South Branch of South Ekahanui	Genetic storage	0	0	0	0
Reintroductions					
West Makaleha	Manage reintroduction for stability	N/A	N/A	0	0
Central and East Makaleha	Manage reintroduction for stability	N/A	N/A	0	0

Genetic Storage

The Nature Conservancy staff collected mature fruit from the now extirpated Ekahanui population over several years, but the seeds were not viable. Because seeds violently dehise, NRS is working with the State to bag fruits for seed collection this year. NRS have refined a technique for bagging seeds of *Chamaesyce celastroides* var. *kaenana*, and that same technique will be used for bagging seeds of this species. Seeds collected this year will be propagated and reintroduced. The reintroduced plants will be used for seed collection for storage and storage testing.

Genetic Storage of *In-situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Kapuna to Pahole	Manage for stability	52/3	0	0	0	0
Out of AA						
South Branch of South Ekahanui	Genetic storage	0	0	0	0	0

Propagation/Germination Techniques

NARS staff grew plants from seeds for an outplanted in Kapuna. NARS staff also collected seeds from several of the Pahole plants in the mid-1990's and had plants in the greenhouse for several years. The plants were very healthy, and flowered more than once. The plants were outplanted below the NIKE site greenhouse in 2003. The plants are doing well, and State biologists expect to be able to collect seed from them this year. This year NRS will be working with the State NARS biologist to bag immature fruits in Pahole and Kapuna for collection. Seeds will be propagated for reintroduction into Pahole. Cuttings will not be attempted as they have not worked for other *Chamaesyce* species.

Unique Species Observations

This species has gone through a major decline in numbers in the last five years (T. Takahama, pers. comm.). One of the gulches monitored in Pahole this year had 25 mature plants and 20 dead plants.

Outplanting Issues

NRS have not propagated this species, so no outplantings have been attempted. The State successfully outplanted into a small exclosure in Kapuna. Plants were over one meter tall when outplanted. NRS weeded around this population last year, but does not monitor the plants.

Research Issues

Research on germination, seed storage, and propagation needs to be conducted. In addition, research into the reason for the recent decline in numbers should be conducted. Possibilities to be investigated include pathogens, invertebrate or vertebrate attack, or drought.

Surveys

Nature Conservancy staff monitor the site of the former Ekahanui population annually, but have never found any new seedlings. This year the HINHP botanist will spend four days surveying Makaleha and Mt. Kaala NAR for possible new populations.

Taxon Threats

Weeds such as *Ageratina adenophora, Rubus rosifolius, Buddleia asiatica, Clidemia hirta,* and *Psidium cattleianum* have dramatically altered the mesic habitat this taxon grows in. Plants produce many flowers and immature fruits each year, but not many fruit are left on the plants at maturity. The mature fruit are red, and it's possible bulbuls or other birds eat them. In addition, rats may eat the seeds once they fall from the trees. Feral ungulates alter the gulch bottom habitat where this species grows in Kapuna, which is not yet protected by a fence.

Population Unit Level Discussion

Manage for Stability PUs:

Kapuna to Pahole: The number of individuals in the final Makua IP was a tally of the State NARS biologist Talbert Takahama's observations between 1991 and 1999. Based on extensive monitoring in Pahole and Kapuna this year, and discussions with Mr. Takahama, it is clear that this species has declined greatly in numbers in the last five years. No genetic storage collections have been made from this population. NRS will work with Mr. Takahama to bag fruits and collect seeds this year. NRS will also begin weeding around the Pahole plants this year. All of the known Pahole plants are fenced. NRS spent 60.5 hours weeding over approximately 7 acres in the vicinity of the Kapuna plants this year. The target weeds included *Clidemia hirta, Rubus rosifolius, Lantana camara, Schinus terebinthifolius, Psidium cattleianum, Buddleia asiatica,* and *Christella parasitica.* While weeding, NRS discovered 2 mature and 3 immature plants at a historical location. This location is currently not fenced, but is scheduled to be fenced in year 2 of the MIP.

Of the individuals monitored in the last couple years, 50 mature and 3 seedlings are in the Pahole fence. Two mature and three immature plants were found this year in Kapuna, and there are likely more plants in the area. Kapuna is proposed for fencing in year 2 of the MIP.

Other PUs:

South Branch of South Ekahanui: The last of these plants died in 2002. The site was surveyed by TNC in the last year, but no new plants were found. The site is inside the Ekahanui fence. TNC staff collected seeds from this population when it was extant, but were never able to propagate any plants. No weeding was conducted at this site this year.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Kapuna to Pahole	Manage for stability	Partial	Partial	No
Out of AA				
South Branch of South Ekahanui	Genetic storage	Yes	Yes	No

5.6 *Cyanea grimesiana* subsp. *obatae*

Requirements for Stability:

- 3 population units (PUs)
- 100 reproducing individuals in each PU (short-lived perennial with large fluctuations in population size and recent history of decline)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

The healthiest extant populations with mature plants will be managed. Pahole and West Makaleha is the only PU in the action area. Mixed stock will be used for augmentations into the gulches between Pahole and West Makaleha (Kapuna/Keawapilau). There is an existing reintroduction in Pahole from Pahole stock. The Palikea (South Palawai) plants have been augmented with stock from this site by TNC staff. This year the Central Kaluaa population will be augmented with stock from Central Kaluaa. In addition, there will be a separate reintroduction site with pure South Kaluaa stock, which is the holotype for this taxon. While this taxon is easy to propagate and reintroduce, reaching stability will be challenging. Though plants produce viable seed, there is a limited genetic base due to the low number of founders. Rats and slugs attack plants of all size classes. Because of these predators, there is no *in situ* recruitment.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Pahole to West Makaleha	Manage for stability	8/5	7/3	14/19	21/22
Out of AA					
Palikea (South Palawai)	Manage for stability	3/25	8/7	0/35	8/42
Central Kaluaa	Manage for stability	New population	1/0	None	1/0
South Kaluaa	Genetic storage	2	1/0	None	1/0
North Branch of South Ekahanui	Genetic storage	5	0	0/9	0/9
Palikea Gulch	Genetic storage	0/1	0/1	None	0/1

Genetic Storage

Seed storage testing has been done on a small number of individuals. Initial results showed that the best storage method was freezing, but tests done on seeds stored for two years showed germination only in treatments stored at room temperature and 10% relative humidity. All seeds put into storage before 2002 will be pulled out of storage for immediate germination. Plants can

be stored in micropropagation. They can be subcultured, so it is possible to store many clones from one plant.

Genetic storage of *In situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Pahole to West Makaleha	Manage for stability	7/3	2	1	1	1+
Out of AA						
Palikea (South Palawai)	Manage for stability	8/7	4	5	2	5+
Central Kaluaa	Manage for stability	1/0	0	0	1	0
South Kaluaa	Genetic storage	1	0	0	1	1
North Branch of South Ekahanui	Genetic storage	0	0	1	0	1
Palikea Gulch	Genetic storage	0/1	0	0	0	0

Propagation/Germination Techniques

Germination rates were mixed in tests done at the seed storage lab at Lyon Arboretum. In the first batch of plants tested only 4 of 10 seeds germinated. Later batches had closer to 80% germination. Plants can be grown from cuttings, but since most plants have only one terminal branch this method can't be widely used.

Unique Species Observations

The plant in Central Kaluaa is extremely prolific, and produces lots of flowers and fruits over several months in the summer and fall. The Ekahanui plants produce pure white flowers, and all other populations have purple and white flowers. Unlike most species, not all populations flower at the same time of year. The Pahole to West Makaleha, Palikea (South Palawai), and North Branch of South Ekahanui PUs flower in winter, and the Central Kaluaa and South Kaluaa PUs flower in summer. This taxon has more individuals and better fruit and seed production at the higher elevation, wetter sites in Pahole to West Makaleha and Palikea (South Palawai).

Outplanting Issues

Cyanea grimesiana subsp. *obatae* has been augmented or reintroduced at four separate sites, three on TNC land and one on State land. A fifth reintroduction/augmentation will take place in the Central Kaluaa PU this December. Sites that most closely resemble the *in situ* sites were selected for reintroductions into new areas. All of the reintroductions were conducted within the last two years. The young outplanted plants are very susceptible to rat and slug predation.

Research Issues

Slugs attack plants of all size classes in this species. Next year NRS will work with Stephanie Joe, a UH-Manoa graduate student, on obtaining a permit for use of slug baits in natural areas. A UH-Manoa graduate student, Christina Crooker, studied the genetic diversity within and among the small populations of *C. grimesiana* subsp. *obatae.* Her studies found that there was low genetic diversity within all of the populations of this taxon, and with the exception of the now extirpated Ekahanui population, low genetic diversity between all populations as well. The Ekahanui population showed moderate genetic differentiation from all of the other populations, and it is therefore important to preserve the Ekahanui genetic stock (Crooker 2003).

Surveys

One day was spent surveying North Kaluaa for additional plants in August 2003 as part of Urgent Actions 2. No plants were found.

Taxon Threats

Slugs prey on plants of all size classes of this species. Steph Joe of the University of Hawaii is currently conducting research on slug deterrents has part of her Master's thesis research.

In May 2002, NRS discovered major rat damage to the five mature plants in West Makaleha. Four had leaves eaten off and one had a damaged stem. By September 2002, the damaged plants were healthy and mature fruit was collected and brought to Lyon for propagation and storage. In response to the rat damage, NRS increased the number of bait stations from six to eight, and monitor them twice a quarter. Weeds are a threat at all PUs. *Myrica faya* is a problem weed at the Palikea (South Palawai) PU, and *Rubus argutus* is a threat to the West Makaleha PU. Predator control is currently ongoing at all of the PUs except Palikea Gulch, which consists of just one juvenile plant in a small exclosure.

Population Unit Level Discussion

Manage for Stability PUs:

Pahole to West Makaleha: There are two extant plants within the large exclosure in Pahole NAR. The NARS biologist has been monitoring and collecting from these plants. NARS staff is working to develop a plan for the management of these plants and will enlist the help of NRS if necessary.

An ungulate exclosure fence was constructed around the West Makaleha plants in 2001. During the flowering/fruiting season of 2001, NRS established six rat bait stations and 12 snap traps in the area to control rats. The bait stations were restocked quarterly. In May 2002, NRS discovered major rat damage to five mature plants. Four plants had at least half of their leaves eaten off, and one had a girdled stem. By September 2002, the damaged plants were back to health and mature fruit was collected and taken to Lyon Arboretum for propagation and storage.

In response to the rat damage, NRS increased the number of bait stations to 13 and the number of snap traps to 26, and increased the monitoring interval to twice a quarter. No mature fruit was collected in 2003. One mature and two immature plants at West Makaleha died in 2003. These plants had all been impacted by the rat predation in 2002, and probably died as a result. Mature fruit collection is anticipated for 2004 with two mature plants flowering at the present time. NRS spent 91.5 hours weeding within the exclosure this year. This time has primarily been divided between controlling *Psidium cattleianum, Melinis minutiflora,* and *Rubus argutus,* three of the most problematic weeds within the exclosure. To assist in spraying and to avoid lugging water up the steep trail to the exclosure, a water catchment system was installed this year to compliment control. *Acacia koa* and other natives will be planted to accelerate native revegetation of these areas.

NRS assisted the State with reintroducing 45 plants of Pahole stock into the Pahole exclosure in 2003. NRS monitored the outplanting this August. Some of the plants died from slug damage, but overall the plants were doing well. There were 14 mature, flowering plants, and 19 immature plants. NRS is currently germinating seeds from the West Makaleha plants for reintroduction into the two-acre West Makaleha exclosure next year.

Palikea (South Palawai): These plants are in two-acre fence, and are monitored regularly by TNC and NRS staff. TNC staff augmented this population in 2002 and 2003 with 35 individuals of its own stock. The current fence around this population is approximately 2 acres, and needs to be expanded for future outplantings. NRS along with TNC staff bait the site for rats, and control feral pigs outside the fence with snares. TNC weeded in the area this area.

Central Kaluaa: South Kaluaa stock was reintroduced into Central Kaluaa in 2003. The population is pretty healthy; 15 plants remain, approximately 75% of the original outplanting. Several of the plants bore fruit this August. Last year, a new plant was discovered inside the large Kaluaa fence. This plant fruited multiple times this year, and TNC staff collected seed for propagation. NRS received more than a hundred seedlings from this plant from TNC and plan to outplant these individuals. A site is being prepared for these to be outplanted this December. The outplants will go into northern-most gulch of Central Kaluaa. Because there is an outplanting of South Kaluaa stock in Central Kaluaa, NRS will bag the flowers of the *in situ* plant next year so seed of pure Central Kaluaa stock can be collected for storage and propagation. NRS and TNC staff spent 42 hours weeding *Psidium cattleianum, Clidemia hirta,* and *Passiflora suberosa* in the area this year.

Other PUs:

South Kaluaa: One of the two plants at this site died last year. This population is significant since it includes the holotype for the species. NRS constructed a small fence around the remaining plant in May 2004.

North Branch of South Ekahanui: The last remaining wild plants at this site died in 2002. A reintroduction of mixed Ekahanui and Kaluaa stock was planted in the Ekahanui fence in 2003. Fourteen plants were outplanted, but slugs have damaged many of the plants and only 3 mature and 7 immature plants remain. Other plants sustained slug damage and are in poor condition.

Limited *ex situ* stock from this site is available; therefore all fruit from the outplanted individuals will be collected and put into propagation. NRS will work with TNC staff to conduct weed control in the area next year.

Palikea Gulch: This plant was monitored in August 2004, and it remains a juvenile. Its identity has not been confirmed since it has not yet flowered. This site was weeded in 2003.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Pahole to West Makaleha	Manage for stability	Yes	Yes	Partial
Out of AA				
Palikea (South Palawai)	Manage for stability	Yes	Yes	Yes
Central Kaluaa	Manage for stability	Yes	Yes	Partial
South Kaluaa	Genetic storage	Yes	Yes	Yes
North Branch of South Ekahanui	Genetic storage	Yes	Yes	Yes
Palikea Gulch	Genetic storage	Yes	Yes	No

5.7 *Cyanea longiflora*

Requirements for Stability:

- 3 population units (PUs)
- 75 reproducing individuals in each PU (short-lived perennial with fluctuating population numbers and trend of local decline)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

All extant populations will be managed. There are no populations on Army land, so all management is contingent upon cooperation with the Board of Water Supply and State of Hawaii. The Kapuna to West Makaleha and Pahole PUs are both in the action area. The majority of the individuals in this species are found in these two PUs. The Makaha side of the Makaha and Waianae Kai population will be managed, and will be augmented with Waianae Kai stock. This PU was impacted by the 2003 fire in Waianae Kai. In order to protect this species outside the action area in an area of lower fire threat, plants will be reintroduced into Central and East Makaleha. In general, populations are located in manageable habitat and threats are controllable. Full genetic storage collections for this species are underway.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Kapuna to West Makaleha	Manage for stability	66	40/0	None	40/0
Pahole	Manage for stability	114	50/0	None	50/0
Out of AA					
Makaha and Waianae Kai	Manage for stability	4	3/8	None	3/8
Reintroduction					
Central and East Makaleha	Manage reintroduction for stability	N/A	N/A	0	0

Genetic Storage

No seed storage testing has been done. Seeds have gone directly into the seed bank. Over 4,700 seeds have been deposited at the Lyon Arboretum seed bank. This year collections will be made from the most prolifically fruiting plants for storage testing. The current collections are too valuable to be used for testing. All collections and testing are contingent upon receiving permission from the State or Board of Water Supply.

Genetic Storage of *In-situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Kapuna to West Makaleha	Manage for stability	40/0	2	1	2	0
Pahole	Manage for stability	50/0	7	0	0	0
Out of AA						
Makaha and Waianae Kai	Manage for stability	3/8	4	0	0	0

Propagation/Germination Techniques

For good germination, seeds must be mature. The best germination has come from seed that was dark brown. Typically the flesh of the fruit at that stage is still green. Mature seeds germinate best on agar. Initial viability varies between 55% and 85%.

Unique Species Observations

This species is not fire-resistant. There are currently three mature plants left on the Kumaipo ridge, which separates Waianae Kai and Makaha. A campfire that got out of control in early September 2003 killed at least one plant (see Figure 5.7 below). Other undiscovered individuals may also have burned.

Outplanting Issues

NRS have not conducted any outplantings with this species.

Research Issues

Slugs attack other species in the Campanulaceae family, and it is likely they also impact this species. Next year NRS will work with Stephanie Joe, a UH-Manoa graduate student, on approving slug baits for use in natural areas.

Figure 5.7 Burned *Cyanea longiflora*

Surveys

No Urgent Action surveys were conducted for this species.

Taxon Threats

Fire is a threat to this species, and at least one plant burned in the 2003 fire in Waianae Kai. Pigs are a major threat to this species as they drastically alter the species' habitat. Weeds such as *Psidium cattleianum* and *Coffea arabica* are also major habitat modifiers. It is possible that slugs prey on seedlings. NRS have not observed rat predation on this species, but will monitor for it as other species in this family have been impacted by rats.

Population Unit Level Discussion

Manage for Stability PUs:

Kapuna to West Makaleha: None of the plants in this PU are currently fenced. The State will be building a large fence in Kapuna in the coming years. The West Makaleha plants are growing on a cliff and not at risk from pigs. The habitat around these plants is scheduled to be fenced in year 2 of the MIP. The number of individuals included in the final Makua IP was NARS Biologist Talbert Takahama's estimate based his 1998 observations. This year NRS monitored portions of this area, and also asked NARS biologist Talbert Takahama for his latest population estimates.

There are currently three known sites with this species in Kapuna Gulch. The NARS biologist estimates that there are 40 mature plants left in Kapuna and Keawapilau combined. This year, NRS spent 7.5 hours weeding in the vicinity of this population. In the coming year, NRS will monitor the known sites and assist State NARS staff in preparing the site for fence installation in Kapuna.

There are two known sites in Keawapilau Gulch. NRS has not monitored these sites, but will in the coming year. There is currently no ungulate control in this area and pigs undoubtedly affect the plants. This year, NRS spent 11.75 hours weeding *Psidium cattleianum, Lantana camara, Clidemia hirta, Stachytarpheta dichotoma* and *Schinus terebinthifolius* in the vicinity of one of the sites. NRS will monitor both sites in the coming year and determine the need for management.

There are three mature plants located in West Makaleha. The plants are not within a fence but are not threatened directly by pigs as they are growing on a vertical cliff. NRS spent 12 hours weeding the habitat around these plants this year. This past year, NRS didn't collect any fruit since Lyon Arboretum has over 2,000 seeds in stock from these plants. NRS is hopeful that by not collecting, and allowing seeds to hit the ground, seeds will germinate on their own. In the coming year, NRS will monitor the mature plants as well as look for seedlings. No seedlings have been observed at this site, but seedlings may be difficult to detect due to the thick uluhe understory.

Pahole: This year NRS monitored two of the five gulches in Pahole and counted 22 mature plants, 41 immature plants and 19 seedlings. Based on NRS's monitoring observations and conversations with NARS biologist Talbert Takahama, it is estimated there are approximately 50 mature plants in Pahole. This population appears healthy, with plants of all size classes present. However, Mr. Takahama reports that there has been a dramatic decrease in the number of individuals in this gulch in the last six years. This population is fenced, so a factor other than ungulates must be causing the decline. NRS will work with Mr. Takahama to try to determine the cause of the decline. These plants are all within the Pahole fence and are protected from ungulates. The habitat is dominated by native species, and requires minimal weed control. NRS will visit the area for weed control biannually. NRS spent 12 hours conducting weed control in the vicinity of these plants this year. NRS plan to work with the NARS biologist to collect fruit from all of the plants next year.

Makaha and Waianae Kai: NRS, together with the BWS biologist, regularly monitor this site. NRS is currently finishing a permit application to build a small fence around this population. The September 2003 Waianae Kai fire burned one of the mature plants at this population. NRS monitored the plants in August 2004 but did not collect. Seed collections have been made from this site the last several years. *Coffea arabica* and *Psidium cattleianum* are a major weed threats at this site. NRS will work with the NARS biologist to conduct more surveys along the Waianae Kai side of this PU, as this area is undersurveyed. The one mature Waianae Kai plant fruits more prolifically than any of the other plants of this species observed by NRS. NRS will coordinate with the State NARS biologist to collect seeds from this plant for storage testing. NRS will begin conducted weed control around the plants in the coming year. After the 2003 fire, NRS

assisted the State with erosion mitigation work in the burn area. Hopefully these efforts will help foster forest restoration.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Kapuna to West Makaleha	Manage for stability	No	Partial	No
Pahole	Manage for stability	Yes	Partial	No
Out of AA				
Makaha and Waianae Kai	Manage for stability	No	No	No

5.8 *Cyanea superba* subsp. *superba*

Requirements for Stability:

- 3 population units (PUs)
- 50 reproducing individuals in each PU (long-lived perennial with a history of precipitous decline, nearly extirpated in the wild, and extremely low genetic variability)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

There are no remaining wild plants. The last wild plant died in 2002. There are currently seven reintroduction sites. All of the sites are in the action area. Four are in the Kahanahaiki PU and three are in the Pahole to Kapuna PU. Reintroductions into Central and East Makaleha and Makaha will be at sites with appropriate intact habitat. All reintroduced plants stem from two founders from the Kahanahaiki population. Based on genetic studies done at UH, the genetic diversity of this taxon is low. Plants flower and produce viable seed, but there is no evidence of recruitment in the wild.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Kahanahaiki	Manage for stability	0	0	2/149	2/149
Reintroductions					
Pahole to Kapuna	Manage reintroduction for stability	N/A	N/A	31/139	31/139
Central and East Makaleha	Manage reintroduction for stability	N/A	N/A	0	0
Makaha	Manage reintroduction for stability	N/A	N/A	0	0

Genetic Storage

There close to 50,000 seeds in storage that have been collected from outplanted plants. Four different storage treatments have been tested for two years. Storage treatments at room temperature and room humidity, and storage at –18°C at 20% relative humidity both yielded 0% germination. Storage treatments at room temperature and 10% relative humidity and 4°C and 33.5% relative humidity both yielded 50% germination. Storage potential beyond two years has not been established.

Genetic Storage of *In-situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted	Number of *ex situ* or *intersitu* plants with >25 seeds in storage
In AA							
Kahanahaiki	Manage for stability	0	2	1	3	3	18

Propagation/Germination Techniques

Initial germination rates for seeds germinated with gibberelic acid on paper were over 90%. It is also possible to germinate seeds in Vermiculite and Perlite. Even though there is low genetic diversity, this taxon is not showing signs of inbreeding depression in terms of seed viability or vigor. The percent germination of seeds from the outplanted plants is high, close to 75%. NRS have attempted vegetative propagation, but cuttings in the greenhouse or in micropropagation do not grow.

Unique Species Observations

The remaining plants in this taxon have very low genetic diversity. See the 'Research Issues' section below for details.

Mark Gardener, a University of Hawaii at Manoa post-doctoral associate, did a study on the pollinators of *C. superba* subsp. *superba.* Native bees, tentatively identified as *Hylaeus connectans,* visited the flowers and appeared to pollinate them. The introduced Japanese white eye, *Zosterops japonicus,* was observed nectar-robbing, but also occasionally contacting the stigma and carrying pollen between flowers.

Outplanting Issues

Outplantings have been conducted in a variety of different microsites. Outplantings that are planted into main gulch bottoms in full sun are the most successful. The plants are very robust, and mature faster than plants outplanted into other areas. Outplantings are also more successful if the plants are a couple years old and close to one meter tall or taller when outplanted.

Research Issues

Recent genetic testing by Dr. Cliff Morden of the University of Hawaii Botany Department on wild and reintroduced plants found that the majority of the plants were genetically very similar. There were ten outlier plants that were genetically different from the rest of the plants. One of the outliers was a plant of unknown origin from Keith Robinson's outplanting of this taxon on Kauai. NRS will attempt to get stock from this plant this year. Seven of the outlier plants have died. The remaining two outliers were greenhouse plants that have since been outplanted. NRS are currently tracking these plants so seed can be collected once the plants mature.

Slugs are a threat to all plants in the family Campanulaceae. A UH-Manoa graduate student, Stephanie Joe's, is conducting research on slugs as part of her graduate research. NRS will hire Ms. Joe next year to conduct research on control techniques, and to pursue a permit for slug bait for use in natural areas.

Surveys

No Urgent Action surveys were conducted for this taxon.

Taxon Threats

NRS have observed a rapid decline in plant vigor on some plants, starting from the meristem region, which begins to wilt and fall over. Plants die soon thereafter. It is hypothesized that a nematode may be affecting the plants. It is also possible that plants may have root rot. The introduced fern *Blechnum occidentale* was a major component of the understory around the last *in situ* population in Kahanahaiki. It is hypothesized that this thick groundcover may have limited any potential seed germination. Seedlings and young plants of this species are susceptible to slug predation. Fruits are subject to rat predation, so it is necessary to bait for rats during the fruiting season in order to collect seeds.

Population Unit Level Discussion

Manage for Stability PUs:

Kahanahaiki: The last wild plant died in 2002. NRS reintroduced 251 *Cyanea superba* ssp. *superba* plants at four sites in Kahanahaiki from fruit collected from the wild plants. All of these plants are stock from three of the now extirpated Kahanahaiki *in situ* plants. This is the first year that any of these reintroduced plants have flowered. NRS spent 58 hours weeding in the vicinity of these plants this year.

Pahole to Kapuna: Eighty-nine plants from Kahanahaiki stock were planted at one site in Pahole gulch. Last year, only two plants were mature. This year there are 12 mature plants. NRS will use seed collected from this outplanting site to refresh the seed stock at the Lyon Arboretum seed bank. NRS spent 45 hours weeding in the vicinity of these plants this year. *Rubus rosifolius* and *Oplismenus hirtellus* are the major weeds at this site.

There are two sites with a total of 45 reintroduced *Cyanea superba* ssp. *superba* in Kapuna Gulch. Nineteen of these plants are mature. State NARS staff originally outplanted plants into these sites in 1997 and 1998. It is not known what stock was used for this outplanting. NRS supplemented the sites in 2001 with stock from recent collections from Kahanahaiki. NRS monitors these sites periodically when conducting other management. In the past, NRS assisted the State in controlling rats around these plants and collecting the fruits for storage at Lyon Arboretum. This year NRS spent 14 hours weeding in the vicinity of these plants. Genetic tests have shown that the Kapuna reintroductions are genetically similar to the reintroductions in Kahanahaiki and Pahole. Therefore NRS will focus their efforts on the Kahanhaiki and Pahole

reintroductions. The Kapuna reintroductions will be collected from, but no other management will take place.

Other PUs:

Honouliuli: Thirty-nine individuals of mixed stock were planted into the Palikea fence in North Palawai in spring 2004. Another 97 individuals of mixed stock were planted within the Kaluaa fence in spring 2004. NRS and TNC continue to monitor their growth and manage the rat populations with bait stations.

Lyon Arboretum: Five plants were planted on February 14, 2003 in the Hawaiian section at Lyon Arboretum. However, the plants are not thriving, and probably won't live much longer. NRS will strive to create a healthy living collection at a Botanical garden in the future.

Population Unit Threat Management:

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Kahanahaiki	Manage for stability	Yes	Yes	No
Reintroductions				
Pahole to Kapuna	Manage reintroduction for stability	Yes	Partial	Yes

5.9 *Cyrtandra dentata*

Requirements for Stability:

- 3 population units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

The Kahanahaiki and Pahole to West Makaleha PUs are found growing in gulches over a widespread area. These two PUs are both have stable numbers of individuals. These PUs are also the center of abundance for this species, so even though they are both found in the action area, they are both designated 'manage for stability'. The plants in these two PUs are spread over a large area, and it is unlikely that one catastrophic event could wipe out all of the plants. The two PUs found outside of the action area are both in the Koolau Mountains. Opaeula will be managed rather than Kawaiiki because Opaeula has more manageable terrain, and there are many other rare species in the Opaeula proposed management unit. Opaeula is undersurveyed, and it is likely there are more individuals in this PU. All of the populations have good recruitment. When ungulates are controlled, this species does well *in situ.*

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Kahanahaiki	Manage for stability	52/45	156/6	None	156/6
Pahole to Kapuna to West Makaleha	Manage for stability	300	478/470	None	478/470
Out of AA					
Opaeula (Koolaus)	Manage for stability	21/5	22/12	None	22/12
Kawaiiki (Koolaus)	Genetic storage	50	21/33	None	21/33

Genetic Storage

Seeds were collected and taken to Lyon Arboretum for seed storage testing this year. Fresh germination on agar was 100%. After six months of storage, refrigerated seeds had the highest germination, approximately 90%. No additional collections have been made, and no seeds are in storage.

Genetic Storage of *In Situ* Plants

Population Unit	Management Designation	Total number of *in situ mature*/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Kahanahaiki	Manage for stability	156/6	0	0	0	0
Pahole to Kapuna to West Makaleha	Manage for stability	478/470	0	0	0	0
Out of AA						
Opaeula (Koolaus)	Manage for stability	22/12	0	0	0	0
Kawaiiki (Koolaus)	Genetic storage	21/33	0	0	0	0

Propagation/Germination Techniques

Seeds germinate best when the fruit is browning and cracked open. This allows the seeds to absorb the sugars from the fruit, which increases germination (Dr. Jim Smith, Boise State University, pers. comm.). No attempts have been made to grow plants from cuttings.

Unique Species Observations

The leaf shape and sepal width varies between populations.

Outplanting Issues

NRS have not outplanted this species.

Research Issues

Research could be conducted on any possible genetic differences between plants in the Koolau Mountains and the Waianae Mountains.

Surveys

No Urgent Action surveys were conducted for this species.

Taxon Threats

It is possible slugs attack seedlings of this species. However, this species recruits well *in situ* with no slug controls in place, so it is unlikely slugs are a major threat. This species grows in wet gulches, which are heavily impacted by feral pigs. The major weed threats to this species include *Ageratina adenophora, Buddleia asiatica, Rubus rosifolius, Clidemia hirta,* and

Christella parasitica. Rat damage has not been observed, but NRS will continue monitoring for leaf or stem chewing or seed predation.

Population Unit Level Discussion

Manage for Stability PUs:

Kahanahaiki: All of the plants in this PU are fenced. The number of individuals in the final Makua IP was a 1999 estimate by NRS staff. Plants were counted last year, and the current number more accurately reflects the actual population size, though there may be more individuals that have not yet been counted. NRS have observed an increase in population numbers in Kahanahaiki since the fence was constructed. Seeds were collected for storage testing from this PU this year. NRS spent 59.5 hours weeding in the vicinity of these plants this year.

Pahole to Kapuna to West Makaleha: The Pahole portion of this PU is fenced. The Kapuna portion of this PU is scheduled to be fenced in year 1 of the MIP. This area was partially monitored this year and large numbers of individuals of all size classes were counted. Future surveys would likely reveal even more plants. Plants in this PU appeared healthy and were recruiting well. Seeds were collected for storage testing from this PU this year. NRS spent 143 hours weeding in the vicinity of these plants this year.

Opaeula: Joel Lau and NRS's 1999 survey results from this area were reported as the number of individuals in the final Makua IP. Those sites have not been monitored since 1999. A new site with 1 mature and 7 immature plants was found by NRS in 2003. NRS spent 68 hours weeding in the vicinity of these plants this year.

Other PUs:

Kawaiiki: The number of individuals reported in the final Makua IP was a partial count of the population. Joel Lau made a more accurate count of this population in 1999. The PU has not been monitored since 1999.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Kahanahaiki	Manage for stability	Yes	Yes	No
Pahole to Kapuna to West Makaleha	Manage for stability	Partial	Partial	No
Out of AA				
Opaeula (Koolaus)	Manage for stability	No	Partial	No
Kawaiiki (Koolaus)	Genetic storage	No	No	No

5.10 *Delissea subcordata*

Requirements for Stability:

- 3 population units (PUs)
- 100 reproducing individuals in each PU (short-lived perennial with population fluctuations and local declines, potentially an obligate out-crosser)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

The larger extant populations in good habitat were chosen for management. The Haili population was discovered recently by the NARs biologist Talbert Takahama. NRS have not been to this site. It is currently the largest known *in situ* population, but the population is in a game management area where building a larger-scale ungulate exclosure would not be possible. Therefore, Haili stock will be collected and reintroduced into a sub-site of Kahanahaiki. This species is very rare and is declining in numbers. NRS will focus on getting genetic storage collections from all PUs. Plants can be propagated from seeds, and occasionally new plants are found in sites away from known populations, suggesting they may be dispersed by birds. It is also possible this species has a persistent seedbank. During seed storage testing, it was found that seeds stored imbibed in the dark germinate well when exposed to light, supporting the seedbank hypothesis. Because it is possible to propagate plants from seed and the habitat this species is found in is manageable, it will be possible to augment populations to stable numbers. However, until the reason for low levels of recruitment in the field is discovered, it is unlikely this taxon will be stable without NRS management.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Kahanahaiki to Keawapilau	Manage for stability	15/1	5/0	24/1	29/1
South Mohiakea	Genetic storage	2	1/1	None	1/1
Out of AA					
Ekahanui	Manage for stability	14	3/1	0/44	3/45
Kaluaa	Manage for stability	1	1/1	43/0	44/1
Huliwai	Genetic storage	7	0	None	0
Kaawa	Genetic storage	2	0	None	0
Palawai	Genetic storage	1	2/3	None	2/3
Palikea Gulch	Genetic storage	2	2/0	None	2/0
Haili	Genetic storage	New population	7/0	None	7/0

Genetic storage

Four different seed storage treatments have been tested: room temperature/room humidity, room temperature/10% relative humidity, 4°C/33.5% relative humidity, and –18°C/20% relative humidity. After one year, seeds stored at room temperature and room humidity had no germination. There was no difference between the other three treatments, all had approximately 80% germination, indicating that the best storage temperature and drying relative humidity have yet to be determined. Another collection that was tested at –18°C/10% relative humidity and –18°C/20% relative humidity yielded very low germination after two years. Further testing needs to be done. There are currently 6741 seeds in storage from the Kahanahaiki to Keawapilau PU (though most of those seeds are from a reintroduction of Kapuna stock), 118 seeds in storage from the Palawai PU, and 742 seeds in storage from the South Mohiakea PU.

Genetic Storage of *In situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Kahanahaiki to Keawapilau	Manage for stability	5/0	4	0	0	4
South Mohiakea	Genetic storage	1/1	2	0	1	2
Out of AA						
Ekahanui	Manage for stability	3/1	0	2	2	0
Kaluaa	Manage for stability	1/1	0	0	0	0
Huliwai	Genetic storage	0	0	0	0	0
Kaawa	Genetic storage	0	0	0	0	0
Palawai	Genetic storage	2/3	1	3	0	0
Palikea Gulch	Genetic storage	2	0	2	0	1
Haili	Genetic storage	7/0	0	0	0	0

Propagation/Germination Techniques

Fruit should be collected when the fruit are purple and fleshy, but still somewhat firm. Seeds germinate well in flats on vermiculite and perlite. Initial germination rates on agar during the seed storage trials at Lyon Arboretum were 82%. It is also possible to grow plants from cuttings, but plants usually have only one growing point so cuttings are not the preferred method of propagation unless appropriate material is available.

Unique Species Observations

HINHP botanist Joel Lau has observed germination of same-aged plants in the field in areas where there is no obvious parent plant, suggesting there may be a persistent seed bank. Seed storage testing has shown that seeds stored imbibed in the dark germinate well when exposed to light, also suggesting there is a good potential this species forms soil seed banks. Bird predation

on fruits has been observed, and at two separate sites a juvenile plant is growing right next to a fence. This could be because of bird dispersal, or possibly because soil disturbance enhances seed germination.

Outplanting Issues

There are currently three outplantings of this species. Kapuna stock has been reintroduced into Kahanahaiki, South Mohiakea stock has been reintroduced into Kaluaa, and Palikea Gulch stock has been reintroduced into West Makaleha. Details on the individual outplants are below under 'Population Unit Level Discussion'. This taxon is tolerant of weedy areas, so it is not difficult to find sites for outplanting. However, the plants are susceptible to slug predation while they're young. Once plants become mature, they do well.

Research Issues

Slugs are a threat to seedlings of this species, and slug damage has been observed on plants of all size classes. Next year NRS will work with Stephanie Joe, a UH-Manoa graduate student, to obtain a permit for use of slug baits in natural areas.

Surveys

HINHP botanist Joel Lau spent four days surveying for this species as part of Urgent Actions 2. Surveys were focused on refinding existing populations that had not been monitored for several years, and searching the general vicinity of those populations for potential new plants. Mr. Lau's surveys of Huliwai and Kaawa revealed that those populations were both gone, and the habitat severely degraded. Mr. Lau monitored the known plants in Palawai and Ekahanui, but no new individuals were found. While conducting a survey for another species, Mr. Lau found a previously unknown mature plant in Kapuna this year.

Taxon Threats

Slugs eat seedlings of this species, and slugs appear to have eaten the stem of an immature plant at the West Makaleha reintroduction. Rats prey upon the seeds of this species. A grid of rat bait stations and snap traps has been set up around the West Makaleha reintroduction. This species tends to be found in weedy habitat in mesic forests, and weeds such as *Schinus terebinthifolius* and *Passiflora suberosa* are major threats.

Population Unit Level Discussion

Manage for Stability PUs:

Kahanahaiki to Keawapilau: The plant in Kahanahaiki is within a fence, and is monitored regularly. The origin of this single plant is still unclear. It may be an F1 plant from the nearby reintroduction, or it may be a wild plant transported to the site by a bird. This plant may also be a new seedling from a historic population. NRS collected leaf material from the plant for genetic

analysis by Dr. Cliff Morden at the University of Hawaii. Until the results are in, NRS will treat this individual plant as unique and significant.

NRS outplanted 30 immature plants into the Kahanahaiki fence in January 1999. There are currently 22 mature and 1 immature plants at this site, and the mature plants have been observed flowering and fruiting. No seedlings, apart from possibly the plant of unknown origin discussed above, have been observed in this reintroduction. Mature fruit has been collected for genetic storage trials at the Lyon Arboretum. NRS spent 18 hours weeding at the reintroduction site this year.

NRS have not been the plants in Pahole NAR. The State NARS biologist has collected seeds from this population in the past. NRS will accompany the NARs biologist to monitor the Pahole plants this year.

NRS visited the known population location in Kapuna gulch with State NARS staff in the last year, and no live plants were found. However, the HINHP botanist found a new site with one mature plant near the historic location in Kapuna this year. In the coming year, NRS will assist NARS staff to monitor this plant and collect fruit for genetic storage at the Lyon Arboretum. NRS spent 60.5 hours weeding in this area to support other species.

Ekahanui: The number of individuals in the final Makua IP was from TNC's 2001 observations. Since that time, several plants have died. TNC staff outplanted 46 immature plants from stock collected from now dead Ekahanui plants. There are currently two sites with *in situ* plants. One site has one immature and two mature plants, and the other site has one mature plant. NRS and TNC staff built fences around these sites in the last year. Seed collections were made this year. Some of the seeds went to Lyon Arboretum for storage, and the rest are being grown for reintroduction. NRS will continue to monitor the plants at these sites and collect seeds for storage and storage testing. NRS spent 44.5 hours weeding around these sites this year.

Kaluaa: The *in situ* plant included in the final Makua IP died. Recently, TNC staff found two new plants on a ridge in Central Kaluaa in the fenced area. TNC staff and NRS monitored the plants for fruit this year, but the buds aborted before flowering. The plants are young, and NRS believe this may have been the first year they flowered. In 2002, NRS and TNC staff outplanted 43 plants of South Mohiakea stock into the Kaluaa exclosure. This past year, mature fruit was collected from reintroduced plants for seed sowing trials being conducted by TNC. NRS spent 66 hours weeding in the vicinity of this reintroduction this year.

Other PUs:

South Mohiakea: Last year, two mature plants were known in Mohiakea gulch. Both were within a small fence. This year one of the plants died after it was decapitated by a rock fall. The top of that plant was brought back to the Army nursery where it rooted. This year, an immature plant was discovered by NRS within the fence. Access to the population is restricted by training activity, which limits the management options available to NRS. There have been successful collections of mature fruit from this population in the past. Collections are being stored at Lyon

Arboretum. Seedlings from germination testing were grown at the Army Nursery. Plants from this population have been reintroduced to Kaluaa gulch.

Huliwai: HINHP botanist Joel Lau monitored this site this year, and the plants are gone. The habitat has been severely degraded by weeds and ungulates. No stock from this PU remains.

Kaawa: Joel Lau and NRS surveyed the historic location for this species the last year. No live plants were found. No stock from this PU remains. This site may be monitored in the future for new plants when conducting other management in the area, but will not be a target for management. The habitat at this site has been heavily impacted by feral ungulates. NRS conducted goat control in Lower Kaala NAR this year, which should benefit the habitat.

Palawai: The plant included in the final Makua IP died. TNC found two new small populations, and this year fences were constructed around these plants. One of the sites consists of two mature plants; the other site consists of three immature plants. NRS collected seed for storage from the two mature plants this year. Palawai stock will be used for augmentations at other sites.

Palikea Gulch: Two locations with this species are known from Palikea Gulch in Lower Ka`ala NAR. One has one mature plant and it was in poor condition when monitored in July of 2003. There have been no known collections from this plant. State NARS staff has monitored the other site in the past and fruit has been collected and is stored at the Lyon Arboretum. NRS will assist NARS as needed in monitoring and collecting from these sites in the coming year.

Haili: Last year, NARS biologist Talbert Takahama found a new population of 7 mature individuals on State land. NRS have not been to this site. This population is in a game management area, so constructing a larger-scale ungulate exclosure would not be possible.

West Makaleha: In 2002, NRS worked with NARS staff at West Makaleha to establish a reintroduction of stock collected from the Palikea Gulch population. Twenty plants were planted inside the exclosure in January 2003. Two plants sustained damage from rats and several from slugs in May 2003 and were in moderate health at that time. In response to the rat predation, bait stations were placed around the outplanted plants and monitored quarterly. During 2004, monitoring increased to twice quarterly and 10 snap traps were added to the baiting area. In July 2004, the two plants damaged by rats had died, but the remainder of the plants were in good health with several fruiting. In the coming year, NRS will restock the stations and monitor the plants.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Kahanahaiki to Keawapilau	Manage for stability	Partial	Partial	No
South Mohiakea	Genetic storage	Yes	Yes	No
Out of AA				
Ekahanui	Manage for stability	Yes	Partial	No
Kaluaa	Manage for stability	Yes	Partial	No
Huliwai	Genetic storage	N/A	N/A	N/A
Kaawa	Genetic storage	N/A	N/A	N/A
Palawai	Genetic storage	Yes	Partial	Partial
Palikea Gulch	Genetic storage	No	No	No
Haili	Genetic storage	No	No	No

5.13 *Hedyotis degeneri* var. *degeneri*

Requirements for Stability:

- 3 population units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

The largest populations in the best habitat were chosen for management. The East Branch of East Makaleha PU overlaps with a *Pritchardia kaalae* PU, and will be included in the Makaleha fence. Kahanahaiki to Pahole is one contiguous area and will be treated as one effort. This taxon generally grows in a very narrow band on ridge crests. There is a lot of undersurveyed habitat for this taxon, and there are likely many more *in situ* plants from Makaleha to Alaiheihe. This taxon is heavily impacted by goat traffic and occasional goat browsing where goats are present. Feral pigs also degrade its habitat. Plants can be propagated from seeds or cuttings, and where feral ungulates aren't degrading the habitat, recruitment occurs *in situ*. Outplantings have not yet been attempted for this taxon, but NRS don't forsee any major difficulties. Once ungulates and weeds are controlled, it should be possible to stabilize this taxon.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Kahanahaiki to Pahole	Manage for stability	161	40/0	None	40/0
Out of AA					
Alaiheihe and Manuwai	Manage for stability	60+	60/0	None	60/0
East Branch of East Makaleha	Manage for stability	10	10/0	None	10/0
Central Makaleha and West Branch of East Makaleha	Genetic storage	47+	35/3	None	35/3

Genetic storage

There are 9219 seeds from 11 plants from the Central Makaleha and West Branch of East Makaleha PU in storage (two of those plants have fewer than 25 seeds in storage so aren't counted in the table below). There are 1471 seeds from three plants in storage from the Kahanahaiki to Pahole PU. In the last year, NRS attempted to collect more seed for genetic storage, but were unable to collect any mature seeds. This taxon does not have a predictable phenology, so it is very difficult to know when mature seed will be present. Plants respond well

to subculturing in micropropagation. This year NRS will collect cuttings for micropropagation and research the possibility of using micropropagation as an alternative storage method for large numbers of individuals.

Propagation/Germination Techniques

No seed storage testing has been done. Seeds are currently stored at 4C and 20% relative humidity. Initial germination trials have shown quite a bit of variability. Only approximately 30% of seeds from a batch collected in West Branch of East Makaleha for storage in November 2003 germinated. Of the 50 seeds tested from a batch collected in Kahanahaiki for storage in January 2004, 84% germinated. Plants can also be propagated from cuttings. Approximately 30% to 50% of cuttings collected in November 2003 rooted. There is currently one plant in the NRS greenhouse that was propagated from a cutting collected in West Branch of East Makaleha in November 2003. Because plants have an unpredictable fruiting time, NRS will focus on collecting cuttings to be grown in the greenhouse and used for seed production for storage.

Genetic Storage of *In situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Kahanahaiki to Pahole	Manage for stability	40/0	3	0	0	0
Out of AA						
Alaiheihe and Manuwai	Manage for stability	60/0	0	0	0	0
East Branch of East Makaleha	Manage for stability	10/0	0	0	0	0
Central Makaleha and West Branch of East Makaleha	Genetic storage	35/3	9	0	1	0

Unique Species Observations

Hedyotis degeneri var. *degeneri* grows alongside *Hedyotis acuminata* and *Hedyotis schlechtendahliana* in Makaleha, and the taxa could potentially hybridize. This makes it difficult to positively identify var. *degeneri* in places where the three taxa coexist.

Outplanting Issues

NRS have not outplanted this species, nor have any other natural resource programs on Oahu.

Research Issues

Seed storage trials need to be conducted.

Surveys

No Urgent Action surveys were conducted for this species. While surveying for other species in November 2003, HINHP botanist Joel Lau found 1 immature and 13 mature plants of this taxon in Central Makaleha. NRS surveyed in East Branch of East Makaleha this year, and found an additional site with at least one mature *Hedyotis degeneri* var. *degeneri*. There were two other species of *Hedyotis* in the area, so some of the other plants that appeared to be var. *degeneri* could not be positively identified, as they may have been hybrids.

Taxon Threats

Weeds such as *Ageratina adenophora* and *Rubus argutus* are threats to this taxon's habitat. Feral pigs and goats also threaten this taxon. In Makaleha, goats have created erosion that is limiting the available habitat for this taxon, and goat browsing has been observed on some of the plants.

Population Unit Level Discussion

Manage for Stability PUs:

Kahanahaiki to Pahole: There were 11 individuals in the final Makua IP from Kahanahaiki, several of which were in poor condition. This site is monitored regularly by NRS, and currently there are only 4 plants. NRS have observed recruitment at this site. This population is located within the Kahanahaiki MU, but is outside the Kahanahaiki fence. A fence is planned for this area in year 1 of the MIP. This species benefits from ungulate control conducted in the area. The MMR fire in July 2003 burned to within 50 meters of this population. NRS will continue to attempt to collect for genetic storage and will continue ungulate control in the area.

The number of individuals in Pahole in the final Makua IP was based on Ken Wood's 1996 estimate of 150 plants. This year NRS began working more frequently in Pahole Gulch and visited known populations of *H. degeneri*. NRS approximated 24 plants at one site, but the area is undersurveyed and there are likely more plants. On a separate day, NRS visited a site with 12 plants. As NRS continue to survey in Pahole, it is expected that more plants will be discovered. This year, NRS will monitor the known sites and attempt to collect for genetic storage.

East Branch of East Makaleha: One of the sites has not been monitored since 1999. NRS found a second site with at least one var. *degeneri,* and possibly more, while surveying East Makaleha in 2004. More surveys will be done in this area to sort out species identification and determine how many of the plants are *H. degeneri* var. *degeneri*. This species benefits from the goat hunts that NRS and the State of Hawaii have been conducting in the area.

Alaiheihe and Manuwai: These sites have not been monitored since 2000. Currently this area is scheduled to be fenced in year 8 of the MIP. NRS surveyed the Manuwai area this year, and found that it is very weedy and very steep, and not easily fenceable. Other options for fencing may be considered. NRS will conduct surveys to determine if smaller fences on the ridge crests,

the primary habitat for this taxon, will be more practical than a large fence. If so, these smaller fences will be constructed immediately. Habitat management would then take place outside of the smaller fences. These plants benefit from ungulate control in the area. In the coming year, NRS will continue ungulate control, survey for more plants in this area, and collect for genetic storage.

Other PUs:

Central Makaleha and West Branch of East Makaleha: Mature and immature plants were inadvertently tallied in the final Makua IP. The actual number of plants should have been 34 mature and 13 immature. At this time there are 45 mature plants in Central and East Makaleha at four different locations. There are a few juveniles and seedlings between the populations. In the coming year, NRS will continue genetic storage collections from this PU, and survey for more individuals.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Kahanahaiki to Pahole	Manage for stability	Partial	Partial	No
Out of AA				
Alaiheihe and Manuwai	Manage for stability	No	No	No
East Branch of East Makaleha	Manage for stability	No	No	No
Central Makaleha and West Branch of East Makaleha	Genetic storage	No	No	No

5.14 *Hedyotis parvula*

Requirements for Stability:

- 3 population units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

All remaining *in situ* populations will be managed. Ohikilolo is the center of abundance for this species, and the Ohikilolo PU has stable numbers of individuals. The portion of the Halona PU that is on State land will be managed, and the portion on Navy land will be monitored. The State portion of the Halona PU needs to be revisited to determine if a fence is needed. In addition to managing the Halona PU off-site, a reintroduction may be conducted in Central and East Makaleha near a historical location for this species. A revised fire threat model is being run for Makua Valley, and it is expected that the Ohikilolo Mauka portion of the PU will have a lower fire risk. When the fire model is complete, NRS will reconsider how fire threat impacts the proposed management of this species. If fire models show that the Ohikilolo PU has a lower fire threat, it may not be necessary to reintroduce into Central and East Makaleha. Plants tend to grow on steep cliffs where feral ungulates are less of a threat, and currently weeds are not a major problem. This species can be grown from seeds or cuttings, and while reintroductions have not been attempted, NRS believe they are possible. This taxon has a good prognosis for reaching stability.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Ohikilolo Makai and Ohikilolo Mauka	Manage for stability	66/1	78/12	None	78/12
Out of AA					
Halona	Manage for stability	64-79	12/0	None	12/0
Reintroductions					
Central and East Makaleha	Manage reintroduction for stability	N/A	N/A	0	0

Genetic Storage

No seed storage testing has been done. There are currently close to 50,000 seeds in storage from 58 plants from the Ohikilolo Makai and Ohikilolo Mauka PU. Two of the plants have fewer than 25 seeds in storage, and therefore don't show up on the table below. As the MIP requires

collection from 50 plants from each PU, storage requirements from this PU have been met. NRS will focus on collecting seeds from the Halona PU this year.

Genetic Storage of *In situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Ohikilolo Makai and Ohikilolo Mauka	Manage for stability	78/12	56	0	0	0
Out of AA						
Halona	Manage for stability	12/0	0	0	0	0

Propagation/Germination Techniques

Plants can be propagated from seeds or cuttings. Initial viability of seeds is very variable, but the reason some of the collections have poor viability is unknown. In 2002, 50 seeds were tested for initial germination and close to 70% germinated. In 2003, 50 seeds were tested for initial germination and only 2% (one seed) germinated. Seeds from herbarium specimens from the National Tropical Botanical Garden were taken to Lyon Arboretum for germination testing, but none of the seeds were viable. NRS are currently collecting cuttings to be used for micropropagation. If micropropagation is successful, it may be a viable alternative to seed storage. NRS have not worked extensively with cuttings of this species, but it is expected they will be easy to grow, much like *Hedyotis degeneri*.

Unique Species Observations

There are no unique observations for this taxon.

Outplanting Issues

No outplantings of this species have been done. It may be challenging to find locations for outplanting. Plants grow on very steep cliffs, so outplantings may have to take place on rappel. If outplanting is conducted, NRS will use the upper and lower ends of cliffs to limit the amount of rope work required. If an appropriate spot is not available, NRS will look further down cliffs for spots where holes can be dug. To experiment with outplanting on cliffs, NRS outplanted three *Lysimachia* plants onto a cliff on Ohikilolo. The outplanting was done on rappel. Two of the three individuals survived.

Research Issues

Seed storage testing needs to be done for this species. In addition, research on seed viability and seed dormancy should be conducted.

Surveys

No Urgent Action surveys were conducted for this species. NRS surveyed the historical location in East Makaleha this year, but were unable to locate any plants.

Taxon Threats

Hedyotis parvula grows on very steep cliffs, and goats impact its habitat. No goat browsing has been observed on plants of this species, but NRS will continue to monitor for browsing. *Rubus argutus* is a threat to the Ohikilolo Mauka plants, and *Melinius minutiflora* is found directly above the Makai plants. Last year NRS spent 17 hours controlling *Rubus argutus* near the Mauka plants, and 4 hours conducting grass control above the Makai plants. NRS will continue to monitor *Melinis minutiflora, Rubus argutus,* and *Erigeron karvinskianus* in the area. It is unknown if slugs impact this species.

Population Unit Level Discussion

Manage for Stability PUs:

Ohikilolo Makai and Ohikilolo Mauka: There are two known sites with *H. parvula* in MMR. Currently the Makai location has 46 mature, 12 immature and 11 seedlings. The Mauka location has 32 mature and 6 immature plants. Over the last couple years NRS have focused on managing ecosystem threats to this species. Since 1995, over 1,500 goats have been removed from MMR. It is estimated that fewer than 20 goats remain. NRS continue to control goats within MMR with the short-term goal of complete eradication. Since goat numbers have been drastically reduced, NRS have observed *Hedyotis parvula* in areas formerly impacted by goats. Last year NRS spent 17 hours weeding *Rubus argutus* in the vicinity of these PUs, and 4 hours doing grass control. In addition, erosion control measures put into place on the steep ridge above this population have helped prevent loss of habitat.

Halona: The number of individuals in the final Makua IP was from Steve Perlman's 1995 observation of between 60 and 75 plants on Navy land, and Joel Lau's 1994 observation of four individuals on State land. The portion of this PU on Navy land was monitored in July 2003. The numbers of individuals in the 'Taxon Status' table above reflects only the NRS monitored Navy portion of the population. There were no immediate threats to the population, and the plants appeared healthy. No collections were made. In the coming year, NRS will revisit these plants and collect for genetic storage. In addition, NRS will monitor the plants on the State portion of this PU.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Ohikilolo Makai and Ohikilolo Mauka	Manage for stability	Yes	No	No
Out of AA				
Halona	Manage for stability	No	No	No

5.15 *Hesperomannia arbuscula*

Requirements for Stability:

- 3 population units (PUs)
- 75 reproducing individuals in each PU (long-lived perennial but with low seed set, and recent severe population declines)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon-Level Discussion

There are five remaining populations of *Hesperomannia arbuscula*. The one PU in the action area and the two largest PUs outside of the action area will be managed for stability. All of the PUs have declined in numbers since the final Makua IP. Ungulate damage, and possibly old age or drought, have reduced the number of mature plants in the wild (S. Ching, pers comm.) NRS in cooperation with the BWS biologist and the Oahu Genetic Safety Net biologist monitored all of the populations this year. There are a lot of obstacles to stability of this taxon. Population numbers are very low, and there is little recruitment in the wild. Seed viability is very low. Seeds germinate in micropropagation, but never produce roots. Vegetative propagation using air-layers is possible, but difficult and time consuming.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Kapuna	Manage for stability	7	1/0	None	1/0
Out of AA					
North-north Palawai	Manage for stability	New population	6/0	None	6/0
Makaha	Manage for stability	13/1	8/0	None	8/0
Kaaikukai	Genetic storage	1	0	None	0
North Palawai	Genetic storage	5/2	1/0	None	1/0
Waianae Kai	Genetic storage	9/1	5/1	None	5/1

Genetic storage

Genetic storage for this species is difficult. Seed storage has not yet been attempted because reliable seed germination techniques have not been determined. The Lyon Arboretum seed propagation facility started germination trials this July with 156 seeds from North-north Palawai. The initial assessment of the seeds found that only approximately 30 of them were viable. Five air-layers and four seedlings are growing at the Pahole nursery to be used as a source for creating more stock through air-layering or seed collection. This year one of the plants flowered but failed to produce viable seed. Due to the low numbers of seeds produced each year, most seeds

are put into micropropagation rather than used for seed germination trials. There are many small plants started from seed in Lyon Arboretum's micropropagation facility, but only one plant has ever produced roots. That plant was moved to the Army's Wahiawa nursery in 2001 but died two years later. Trials continue at the micropropagation facility in an attempt to get the plants to produce roots.

Genetic Storage of *In-situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Kapuna	Manage for stability	1/0	0	0	0	0
Out of AA						
North-north Palawai	Manage for stability	6/0	0	2	4	0
Makaha	Manage for stability	8/0	0	2	0	0
Kaaikukai	Genetic storage	0	0	0	0	0
North Palawai	Genetic storage	1/0	0	0	0	0
Waianae Kai	Genetic storage	5/1	0	3	1	0

Propagation/Germination Techniques

Seeds from the North-north Palawai plants were taken to the micropropagation facility at Lyon Arboretum where some of them have germinated. In previous years, seeds were collected from Makaha and Waianae Kai and put into micropropagation where many of them germinated. So far only one seedling has ever produced roots, even though many different treatment methods have been tested. The seedling that did form roots was accidentally placed upside-down in the test tube. Air-layers were attempted this year on plants in Makaha, Waianae Kai, North Palawai, North-north Palawai and Kapuna. There are currently five plants from air-layers, four from North-north Palawai and one from Waianae Kai, growing in the nursery at Pahole. Five seedlings that weren't doing well in the wild in Palawai were removed to the mist house at Pahole this year, and four of them survived and are growing. The goal is to grow the plants in the greenhouse for either seed production or to produce more air-layers so there are sufficient individuals to attempt outplanting.

Unique Species Observations

Plants have poor seed and pollen viability. The flowers are very showy, and apparently were picked off the Waianae Kai plants this year (see Threats discussion below).

Outplanting Issues

Until NRS are able to propagate large numbers of individuals, no outplanting can be done with this species.

Research Issues

Testing of different types of media in micropropagation needs to be continued. In addition, more research needs be done on the reproductive biology of this species. As part of her Master's thesis, Susan Ching-Harbin researched the pollen viability and seed viability of this species. She found 44.6% pollen viability over three years of sampling, with a range of 8.9% to 85.7% viability. From a total of 2334 achenes collected from 11 individuals over three years, she found only 2.6% seed viability. Of the 2.6% (61 embryos) that germinated, only 2 survived for approximately 2 years in micropropagation (S. Ching-Harbin 2001). If the air-layered plants at the Pahole nursery flower this spring, the North-north Palawai plants will be cross-pollinated with the Waianae Kai plant to see if this increases seed viability.

Surveys

Additional surveys for *H. arbuscula* were contracted as part of Urgent Actions 2 and 3. The HINHP botanist, Joel Lau, spent 3 days surveying in Honouliuli in 2003. During these surveys Mr. Lau found the new North-north Palawai population. This year Mr. Lau will conduct more surveys in Honouliuli for this species.

Taxon Threats

The Waianae Kai plants are very close to the trail, and this year the flowers from several of the plants mysteriously disappeared. The Genetic Safety Net biologist believed they had been picked, so put a sign up near the plants describing the rarity of this species and the importance of allowing the flowers to remain on the plants to produce seed. The plants flowered again, but at a later monitoring the flowers were gone and appeared to have been picked again.

Plants may be susceptible to the black twig borer. When recently dead plants were examined, borer holes were found in the stems.

Feral pigs are degrading this species' habitat, and appear to be directly responsible for the death of at least one plant in Makaha by digging up its roots.

Weeds are degrading the habitat where this species grows. However, plants are fragile, and NRS are concerned that the physical impact to the plants while weeding in the vicinity may be detrimental.

Population Unit Level Discussion

Manage for Stability PUs:

Kapuna: The number of individuals reported in the Final Makua IP was based on NARS biologist Talbert Takahama's 1998 monitoring. When the site was monitored this year, only one plant remained. Air-layers were put on the plant by the Oahu Genetic Safety Net biologist, who is monitoring their progress. To date, the air-layers have not yet produced roots. NRS spent

60.5 hours weeding in the vicinity of this plant this year. In the coming year, NRS will assist NARS staff in monitoring and collecting from this plant. This plant is an area proposed for fencing in year 2 of the MIP.

North-north Palawai: This population was discovered by the HINHP botanist Joel Lau in September 2003. In November 2003 NRS and TNC staff erected a fence around these plants and TNC staff and NRS spent 26 hours weeding this area. Target weeds included *Passiflora suberosa, Melinis minutiflora, Schinus terebinthifolius, Psidium cattleianum,* and *Clidemia hirta.* Flowers were observed on the plants this year, and seeds were collected and taken to Lyon Arboretum for germination trials. The Oahu Genetic Safety Net botanist set up air-layers on several of the plants, four of which successfully rooted and are growing at the Pahole nursery. Four seedlings that were doing poorly at this site were relocated to the Pahole nursery. One of them died, and the other three are growing in the mist house. All of the seedlings that were left in the wild died. Thirteen fruits were collected by TNC staff in July and taken to Lyon Arboretum for germination trials. Most of the seeds floated in water, suggesting they are not viable, but all 156 of them were sown on agar.

Makaha: NRS and the BWS biologist monitor this population annually. Several of the plants died last year, probably due to the high level of feral pig activity in the area. The Oahu Genetic Safety Net botanist attempted air-layers on these plants, but none of them were successful. Plants flowered this year, but the PU was revisited too late for seed collection. This year four new seedlings were found, though they may be a couple years old. A small-scale fence was scoped and cultural surveys were conducted at this site in August. The State departmental permit application for building a small fence around these plants is in process, and fence construction will begin as soon as permission is obtained. This population is also in the larger proposed fence in Makaha.

Other PUs:

Kaaikukai: Dan Sailer, the Nature Conservancy Natural Resource Manager, monitored this plant this year and reports that it is now dead.

North Palawai: All but one of these plants has died in the last two years. Air-layers were attempted on the remaining individual by the Oahu Genetic Safety Net botanist, but they were not successful. One seedling that was near a trail and doing poorly was taken to the Pahole nursery and is growing in the mist house.

Waianae Kai: NRS and the Genetic Safety Net botanist monitored this site last year and only five mature plants remained alive. Air-layers were attempted, two of which were successful. Both air-layers were taken to the Pahole nursery. One of the air-layers died when the plant blew over in a windstorm earlier this year. The remaining plant flowered this year, but did not produce viable seed. These plants flowered this year, but someone apparently picked the flowers (see 'Threats' above). NRS assisted the Genetic Safety Net botanist with scoping a small fence for this site. The fence will be constructed this year. NRS will weed at this site in October 2004.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Kapuna	Manage for stability	No	Yes	No
Out of AA				
North-north Palawai	Manage for stability	Yes	Yes	No
Makaha	Manage for stability	No	No	No
Kaaikukai	Genetic storage	No	No	No
North Palawai	Genetic storage	No	No	No
Waianae Kai	Genetic storage	No	No	No

5.16 *Hibiscus brackenridgei* subsp. *mokuleianus*

Requirements for Stability:

- 3 population units (PUs), one of each type
- 50 reproducing individuals in each PU (short-lived perennial)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

There are three slightly different types of *Hibiscus brakenridgei* ssp. *mokuleianus* found on Oahu (Joel Lau pers. comm. 2001). The "short" type is from Makua, the "medium" type is in Haili to Kawaiu and the "tall" type is in Kaimuhole to Palikea. While there are certainly exceptions to these classifications, they are in three different geographic regions. The type known from Makua resembles the plants historically known from Molokai (subsp. *molokaiana*). No plants are known from Molokai today. One population of each of the types (tall, medium, and short) will be managed. Only one population is on Army lands and it is the only one in the action area, so management is contingent upon cooperation with the State of Hawaii and Dole Food Co. Many of the plants on State and Dole lands are on cliffs in severely degraded areas so reintroductions using this stock will be done into more manageable areas. Stock from three of the five wild population units has been planted off-site around the island by NRS. If threats from ungulates can be controlled and plants can be planted into manageable areas, this taxon has a good probability for stabilization.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Makua	Manage for stability	4/3	18/8	None	18/8
Out of AA					
Haili to Kawaiu	Manage for stability	3/1	1/22	None	1/22
Kaimuhole and Palikea Gulch	Manage for stability	3/5	7/230	None	7/230
Kaumoku Nui	Genetic storage	0/2	2/750	None	2/750
Kihakapu	Genetic storage	1/2	6/316	None	6/316

Genetic Storage

This species grows easily from cuttings. This allows for plants to be cloned in the nursery and many plants can be produced quickly. This species appears to do well in cultivation for a few years in large pots and for several more when planted in the ground at botanical gardens. There are plants from eleven founders from the Makua PU currently in botanical gardens and at Makua Range Control. Plants from one founder from Palikea Gulch and plants from six founders from

the Kaumoku Nui population are represented at Waimea Botanical Garden and at the Army Baseyard.

Mature plants can produce hundreds of flowers in a season and plants produce several hundred seeds in a season. In order not to affect seed production in the wild patch, few seeds have been collected from those plants. Instead, more than 12,000 mature seeds were collected from clones of the Makua plants in the ground at Makua Range Control. Unfortunately, much of the seed that was collected is not viable. In addition, there is a long processing time required to get the seed out of the woody capsule, making it difficult to quickly obtain large numbers to offset low viability. Lauren Weisenberger of the Lyon Seed Storage Lab investigated the seed collected from other living collections at Koko Head and Kaala Learning Center and found similar results. She came to Makua Range Control to investigate the site and see if she could determine causes for low viability. She found that the growing tips of some plants appeared stressed and suggested that perhaps this was why the plants did not produce viable seed. NRS will work with her next year during collection to examine causes and improve efficiency of collection. In an attempt to improve vigor and hopefully seed viability in the Range Control plants, they were selectively pruned to reduce plant stress and to direct next season's flowering branches. A slow release fertilizer was broadcast after pruning. A slow release insecticide was also applied to address the insect pests in the area.

Genetic Storage of *In situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Makua	Manage for stability	18/8	6	1	11	11
Out of AA						
Haili to Kawaiu	Manage for stability	1/22	0	0	3	0
Kaimuhole and Palikea Gulch	Manage for stability	7/230	0	0	1	1
Kaumoku Nui	Genetic storage	2/750	0	0	0	0
Kihakapu	Genetic storage	6/316	0	0	0	0

Propagation/Germination Techniques

Clones are easily grown from these plants by sticking cuttings in a powdered growth hormone solution, and placing the cuttings in perlite and vermiculite filled pots on a mist-bench. Roots develop in a few weeks and plants are easily transferred into sterile media. They grow very quickly and can fill pots with their roots in a few months. Because of this, it is difficult to keep the plants in pots for very long. Plants being grown for reintroduction must not be prepared to early in the year or they may become too root-bound before planting season. No air-layers have been attempted on this species, but it is likely they would be successful.

Some seeds produced by healthy plants can be easily germinated. However, as mentioned above, few viable seed are produced considering how many a single plant produces. Cuttings are the preferred method for propagating this species.

Unique Species Observations

The Makua PU has undoubtedly been burned dozens of times over the years, yet plants have germinated in new areas of the patch in the last year, suggesting the seedbank is still viable. The plants in a single region can exhibit small differences in the flower color, leaf size and shape spine length and plant size indicating genetic diversity. This taxon appears to do well in cultivation. A plant from the Makua "short" type can grow to six feet tall and at least as wide in a few years when watered, fertilized and treated with insecticide. A single plant can produce thousands of flowers, with more than fifty opening in a day during the height of the season. (J. Lau pers. comm.) Seedlings have germinated and grown along a fence line at the Army Wheeler Base-yard, where the Makua living collection is kept, suggesting new seedlings may become established at reintroduction sites. The Kaumoku Nui PU persisted in a cattle pasture for years and still produces seedlings.

Outplanting Issues

Plants grown from cuttings from the Makua plants have been planted into Kaluakauila, Makua Range Control, Koko Head Botanical Garden and Kaala Learning Center. In general, the plants have thrived, producing flower and some viable fruit. No seedlings have been found at any of these sites. Seedlings have grown at the Wheeler base-yard under mature plants kept in large pots. Plants will need pruning and fertilizer to remain healthy and looking good in a botanical garden setting. The Kaluakauila site is the only remote reintroduction site. It was watered once at planting, watered once more two weeks later, then left alone. Thirty of the original 38 have survived. Four were burned in the 2002 fires, but only one of those died. No seedlings have been observed at this site but plants have only flowered twice since being planted. Seedling establishment may need more time considering the low viability of the other seed collections.

Research Issues

The low viability of the recent seed collections should be researched. This will involve comparing collections of all plants in cultivation from the different sites. Lauren Weisenberger from the Lyon Seed Storage Lab has looked at seed collections from other plantings of the Makua stock. These other collections from the plants at the Kaala Learning Center and Koko Head Botanical Garden also had low viability like the Range control collections. No collections were made from the Kaumoku Nui stock planted at the Wheeler Baseyard, Waimea Botanical Garden and Waialua High School.

Surveys

In the last year, six days of surveys by Joel Lau and NRS on the Dole lands below the Lower Kaala NAR found hundreds of immature plants and a few mature plants. Plants were found in gulches where they had been previously reported (Kihakapu, Palikea, Kaimuhole) and others

were found in nearby Puulu gulch, where they were never reported. More surveys would likely find more sites in these gulches. There are still under-surveyed areas in nearby gulches. Surveys were also done in Kealia and Kawaiu. A new site was found in Kawaiu near the known plants and only the known plants were found in Kealia. NRS will continue to note new locations of this taxon while working in the area, but no new surveys are planned in any areas.

Taxon Threats

Goats and pigs threaten the Kaimuhole and Palikea, and Kaumoku Nui PUs. Cattle have been seen in the Kaumoku Nui PU as well and certainly browse seedlings growing outside the fence. The Haili to Kawaiu and Makua PUs have no ungulate threat. The Kaluakauila reintroduction is partially within the fence and some plants are outside the fence but are unlikely to be threatened by ungulates. Weeds are a major threat at all populations. All populations are found in severely degraded areas with difficult to manage weeds. No significant invertebrate damage has been observed at any populations. Fire is a major threat to all PUs because of the *Panicum maximum*.

Population Unit Level Discussion

Manage for Stability PUs:

Makua: There are now 18 mature, 8 juvenile and 11 seedling *Hibiscus* plants located in Makua valley. Some new plants have emerged from areas below existing mature plants and may have germinated from seed recently produced by those mature plants. Other seedlings have emerged from areas with no mature plants that were previously dominated by Guinea grass. When this PU was discovered, most plants were restricted to the thin soil on and near the cliff. Since the guinea grass has been removed, plants have germinated in the areas with deep soil, which were dominated by guinea grass. NRS collected cuttings from almost all of the mature plants and juvenile plants that were large enough to collect from. NRS have a complete set of these clones at the Army nursery. Clones are also planted at Makua Range Control, Kaluakauila management unit and Koko Head Botanical Garden. A full set of clones is not yet established at any one of these reintroduction sites but in the next year NRS will work to achieve a complete set of founders two of the sites. NRS will be phasing out the living collection at the baseyard as plants are established in at least two living collection sites and in seed storage. Below is a table showing the number of plants in this PU since it was discovered. New plants were discovered between the Mar. 2001 and Jan. 2002 monitoring and the managed area was expanded. The increase in the numbers of plants since Jan. 2002 is from new plants germinating in the managed area.

Monitoring Date	Nov 2000	Mar 2001	Jan 2002	June 2003	March 2004
Mature/Juvenile/Seedling	4/2/2	4/2/3	8/5/2	13/6/2	18/8/11

NRS removed all the ornamental *Hibiscus* spp. that were planted at Makua Range Control in the summer of 2004. This action was spurred by concerns over possible hybridization and pollen competition. NRS interviewed a number of horticultural experts before taking action. NRS

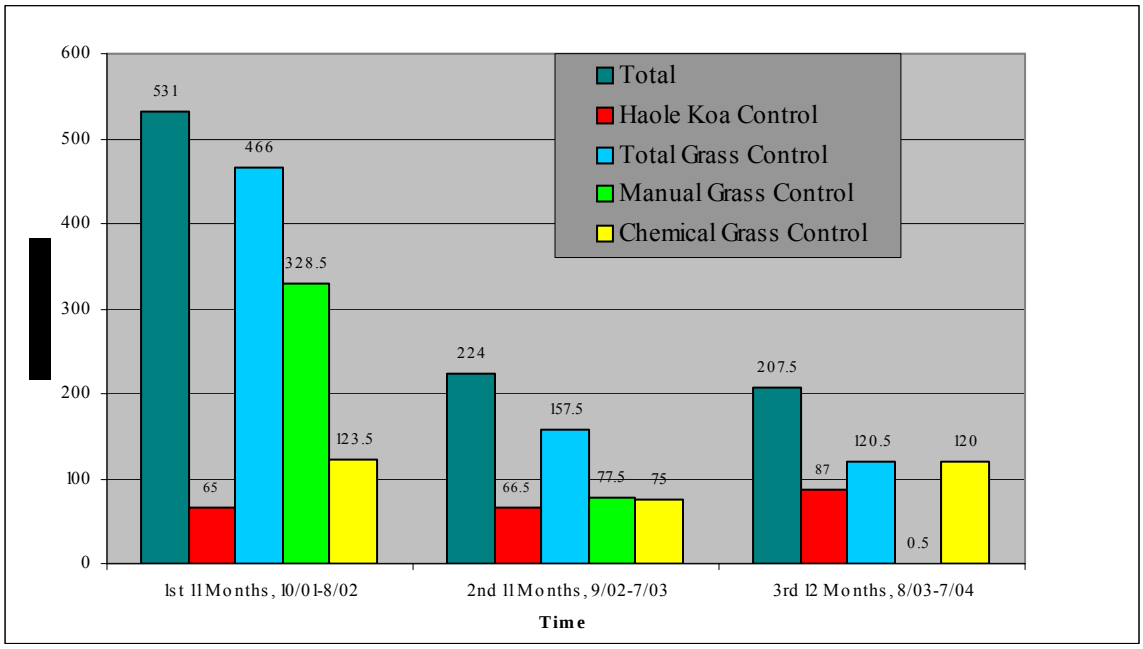
emailed or spoke with among others, the following: Dr. Criley (UH Manoa), Dr. Koob (US Fish and Wildlife), Joel Lau (Hawaii Natural Heritage Program), and Amy Tsuneyoshi (Board of Water Supply). In general, most thought that hybridization was unlikely but that removing the ornamental plantings would be the conservative decision.

Range Control has adopted a new fire-reduction policy that forbids live-fire training when weather conditions are favorable for fire. Hot, dry, and windy conditions are avoided. In addition, Range Control is responsible for maintaining a 30m clear-cut and chemically controlled firebreak inside the firebreak road and a 10m chemically controlled zone outside the firebreak road. These controlled areas are not continuous, and there are gaps in the clear-cut area. One of these gaps is directly below the *H. brackenridgei* population. NRS has been periodically chemically treating this area to keep fuel loads down.

H. brackenridgei faces a high threat from range fire from training and other range activities. In order to reduce this risk, NRS constructed a 30m wide, 3.5-acre fuel-break around the population. I n the last year, NRS spent 207.5 hours maintaining the fuel breaks on these 3.5 acres. In Figure 5.10, time spent conducting different types of control is summed for the *Hibiscus* patch at the Lower `Ōhikilolo site. In the first 11 months of fuel break installation, effort was very high. In the second 11 months of control, total effort dropped by more than half, and grass control effort was about one third what was needed the first year. In the 3rd year of control, total effort stayed relatively constant, but manual grass control effort dropped to almost zero. The third year was also the wettest year NRS has been involved in the project. Although the labor remained constant, had the year had more typical rainfall, NRS would expect the labor have decreased. This generally decreasing trend in effort needed to maintain the fuel-break is very encouraging, given the huge time investment this large project initially required. It signifies the success of sustained control efforts as an effective means to control and reduce *Panicum maximum* populations.

Control of grass at this site is done with the use of backpack sprayers and one of two herbicides. Most of the patch is sprayed with Round-up®, in a 1% mix with water. Other smaller portions, especially around sensitive native plant populations, are sprayed with the grass-specific herbicide Fusilade®, in a 0.6% mix with water. Fusilade® is not used on a larger scale because it is not as effective in killing guinea grass as Round-up®. Two rain-catchments and tanks were constructed in the *Hibiscus* patch. Control of woody species, such as *Acacia farnesiana*, and *L. leucocephala* is done with hatchets, loppers, and handsaws. Each weed is cut low to the ground creating a stump, which is then split with a hatchet scarring the taproot. Scarified taproots are then treated with a 40% Garlon 4 in Forestry Crop Oil.

Figure 5.10 Lower Ohikilolo: Change in Effort Over Time in the *Hibiscus* patch



NRS made a concerted effort this year to reduce the population of *Acacia farnesiana*, and *L. leucocephala* inside the fuel-break. Removal of these species eliminates habitat beneficial to grass propagation and facilitates native plant recruitment.

NRS foresee that in the future, *L. leucocephala* control should take less and less effort, as the site is slowly rid of mature trees, and effort shifts to seedling control. The time spent on manual control of grass has steadily dropped and will hopefully end altogether, while time spent on chemical control of grass has remained constant. Since grass growth is in part dependent on rainfall, this effort will probably fluctuate from year to year, and may remain in the 100-150 person hour range. As guinea grass seeds do not disperse far, we may be able to exhaust the seed bank within the fuel-break. (J. Lau pers. comm.) If so, effort within the fuel-break may drop substantially. The reduction of weed populations within the fuel breaks also encourages the regeneration of native dry shrubland species, such as *Dodonea viscosa*, *Sida fallax*, *Abutilon incanum*, *Heteropogon contortus*, *Erythrina sandwicensis*, and *Waltheria indica*.

In December 2002, NRS reintroduced 38 *H. brackenridgei* from Lower Ohikilolo stock into the Kaluakauila exclosure. The survivorship of these outplants was over 90% as of July 2004. The fires of 2003, from Makua Military Reservation affected these plants. A few were killed and the area is now smothered in *Panicum maximum* responding to the fire. In 2004, eight more plants were put into a different area that is more forested. These plants will be monitored in the coming year and the sites will be supplemented with available stock. F uel management in this area is ongoing. Guinea grass is being removed from the middle of the forest to reduce the threat of fire.

Haili to *Kawaiu*: In the last year, NRS surveyed the Kealia vicinity for ***H. brackenridgei mokuleianus*** with Joel Lau. One mature, ten immature, and six seedlings were seen. Cuttings were taken from the mature and two immature plants. They will be grown at the Army facility as a living collection and propagule source. Plants were seen growing on exposed ledges smothered by *Panicum maximum* and *Sicyos pachycarpus*. This remote site is considered marginal for weed control given the low numbers of plants and the steep terrain. No weed control has been done at this site. Cuttings will be taken from all available founders for genetic storage.

NRS surveyed the Kawaiu gulch area for ***H. brackenridgei mokuleianus*** with Joel Lau in the last year. Six immature plants and two seedlings in two sites were observed. Collections were made from five plants for genetic storage. This remote area is also very steep and occupied primarily by ***P. maximum*** therefore, management in this area is considered difficult.

Kaimuhole and *Palikea Gulch*: Surveys for ***H. brackenridgei*** ssp. ***mokuleianus*** were conducted in areas of the Lower Ka'ala Natural Area Reserve and Dole Foods Co. owned lands below the NAR in the last year. At least ten mature, 210 immature and several seedlings were found in four gulches in the area. Some locations were known historically, however, the majority were never reported. In the coming year, NRS will prioritize management for this area and determine where to build a large proposed fence. Ideally, the fence will surround the most plants in the area with the most potential for restoration. The manageability of the site is of critical concern, given the steep terrain and the pervasive threat posed by the complete domination by guinea grass in this area. Goats, *Panicum maximum, Coffea arabica* and other weeds pose the largest threat to this species in this area, as well as a threat of fire. Proposed management would include fencing, hunting and massive weed control. All plants not within the proposed unit would be cloned and planted into the managed unit. At this time, the proposed unit will be in Kaimuhole Gulch, however, this may change in the coming year as the site is surveyed further. No weed control has been done at this site. Cuttings will be taken from up to fifty founders for genetic storage. In the coming year, NRS will consider how to organize this PU based on the new locations near this PU.

Other PUs:

Kaomoku Nui: The known site in Kaomoku Nui Gulch was not monitored in the last year. There were estimated to be at least 750 seedlings at this site in 2002. Only 2 plants were mature. This PU is partially fenced. Collections made at that time were grown at the Army Nursery and have been planted at the Army's Wheeler Baseyard. Other living collections were established at Kaiser High School Waimea Botanical Garden and Waialua High School. In the coming year, NRS will work with State NARS staff to monitor this site for changes in population and threats. No weed control has been done at this site. Cuttings will be taken from up to fifty founders for genetic storage. In the coming year, NRS will consider how to organize this PU based on the new locations near this PU.

Kihakapu: This population was surveyed in April of this year and 2 mature, 133 immature and 34 seedlings were found in several sites in the gulch. These plants will be cloned and reintroduced into a managed unit in another gulch. No weed control has been done at this site.

Cuttings will be taken from up to fifty founders for genetic storage. In the coming year, NRS will consider how to organize this PU based on the new locations near this PU.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Makua	Manage for stability	No	Yes	No
Out of AA				
Haili to Kawaiu	Manage for stability	No	No	No
Kaimuhole and Palikea Gulch	Manage for stability	No	No	No
Kaumoku Nui	Genetic storage	Partial	No	No
Kihakapu	Genetic storage	No	No	No

5.17 *Lipochaeta tenuifolia*

Requirements for Stability:

- 3 population units (PUs)
- 50 genetically unique individuals in each PU (short-lived perennial with tendency to reproduce vegetatively)*
- Threats controlled
- Complete genetic representation of all PUs in storage

* It is difficult to distinguish genetic individuals, since vegetative reproduction creates adjacent clonal plants of identical genetic make-up. Genetic studies suggest that plant material separated by >2 m is genetically distinct.

Taxon Level Discussion

One population in the action area will be managed for stability. The other two 'manage for stability' populations are located off-site. The three populations chosen for management already have stable numbers of individuals, but threats are not controlled at all three sites. Since the most significant threat to this taxon is goat predation, NRS have focused management efforts first on ungulate control. NRS do not consider weeds to be a significant threat to this taxon because it is found on fairly intact cliffs. Fire has impacted this taxon within Makua in areas where alien grasses are prevalent. This taxon can be propagated very successfully from cuttings but seed collection and germination is challenging. The use of clones is a very viable means of maintaining the genetic stock of *L. tenuifolia*. Overall this taxon has a good prognosis for stability. Threat control planning and implementation is underway at all three 'manage for stability' sites.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Ohikilolo Mauka and Makai	Manage for stability	2008+	2008+	None	2008+
Kahanahaiki	Genetic storage	300+	73/23	None	73/23
Kaluakauila	Genetic storage	113	64/20	None	64/20
Keawaula	Genetic storage	20/20	20/20	None	20/20
Out of AA					
Kamaileunu and Waianae Kai	Manage for stability	880-1320+	796/269	None	796/269
Mt. Kaala NAR	Manage for stability	250+	250	None	250/0

Genetic Storage

A germination technique for *L. tenuifolia* seed is not yet known. While one is being developed, NRS have been using clones of wild plants for genetic storage. While it is possible to meet

genetic storage goals for this taxon via vegetative clones, this approach will require significant amounts of greenhouse space. Thus far, NRS have focused clonal greenhouse storage on fire-threatened sites. NRS are working with Lyon Arboretum to determine if it is possible to store these clones *in vitro* rather than in a greenhouse. NRS submitted a substantial seed collection of *L. tenuifolia* to Lyon for germination testing and seed storage testing.

Genetic Storage of *In Situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Ohikilolo Mauka and Makai	Manage for stability	2008+	16	0	35	0
Kahanahaiki	Genetic storage	73/23	7	0	>50	0
Kaluakauila	Genetic storage	64/20	1	0	9	0
Keawaula	Genetic storage	20/20	0	0	0	0
Out of AA						
Kamaileunu and Waianae Kai	Manage for stability	796/269	0	0	0	0
Mt. Kaala NAR	Manage for stability	250	0	0	0	0

Propagation/Germination Techniques

L. tenuifolia cuttings root easily. A success rate of 50-75% has been observed. NRS have had difficulty collecting substantial amounts of seed from wild populations because seeds tend to fall off the peduncle easily. The seeds are difficult to distinguish from dried sepal parts without close inspection. Therefore, it is difficult to determine from a distance whether substantial collections can be acquired before embarking on a rappel. Also, NRS have not observed a predictable fruiting season where substantial numbers of seeds are available. This situation makes acquiring seed collections from this taxon very difficult.

Despite these challenges NRS have collected wild seed and have recently collected a substantial amount of *L. tenuifolia* seed from greenhouse plants. NRS and Lyon Arboretum staff have been unsuccessful in breaking the seed dormancy of this taxon and thus cannot germinate any *L. tenuifolia* seed reliably. The seed storage lab at Lyon Arboretum has tested a number of different germination techniques with no success. Dr. Don Drake in the Botany Department at the University of Hawaii is running germination tests in incubators to determine if there is a breakable seed dormancy. NRS submitted a substantial collection of *L. tenuifolia* to Lyon for additional and systematic germination testing and subsequent seed storage testing.

Unique Species Observations

A large and catastrophic fire occurred at MMR in July of 2003. This fire burned some *L. tenuifolia* plants within the Kahanahaiki population. Photopoints were taken at the site and

burned plants were tagged. After one year, more plants were present at the site than had been counted before. It is difficult to know if these plants were new seedlings or clones of the burned plants re-sprouting from buried stems.

Plants found at the Ohikilolo Makai site are exposed to extremely dry conditions. The site is at 400 feet in elevation. NRS have observed very low survivorship between years from this site. The plants at this site are small and appear to reproduce mainly via seed rather than vegetatively.

Outplanting Issues

NRS have not attempted to reintroduce this taxon into a wild site and do not expect that augmentations will be necessary to achieve stability at any of the three selected populations. NRS have planted some *L. tenuifolia* at the Army Natural Resources base yard near Wahiawa. This site is at 900 feet in elevation. These plants are growing vigorously after an initial adjustment period. NRS would expect plantings at higher elevations to be at least as successful.

Research Issues

Research is being conducted as stated above to determine a reliable germination technique for this taxon. No other research topics have been raised.

Surveys

No additional surveys have been conducted for this taxon inside or outside the action area.

Taxon Threats

The primary threat to this taxon is goats. In Makua, *L. tenuifolia* is restricted to vertical cliffs and is extirpated or rare in places that are accessible to goats. Following significant ungulate control, *L. tenuifolia* has re-claimed some of these areas. Pigs are not prevalent in areas where *L. tenuifolia* resides because of the steep nature of the terrain. In the few places that are accessible, pigs can trample and uproot *L. tenuifolia*. Weeds do not appear to pose a large threat to this taxon except where alien grass have invaded populations and may serve as fuel for fire. *L. tenuifolia* sends out long creeping stems which can arc over most weeds found within its' habitat. A few weeds which threaten steep habitat include *Erigeron karvinskianus* and *Rubus argutus*. NRS are controlling incipient populations of these weeds where possible and making plans to approach other areas. Rats and slugs have not been observed to be threats to this taxon.

Population Unit Level Discussion

Manage for Stability PUs:

Ohikilolo Mauka and Makai: This PU extends from low elevation cliffs to high elevation cliffs in the east along Ohikilolo Ridge. There is a large break in distribution between the makai plants at 400-foot elevation to the next closest plants at approximately 1200 feet. Although NRS have

not systematically monitored the Ohikilolo population, incidental observations indicate that *L. tenuifolia* is moving back into habitat where it had been extirpated by goats. Thus, NRS anticipate an increase in the overall population numbers. NRS have observed *L. tenuifolia* at the base of cliffs in Koiahi gulch and Lower Makua Valley and at the tops of cliffs just off the main Ohikilolo ridge crest.

Since full funding has not yet been committed to the MIP, NRS have focused time on controlling ecosystem threats to *L. tenuifolia* instead of systematically monitoring this population. NRS have been controlling ungulate threats to this population since 1995 beginning with the construction of a perimeter goat fence along Ohikilolo ridge. Since 1995, over 1,500 goats have been removed from MMR. It is estimated that less than 20 goats remain. NRS recently released two satellite-collared goats into MMR to assist in locating the remaining herd in Makua.

No weed control has been conducted immediately around *L. tenuifolia* but this taxon may benefit from the ecosystem-level weed control that NRS conduct along the forest edge above and below the Ohikilolo cliffs. In addition, NRS has been controlling an incipient population of *Rubus argutus* on Ohikilolo ridge. NRS believe this population became established via bird-dispersed seed from Kaala.

The Makai site along Ohikilolo ridge faces distinct challenges. NRS have committed significant resources to the *in situ* protection of this site and to capturing it in storage. Genetic studies conducted in 1999 showed that these makai plants are different from the rest of the plants on Ohikilolo ridge. NRS contracted the construction of a strategic fence to protect the site because it was outside the larger ridge fence that encircles the valley. NRS experienced some challenges with fence placement initially at this site. Goats found their way into the fence through extremely steep section of cliff where fencing had not been erected. NRS supplemented the fencing at the Ohikilolo Makai site and it has been goat proof since October of 2003. NRS maintain and monitor this fence to ensure that goats from the large feral goat population to the south do not breach the barrier. Another significant threat to the Makai site is fire. Fires started from military training in Makua and arson along Farrington highway have impacted this site in past years. NRS have never documented burned *L. tenuifolia* plants at this site following a fire, but there remains a high potential for such damage. NRS have excellent *ex situ* representation from this site and are comfortable that the genetic make up of these plants has been captured. NRS have spent many hours on rappel collecting cuttings from plants at this site. Many more plants than have ever been observed in a single monitoring of the site are represented in the greenhouse. Clones of the wild plants are maintained as large potted plants for seed storage research, until seed can be stored from these plants.

Kamaileunu and Waianae Kai: The number of individuals reported in the final Makua IP was an estimate that Hawaii Natural Heritage Program botanist Joel Lau developed from the Heritage database. NRS numbers are a total based on accurate monitoring at only some sites within this large PU. This accounts for the difference in numbers presented in the table. NRS plan to manage *L. tenuifolia* plants from the eastern most portion of this PU. A fence will be constructed this year. A total of 63 mature individuals were observed within the proposed fence perimeter over the last year. The *L. tenuifolia* cliff to be included in the Makaha fence is very native and has few weeds of concern. No other threats have been observed at this site.

Mt. Kaala NAR: NRS have not systematically monitored this population since 2000 but will visit the population in the next year to gather more current monitoring information. NRS observed the population from afar and noted that plants look healthy. NRS have been conducting goat hunts across Mt. Kaala NAR in partnership with the State of Hawaii, with emphasis around Puu Kamaohanui, near the *L. tenuifolia* population. So far 152 goats have been removed from the NAR via hunting. In neighboring Schofield Barracks, 33 goats were removed. NRS also began snaring along the Kamaohanui-Puu Pane ridge in 1999. Control via snares has removed 80 goats and 8 pigs from Mt. Kaala NAR. Catch rates have decreased so dramatically that many of the snares were pulled from the ridge in 2004. There is some *Melinus minutiflora* in the vicinity of the *L. tenuifolia* but control would be difficult since most plants are on a very steep cliff. Otherwise, weed threats are low.

Kahanahaiki: The NRS population number for this site is based on visual accurate counts on rappel. This number does not reflect a total for the site, since NRS have not rappelled across the entire PU. The number from MIP is an estimate based on binocular observation and extrapolation. This population benefits from the goat control measures that have been conducted in MMR. In the past, NRS observed goats in the Kahanahaiki forest area approximately 500 meters from the *L. tenuifolia* population. NRS responded with control hunts and snaring and there is no longer any goat sign in the area. Now, NRS estimate that goats number less than 20 total in MMR. NRS continue to maintain snares in the area just above this population. Pigs to do not have a significant impact on this population since it occurs mainly on cliffs.

NRS have not conducted any weed control at this population because of the challenging cliff terrain. NRS have secured a substantial collection of clones from this site, which are being maintained in the greenhouse. NRS have well over the 50 required for genetic storage. This PU has been a focus of collection efforts since it was threatened by the July 2003 fire. The fire burned some of the plants in the PU as stated above.

Other PUs:

Kaluakauila: The number of individuals reported in the final Makua IP was a 1999 estimate made using binoculars and extrapolation. The number reported by NRS is based on actual counts made within the population; however NRS did not sample the entire population. This population is protected from pigs by the Kaluakauila exclosure, which was completed in 2001. The July 2003 fire burned into this management unit and dangerously close to *L. tenuifolia* plants. Since 2002, NRS have been conducting grass control within the Kaluakauila forest patches to minimize the chance that a fire would carry into the forest. NRS will continue this grass control work with attention to the *L. tenuifolia* population. This taxon may also benefit from the ecosystem-level weed control conducted on the edges of the Kaluakauila forest patch. These efforts target weed species such as *Schinus terebinthifolius*, *Psidium cattleianum* and *Leucaena leucocephala*.

Keawaula: NRS monitored this PU in September of 2004 and estimated that there were more than 45 mature plants. Fires threaten this site. In July of 2003 a fire burned from Yokohama Beach Park to into this site. NRS noted during their visit this year that plants must have burned

in the July 2003 fire. This population is not a management priority since it is close to Kaluakauila and of similar genetic make up.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Ohikilolo Mauka and Makai	Manage for stability	Yes	Partial	No
Kahanahaiki	Genetic storage	Partial	No	No
Kaluakauila	Genetic storage	Yes	Yes	No
Keawaula	Genetic storage	No	No	No
Out of AA				
Kamaileunu and Waianae Kai	Manage for stability	No	No	No
Mt. Kaala NAR	Manage for stability	Yes	No	No

5.18 *Neraudia angulata*

Requirements for Stability:

- 3 population units (PUs) (if pure var. *angulata* is found, 4 populations will be managed)
- 100 reproducing individuals in each PU (short-lived perennial, dioecious, prone to large declines or fluctuations in population size)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

The three populations designated 'manage for stability', together with the other genetic collections and reintroductions, should represent the full geographic distribution of this taxon and the morphological differences exhibited by the different stock. The population units with plants of the var. *dentata* are Manuwai and Kapuna. The habitat at both these sites is very degraded so this stock will be represented in the Kaluakauila reintroduction. The Makaha and Waianae Kai Makai PUs have intermediate stock. There are currently no PUs with var. *angulata*. No populations are completely fenced at this time, but fences are proposed for all 'manage for stability' population units. The increases in population size at the two Waianae Kai populations are from finding plants in new areas not a change in abundance in the same area. NRS will augment the populations once they are fenced. It will take a while to stabilize the habitat necessary to support this taxon, but reintroductions have survived and may allow NRS to bring stock out of heavily degraded areas into manageable protected areas and stabilize this taxon.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Makua	Manage for stability	29/2	12/61	0/20	12/61
Kapuna	Genetic storage	1	1/0	None	10
Out of AA					
Makaha	Manage for stability	56/14	7/4	None	7/4
Waianae Kai Makai	Manage for stability	4	46/35	None	46/35
Manuwai	Genetic storage	12	0/2	None	0/2
Leeward Puu Kaua	Genetic storage	3	2/0	None	2/0
Halona	Genetic storage	15	15	None	15/0
Waianae Kai Mauka	Genetic storage	21/25	49/4	None	49/4

Genetic Storage

This taxon does not produce many mature fruit at one time. The fruit ripen on the stem of the plant and there can be fruit maturing on a single plant for weeks or months. Because of this, it

has been difficult to obtain collections from wild plants that are large enough to run seed storage trials. In the last year, a large amount of mature fruit was collected from plants growing at the Army greenhouse and brought to Lyon for storage trials. According to Lauren Weisenberger at the Lyon Seed Storage Lab, the seeds take a long time to germinate, but there has been over fifty percent germination on two different seeds lots collected in 2003 and 2004. The seed storage potential for this taxon has not yet been determined, as tests have only been run on small lots. Preliminary tests show this taxon cannot be frozen.

Cuttings can be rooted easily with traditional methods and most genetic collection from the wild has been done this way. Cuttings can be taken from greenhouse plants, and in this way stock can be kept as a living collection. In the coming year, NRS will attempt to establish clones in micro-propagation to determine if that is a feasible storage method.

Genetic Storage of *In situ* Plants:

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Makua	Manage for stability	12/61	0	0	42	22
Kapuna	Genetic storage	1	0	0	1	1
Out of AA						
Makaha	Manage for stability	7/4	0	0	6	0
Waianae Kai Makai	Manage for stability	46/35	0	0	0	0
Manuwai	Genetic Storage	0/2	0	0	2	0
Leeward Puu Kaua	Genetic storage	2/0	0	0	0	0
Halona	Genetic storage	15	0	0	0	0
Waianae Kai Mauka	Genetic storage	49/4	0	0	0	0

Propagation/Germination Techniques

Seeds take months to germinate but do not appear to need any special treatment. (L. Weisenberger pers. comm.) Cuttings are treated with Dip-n-grow® and placed in a pot with vermiculite and perlite on a mist bench. They develop roots within weeks and can be transplanted to sterile media. The plants kept at the nursery have produced much more flower and fruit than the plants in the wild, enabling large collections to be made for seed storage trials.

Tip cuttings have the highest success rate at 80-90%. NRS now have established material propagated from collections made in 2003-2004 from the Makua PU that currently serve as nursery stock plants. NRS have observed that many of these cuttings will flower and set fruit within one year. Seeds from these plants have been taken to Lyon Arboretum for storage and viability testing.

Unique Species Observations

This taxon appears to be prone to fluctuations in population size. Plants can loose all their leaves in the summer.

Outplanting Issues

Stock from two populations has been out-planted by NRS. No seedlings have been observed at the sites yet. In April of 2003, 26 plants grown from Makua stock were used to augment one of the sites in the Makua PU. In December of 2003, 19 plants were added. When this site was monitored in August of 2004, 36 plants were alive. This site will be supplemented with stock from unrepresented founders in the coming year. Stock from the Kapuna PU was planted into Kaluakauila in March of 2003. This site was supplemented again in March of 2004, so that there are eight individuals from the single Kapuna founder at this site. In the coming year, NRS will supplement this site with more plants from the Kapuna site and stock from the Manuwai PU.

Research Issues

Genetic analysis was done by Dr. Morden at U.H. in 2001. His results showed that the Kapuna stock was distinct. At the time, the Kapuna plant was the only one known from the windward side of the Northern Waianaes and the only one that was identified as var. *dentata*. Since then the Manuwai plants were discovered and are thought to be var. *dentata.* Both of these populations will be represented in the Kaluakauila reintroduction. No additional research needs have been identified by NRS at this time.

Surveys

Since November of 2001, NRS has spent at least 25 days surveying for *Neraudia angulata* with Joel Lau. Many more days have been searching for other targets in habitat appropriate for *Neraudia*. Only one new population was located in Manuwai Gulch in March of 2003. No additional surveys have been proposed for this taxon.

Taxon Threats

Some PUs of this taxon are found in highly degraded areas and are very threatened by ungulates and weeds (Manuwai, Kapuna). Goat browse has been observed on plants at the Manuwai PU. Other PUs are relatively intact and have manageable threats. (Waianae Kai Mauka and Makai, Makua and Makaha) The remaining PUs (Halona and Leeward Puu Kaua) have not been monitored recently by NRS but will in the coming year. In the last year, rats have been observed damaging plants used to augment the Makua PU. It is unknown if slugs are a threat to this taxon. The weeds that are particularly problematic in appropriate habitat for this taxon are *Leucaena leucocephala, Panicum maximum,* and *Ageratina adenophora.*

Population Unit Level Discussion

Manage for Stability PUs:

Makua: The number of individuals in the final Makua IP was based on Joel Lau's 1993 population estimates and NRS observations in 2000. The sites are now monitored regularly, and more strategic fencing will be built this year to protect the plants from feral pigs.

There are three sites in Lower Makua: MMR-A, MMR-B, and MMR-D. MMR-A and MMR-B have been monitored regularly by NRS since 1998. The MMR-A site in Koiahi Gulch experienced a large boom in numbers of seedlings and juveniles. There are currently 31 mature and 25 immature plants at this site. This increase in individuals is attributed to the low numbers of goats in Makua and the high rainfall this past year. NRS has collected cuttings from 22 of these new plants and from eleven other plants that were previously tagged. This brings the total collected to greater than 60 individuals. In this coming year, NRS will outplant more individuals to the augmented population at MMR-E (the reintroduction site). NRS will also build two new fences around the two groups of plants that make up the MMR-A assemblage. These proposed fences will protect the habitat of these plants from pigs, which have dug up all plants that have germinated below the cliffs which support the bulk of the population. By installing a single fence between cliffs at the entrance to the two sub-gulches, pigs can be excluded. The first sub-gulch fenceline will be approximately 40 m and the second sub-gulch fenceline will be approximately 35 m. NRS will continue to monitor MMR-A on a biannual basis. MMR-B is presently only a single mature plant. Collections have been made from this plant in the past. It is represented at the Army nursery and at the MMR-E augmentation site. T here are currently 5 mature plants at MMR-D.

In March of 2003, and again in December 2003, NRS augmented the MMR-D site. The reintroduced plants are tracked as MMR-E. This action was chosen because this area could be blocked off from pigs by the installation of a single short fence between cliffs. After building the 15 m fence, 47 juvenile plants were outplanted, 35 of which are still alive. These plants are all from the natural populations (MMR-A and MMR-B). Rats had girdled ten of the plants when this site was last monitored. None of those plants were dead, but most were in poor health. NRS will continue to monitor this reintroduction and supplement it with unrepresented founders.

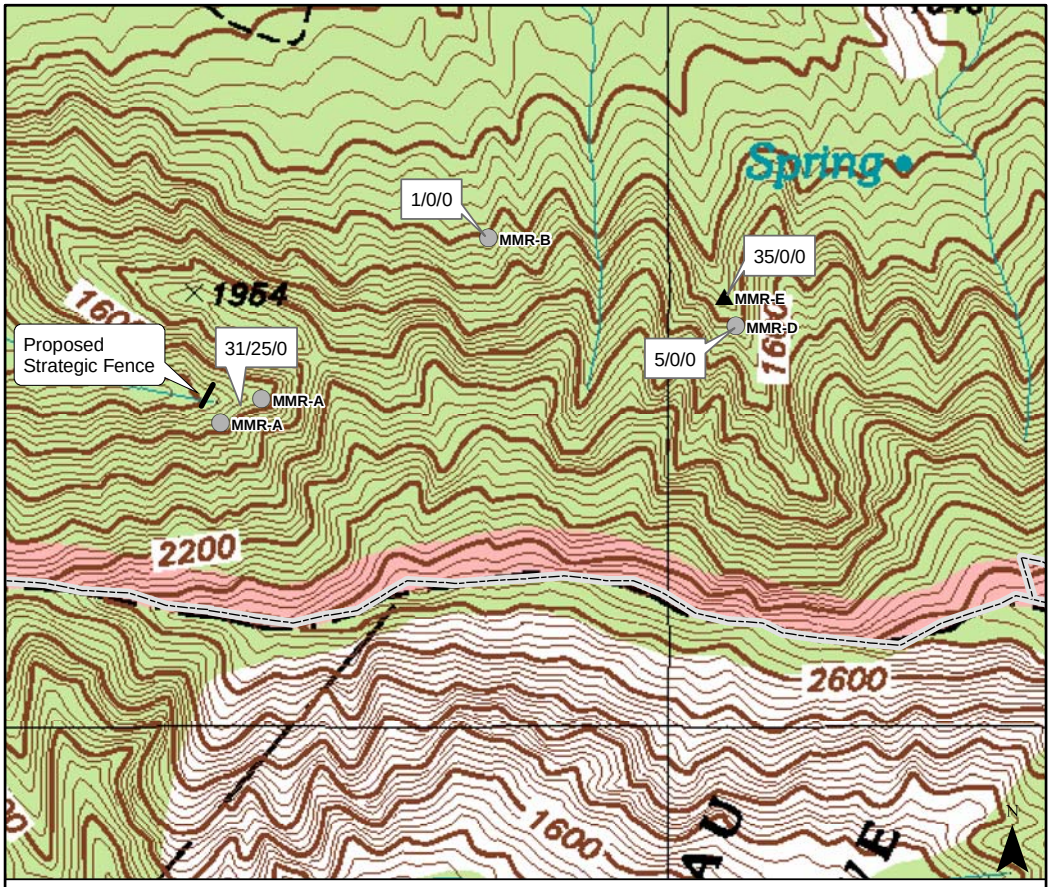


Figure 5.11 *Neraudia angulata var. angulata* Makua Population Unit

Kapuna: There is one remaining plant at the Kapuna site. This plant is growing on a rock shelf and is not threatened by pigs. This site is severely degraded and dominated by weeds. Cuttings of this plant were taken to the Army facility and cloned. In January 2003, three plants were reintroduced onto the Kaluakauila Management Unit in MMR. Five more plants were planted in March 2004. They were monitored in April of 2004, and all eight plants are in healthy condition. Kaluakauila was partially burned in the fires of July 2003. Although the reintroduction area was not threatened, fire remains a major threat to this area. A rather large patch of *P. maximum* was observed along the ridge around the outplanting as well as in open cliff areas on the makai end of the forest patch. A water catchment was constructed in this area and now water is permanently available for future spraying efforts. NRS plan to control the *P. maximum* in the next year. This past year, a total of 42.5 person hours were spent sweeping through the 1.3 acre forest patch surrounding the reintroduction. The forest patch was swept for canopy and understory weeds, including *S. terebinthifolius, L. leucocephala, G. robusta, P. cattleianum, P. guajava, L. camara, H. pectinata, C. hirta,* and *R. humilis*. This reintroduction site is located in an area where rats are controlled for other taxa. NRS has additional plants in the Army greenhouse and will continue to

out plant until the numbers are substantial. Mature seed collected from this site will be stored at Lyon. NRS will monitor the wild plant in the coming year for additional threats.

Makaha: The number of individuals in the final Makua IP was based on 1999 field observations. In July of 2004, NRS observed seven mature and four immature *N. angulata* in Makaha. Cuttings were made from eight of these plants and they are growing in the greenhouse at the Army facility. These plants are threatened by ungulates but will not be included in the larger planned Mākaha enclosure because they are geographically removed from it. This coming year, NRS, along with Amy Tsuneyoshi, the Board of Water Supply's Biologist, will survey the area around the existing known plants, as well as new areas in Makaha for additional plants. NRS will also collect from all known individuals that are large and healthy enough to spare cuttings. A fence will be built in this area to exclude pigs.

Waianae Kai Makai: NRS and Joel Lau surveyed this area last year and found a very healthy population. There are an estimated 45 mature plants and 35 juveniles at one site (WAI-B) and one mature plant at the second (WAI-D). NRS monitored these plants in the past year and have been scoping ungulate control measures with State NARS biologist Talbert Takahama. It seems that goats have never been in the gulch with the larger population (WAI-B). There are *N. angulata* and *Nothotricium humile* within reach of goats in the bottom of the gulch. There is at least one potential route that goats could enter the gulch so NRS will scope and propose a fence to the State of Hawaii in the coming year. In addition, a fence has been scoped to exclude goats from the WAI-D site. In the coming year, NRS will monitor these sites and work with the State of Hawaii to determine the appropriate ungulate control strategy for this PU.

Other PUs:

Manuwai: Eleven mature individuals and one juvenile were found during surveys of Mokuleia Forest Reserve in March of 2003. When NRS visited the site again to scope a planned fence, there had been damage to the plants from a small landslide and goats had browsed several individuals, leaving only six plants. A fence was proposed to be built around the plants; however, permission is still pending from the State. When the site was visited in June of 2004, only two plants could be found, one in very poor condition. Propagules were collected during each visit and are being grown at the Army Nursery. In the coming year, NRS hopes to have permission to fence this area before the plants are all gone. The plants grown at the Nursery will be cloned and planted into a secure location on MMR when ready.

Leeward Puu Kaua: This site was visited this year and two plants were observed. No collections have been made from this PU and no management has been done. In the coming year, NRS will monitor the plants, collect for genetic storage and determine the need for management for genetic storage needs.

Halona: This site has not been visited since 2000. No collections have been made from this PU and no management has been done. In the coming year, NRS will monitor the plants, collect for genetic storage and determine the need for management for genetic storage needs.

Waianae Kai Mauka: There are two sites known in the Waianae Kai Mauka PU. There are about 45 mature plants at one site (WAI-A/E), one plant at the second (WAI-C). NRS monitored the WAI-A/E site in the last year while scoping a fence to exclude pigs from the area and found many more plants. Pigs and weeds threaten this site, however, most plants are up on steep cliffs and inaccessible to pigs. The site with the single plant (WAI-C) has not been monitored since it was reported by Steve Perlman in 2000. In the coming year, NRS will monitor the WAI-A/E site and return to the WAI-C site to monitor that plant. Fences to protect the plants from pig damage have been proposed and permission is being processed by the State.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Makua	Manage for stability	Partial	Partial	No
Kapuna	Genetic storage	No	No	No
Out of AA				
Makaha	Manage for stability	No	No	No
Waianae Kai Makai	Manage for stability	No	No	No
Manuwai	Genetic storage	No	No	No
Leeward Puu Kaua	Genetic storage	No	No	No
Halona	Genetic storage	No	No	No
Waianae Kai Mauka	Genetic storage	No	No	No

5.19 *Nototrichium humile*

Requirements for Stability:

- 3 population units (PUs)
- 25 reproducing individuals in each PU (long-lived perennial)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

Nototrichium humile is known from dry forest habitats in the Waianae Mountains. Many of the large populations that remain are located in deep ravines such as Koiahi gulch and un-named gulches in Waianae Kai. This habitat is relatively protected from fires in the short-term because of the large barren cliffs that surround them and the moist and open gulch-bottom vegetation. Fires have significantly impacted other populations such as those at Punapohaku and Keawaula gulches. *Panicum maximum* is scattered in these locations and surrounds the forest where *N. humile* occurs. Thus, they are extremely at risk from future fires. Two populations were selected for management off-site and one was selected within the Action Area. These populations were chosen based on their size and the habitat quality surrounding them. All three populations have stable numbers of individuals. NRS will place collection priority on the populations found within the Action Area since they are at risk from training-caused fires. This genetic stock will be maintained in protected *in situ* sites as augmentations/reintroductions or in the greenhouse. It is difficult to collect large numbers of seed from this taxon because very few seed ripen per infructescence at any given time. *N. humile* is easy to propagate from cuttings and they can be maintained in the greenhouse but this is very space-consuming. NRS will experiment with in vitro propagation for this taxon to minimize space necessary to accomplish vegetative genetic storage. Navy populations were excluded because Navy personnel are managing them. Ungulates impact the habitat of this taxon. Therefore, along with fire prevention, NRS will make ungulate control a top priority for populations designated as ‘manage for stability’.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Kaluakauila	Manage for stability	200-400	200+/0	None	200+/0
Makua (South Side)	Genetic storage	120-140	56/1	None	56/1
Keaau	Genetic storage	21-31	21-31	None	21-31
Keawaula	Genetic storage	200/30	200/30	None	200/30
Makua (East Rim)	Genetic storage	1	1/0	None	1/0
Kahanahaiki	Genetic storage	140	32/2	None	32/2
Punapohaku	Genetic storage	New population	152/14	None	152/14
Out of AA					
Makaha	Manage for stability	159	159/0	None	159/0
Waianae Kai	Manage for stability	200-320+	200/0	None	200/0
Kaimuhole and Palikea Gulch	Genetic storage	48/6	8/3	None	8/3
Kealia	Genetic storage	3	3/0	None	3/0
Keawapilau	Genetic storage	9/1	5/0	None	5/0
Kolekole (East Side)	None	13	13/0	None	13/0
Nanakuli	Genetic storage	5	5/0	None	5/0
Puu Kaua (Leeward Side)	None	12	12/0	None	12/0

Genetic Storage

Genetic storage is being achieved via the use of cuttings but this approach is space and labor consuming. Seed collection has been difficult and germination very low. *N. humile* inflorescences are indeterminate spikes. Therefore, very few of the fruit are mature at any one time. There is only one seed per fruit. Only one of the fifty seeds submitted to the seed storage lab at Lyon Arboretum germinated. NRS will work with Lyon Arboretum staff to determine a reliable germination technique for this taxon and will work to collect bulk seed collections from greenhouse plants.

Genetic Storage of *In Situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Kaluakauila	Manage for stability	200+/0	4	0	0	0
Makua (South Side)	Genetic storage	56/1	0	0	0	4
Keaau	Genetic storage	21-31	0	0	0	0
Keawaula	Genetic storage	200/30	0	0	0	0
Makua (East Rim)	Genetic storage	1/0	0	0	0	0
Kahanahaiki	Genetic storage	32/2	2	0	0	0
Punapohaku	Genetic storage	152/14	0	0	0	0
Out of AA						
Makaha	Manage for stability	159/0	0	0	0	0
Waianae Kai	Manage for stability	200/0	0	0	0	0
Kaimuhole and Palikea Gulch	Genetic storage	8/3	0	0	0	0
Kealia	Genetic storage	3/0	0	0	0	0
Keawapilau	Genetic storage	5/0	0	0	5	0
Kolekole (East Side)	None	13/0	0	0	0	0
Nanakuli	Genetic storage	5/0	0	0	0	0
Puu Kaua (Leeward Side)	None	12/0	0	0	0	0

Propagation/Germination Techniques

NRS have had a 70% success rate in propagating cutting of this taxon. NRS have not attempted to propagate *N. humile* from seed but will try to develop a technique with Lyon Arboretum seed storage laboratory staff.

Unique Species Observations

N. humile does exhibit some intra and inter-population leaf variation. Within most populations, and even on different branches of an individual tree, there can be both long, slender leaves and ovate leaves. Some populations, such as the upper portion of the Kahanahaiki population, have more plants with slender leaves than ovate leaves. The Keawapilau population plants are strikingly different from others. Keawapilau stock has very small, lanceolate leaves. Stock from the Keawapilau and the Kaimuhole populations are being grown side by side at the Army greenhouse and they have maintained their striking leaf differences.

NRS have also observed remarkable resiliency in this taxon. *N. humile* plants have been broken by falling tree limbs and recovered well.

Outplanting Issues

NRS have conducted one reintroduction into Makua Valley (south side). Eighteen plants were planted as an augmentation to the existing population Makua PU. Thus far, NRS have documented an 83% survivorship rate. This rate may have been higher if *N. humile* had been planted at the best possible spots within the gulch but NRS utilized these prime sites for *Neraudia angulata* outplants. NRS do not anticipate needing to augment any of the manage for stability populations since their numbers are so high.

Research Issues

NRS will work with the Lyon Arboretum seed storage laboratory to determine a reliable germination technique for this taxon and apply this in researching seed storage techniques.

Surveys

No recent surveys have been conducted specifically for *N. humile*.

Taxon Threats

A major threat to certain populations of this taxon is fire. In the summer of 2003, two large fires burned both the habitat of and individual plants of this taxon. A threat shared by all *N. humile* populations is pigs. Pigs do not consume this taxon directly but damage the gulch habitat that it prefers. Pigs rooting may prevent seedling recruitment in flat areas. Goats are also a threat. Goat browse has been observed on plants. Goats can reach many of the plants growing in steep areas that pigs cannot. Significant weed threats to this taxon include *Ageratina adenophora*, *Passiflora suberosa* and *Panicum maximum*. *P. maximum* control is important as it relates to fires. *Schinus terebinthifolius* and *Aleurites molucanna* dramatically change the gulch habitat preferred by this taxon. It is unknown whether slugs impact *N. humile* recruitment and NRS have not observed rat damage to any plants of this taxon.

Population Unit Level Discussion

Manage for Stability PUs:

Kaluakauila: This population is in a fence and monitored regularly by NRS. The population is robust, and there are many individuals, so a complete count has not been done. This PU is fenced and the fence is maintained as pig free. NRS spent 15.5 hours controlling *P. maximum* immediately around *N. humile* plants in Kaluakauila and a total of 134 hours in the 22 acres of dry forest habitat within this management unit. Over the last few work trips, NRS have focused on installing the infrastructure to make management in Kaluakauila less helicopter dependent. NRS constructed water catchments near the largest grass control areas and developed a campsite closer to the major work sites. NRS will represent this population *ex situ*.

Makaha: The number of individuals reported in the final Makua IP was based on Joel Lau's 2001 estimate. Last year NRS monitored 20 plants in Makaha, which were all healthy, but this was by no means a complete monitoring. *N. humile* in Makaha occur side by side with *Abutilon sandwichensis* and *Neraudia angulata*. The main threat to this site is pigs and goats. Although no goat sign has been observed in the area immediately around the rare plants, NRS will still take measures to prevent goats from impacting the population if they move into the area. NRS plan to construct strategic fencing to protect this site. There are a number of vertical cliffs in the vicinity and thus, it would be difficult to construct an exclosure. Weeds are not a significant problem at the site although there is some *Schinus terebinthifolius*.

Waianae Kai: NRS visited one site in Waianae Kai this year and observed an estimated 200 plants. The site is a very deep gulch surrounded by 2000-foot cliffs on all sides. There is no evidence of goats or pigs at the site but lots of goat sign at the mouth of the gulch. NRS spent a few days trying to determine if there are any routes of entry into the gulch from the steep walls of the gulch. NRS feel that through the construction of a few strategic fences the goats and pigs can be kept out. There are no significant weed threats immediately around the *N. humile* plants.

Other PUs:

Makua (South Side): The number of individuals reported in the final Makua IP was based on Joel Lau's 1993 population estimate. A comprehensive monitoring of all the gulches encompassed by this PU has never been conducted. NRS have protected a portion of this PU by fencing the opening to a very deep and steep gulch, which contains at least 30 *N. humile*. This is the same location where 18 *N. humile* plants were outplanted. NRS are also scoping a route for a pig fence to protect the back walls of Koiahi gulch, which contain at least fifty *Neraudia angulata* plants and fifty *N. humile* plants. Currently, the plants are restricted to the cliffs because pigs impact the habitat in the gulch bottom. A major weed threat to this population is *Ageratina adenophora*.

Keaau: The number of individuals reported in the final Makua IP was based on John Obata's 1990 estimate and Joel Lau's monitoring of one individual in 2001. NRS have not visited this population but will attempt to acquire genetic storage collections as it is in the Action Area and has small numbers.

Keawaula: The number of individuals reported in the final Makua IP was based on Joel Lau's estimate in 2000. NRS visited this site in September 2004 and observed 138 mature trees and five immature trees. This site was impacted by the July 2003, Yokohama wildfire. The forest patch surrounding this population is shrinking with each successive fire. NRS will acquire genetic collection from this site and augment the Kaluakauila site with this stock in order to secure it. *Panicum maximum* as a fuel is the biggest threat to this site.

Makua (East Rim): The number of individuals reported in the final Makua IP was based on Joel Lau's 1997 observation. NRS have attempted to re-locate this plant without success. NRS will attempt on one more occasion before considering it dead. If it is re-discovered NRS will collect propagules for genetic storage.

Kahanahaiki: The number of individuals reported in the final Makua IP was based on a tally of Joel Lau's 1985 to 1993 observations. NRS conducted a partial monitoring of this site in the last year. This is why the number in the Taxon Status table is less than Mr. Lau's estimates. NRS collected cuttings this year from close to fifty separate individuals in Kahanahaiki. The plants are spread out within the PU; a small group is inside the Kahanahaiki fence and a larger group is on the slopes below the exclosure. These are growing in the mist house and thus are not yet in our inventory. They will be grown to maturity in the Army greenhouse for seed production for storage. NRS designated collection from these plants a high priority because of the fire risk to these plants. The July 2003 fire burned into the perimeter of this forest patch. NRS have also spent 13.5 hours conducting weed control within the forest patch that *N. humile* inhabitat.

Punapohaku: This population was discovered by Joel Lau and NRS in 2002. It is estimated to have 200 individuals. After the July 2003 Makua fire, this population was monitored and a more accurate count of the population was made. It was estimated that 5 plants burned in the fire. Photopoints were set up so the remaining individuals could be monitored. NRS will visit this population to acquire cuttings from plants to propagate ex situ. This stock will be used to augment the Kaluakauila population within the fence exclosure.

Kaimuhole and Palikea Gulch: The number of individuals reported in the final Makua IP was based on Joel Lau's 2000 estimate. Portions of this population have been monitored by NRS in the last year, but there are likely more plants to be found. Founders from this PU are represented in the Army greenhouse. Although this population will not receive specific management focus, NRS plan to construct a fence exclosure around Kaimuhole gulch to protect *Hibiscus brackenridgei* plants. This fence will also benefit *N. humile*. NRS will also be conducting weed control within the forest protected in the exclosure. NRS may augment this population of *N. humile* once protection is in place, in order to represent the windward stock of this taxon.

Kealia: The number of individuals reported in the final Makua IP was based on Steve Perlman's 1986 observations and Joel Lau's 1990 observations. NRS have not been to this site but have conducted other surveys in Kealia gulch for *Hibiscus brackenridgei* and have not observed any *N. humile*. NRS will visit this population in the next year in order to collect genetic representation of this population.

Keawapilau: NRS monitored this population this year and collected cuttings from all the plants observed. Multiple clones made from these cuttings are now successfully potted in the greenhouse. NRS may reintroduce these plants into the Upper Kapuna management unit once it is complete.

Kolekole (East Side): The number of individuals reported in the final Makua IP was based on Joel Lau's 1994 observation of 9 plants at the southern spot, and Kapua Kawelo's 2000 observation of 4 plants at the northern spot. Since this time, the Navy built an exclosure fence around this population. NRS consider this population managed since if falls under the Navy's jurisdiction.

Nanakuli: The number of individuals reported in the final Makua IP was based on Joel Lau's 2000 observations. NRS have not been to this site. NRS will visit this population in the next year in order to acquire genetic storage collections.

Puu Kaua (Leeward side): The number of individuals reported in the final Makua IP was based on Joel Lau's 1993 observations. NRS will collect and propagate stock from this PU to reintroduce into the TNC Ekahanui exclosure at Honouliuli.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Kaluakauila	Manage for stability	Yes	Yes	Partial
Makua (South Side)	Genetic Storage	Partial	Yes	No
Keaau	Genetic storage	No	No	No
Keawaula	Genetic storage	No	No	No
Makua (East Rim)	Genetic storage	Partial	No	No
Kahanahaiki	Genetic storage	Partial	Partial	No
Punapohaku	Genetic storage	No	No	No
Out of AA				
Makaha	Manage for stability	No	No	No
Waianae Kai	Manage for stability	No	No	No
Kaimuhole and Palikea Gulch	Genetic storage	No	No	No
Kealia	Genetic storage	No	No	No
Keawapilau	Genetic storage	No	No	No
Kolekole (East Side)	None	Yes	No	No
Nanakuli	Genetic storage	No	No	No
Puu Kaua (Leeward Side)	None	No	No	No

5.20 *Phyllostegia kaalaensis*

Requirements for Stability:

- 3 population units (PUs)
- 50 genetically unique, reproducing individuals in each PU (short-lived perennial, seems to be primarily a vegetatively reproducing taxon)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

The status of this taxon has changed for the worse since the MIP was finalized in May 2003. All wild populations are now extripated. This taxon experienced a significant crash over the last five years. There is stock available from the Palikea Gulch, Waianae Kai, Keawapilau and Pahole populations. As a priority for this taxon, these *ex situ* stocks will be preserved and given the highest level of care. NRS will also ensure that they are represented at as many plant propagation facilities as possible. Propagation via cuttings has been extremely successful. Thus far, one reintroduction has been attempted and initial survivorship is low. *P. kaalaensis* occurs in open gulch bottoms which have now been largely overrun by a few weedy gulch species. Pigs also heavily impact this habitat. Stabilizing this taxon will be challenging.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Pahole to Keawapilau	Manage for stability	14-19	0	20/0	20/0
Out of AA					
Palikea Gulch	Genetic storage	10	0	0	0
Waianae Kai	Genetic storage	6/2	0	0	0
Reintroductions					
Manuwai	Manage reintroduction for stability	N/A	N/A	0	0
Makaha	Manage reintroduction for stability	N/A	N/A	0	0

Genetic Storage

Lyon Arboretum staff have never received enough seed to do a comprehensive seed storage test. NRS, the State of Hawaii and Lyon Arboretum have been successful in storing this taxon via cuttings. If not for the success of this technique, *P. kaalaensis* would be extinct as a whole. In 1998, the Genetic Safety Net Program funded collections from very rare plant taxa. *P. kaalaensis* was one taxa selected for collection. These collections were vital in preserving stock

from now extirpated populations. The Lyon Arboretum micropropagation laboratory did most of the propagation work for this project.

Status of Genetic Storage:

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Pahole to Keawapilau	Manage for stability	0	0	2	2	1+
Out of AA						
Palikea Gulch	Genetic storage	0	0	0	4	0
Waianae Kai	Genetic storage	0	0	2	2	0

Propagation/Germination Techniques

Very little *P. kaalaensis* seed has ever been collected. Lyon Arboretum received 12 seeds, which they tried to germinate using a variety of treatments. No seeds germinated. *P. kaalaensis* can be successfully grown from cuttings. NRS has transferred clones out of vials from the Lyon micropropagation facility very successfully. When the micropropagation laboratory was contaminated during construction activities, NRS took and decontaminated the vials containing *P. kaalaensis*. In the greenhouse this taxon is susceptible to powdery mildew and difficult to accommodate because it forms long running stems that stretch out of the pots. Each time greenhouse plants are pruned back, cuttings are used to make more clones.

Unique Taxon Observations

This taxon has extensively underground growth and was found in rocky gulch bottoms. Monitoring of populations could have an inadvertent impact on these plants through rhizome damage. When reintroductions are monitored, care should be taken not to walk through the population more than necessary.

Outplanting Issues

Only one attempt has been made at reintroducing this taxon. Only 20 of the original 35 outplants still remain, resulting in a survivorship rate of 60%. The planting was conducted in February 2004 and 15 of the plants were dead by July 2004. Before planting, all the shoots were pruned to limit the transpiration rate and allow for acclimation. The plants that were reintroduced had been growing at the Pahole nursery for a number of years and were extremely root bound. Perhaps this influenced the success. This year was an extremely wet year so water stress should not have been a significant cause of mortality. NRS will continue monitoring this reintroduction to determine long-term survival. Other reintroductions will be conducted to test a variety of planting site characteristics, plant status pre-planting, variations in planting densities and a variety of stocks. NRS will not hesitate to mix stock from different populations to increase the success of reintroductions but separate stock will always be maintained *ex situ*.

Research Issues

Outplanting techniques, as stated above, require further research. When stock is available research also needs to be done on seed storage techniques.

Surveys

Due to its recent extinction from the wild, NRS and Mr. Joel Lau have recently conducted surveys for *P. kaalaensis*. No additional populations have been found. Surveys were conducted with a focus on gulches where this taxon had previously been known. Pahole gulch, Palikea gulch, Kapuna gulch, Keawapilau gulch and Ekahanui were surveyed. More surveys will be done in Lower Kaala NAR over the next year.

Taxon Threats

The largest threat to this taxon is extinction from low population numbers. Ungulates also impact the preferred habitat of this taxon. Pigs prefer roots for food in gulch bottoms, which is precisely where *P. kaalaensis* existed. Weeds that impact *P. kaalaensis* habitat and potential reintroduction sites include, *Ageratina adenophora, Christella parasitica, Aleurities molokana, Rubus rosifolius, Clidemia hirta, Buddleia asiatica* and *Schinus terebinthifolius.* The impacts of slugs and rats on this taxon are unknown. NRS do not expect rats to be a substantial threat to this taxon.

Population Unit Level Discussion

Manage for Stability PUs:

Pahole to Keawapilau:

Pahole site: Joel Lau acquired collections from the Pahole site during Genetic Safety Net collections in 1998. In the last year, NRS accompanied the NARS biologist to this site. The plants were gone. This population was last observed alive in approximately 2000 by NARS. This site has been protected by the large Pahole exclosure that was constructed in 1998. The *P. kaalaensis* population in Pahole was in good condition just before the fence was completed; therefore pigs are not solely to blame for this population's demise. NRS have spent 32 hours controlling weeds near the Pahole population site in preparation for outplanting next winter.

Kapuna site: There is no stock available from the Kapuna site and no collections were made before the plants disappeared. This site could be used as a reintroduction site in the future.

Keawapilau site: NRS staff collected cuttings from this site in 2000. Some of these cutting survived and are represented at the Pahole Nursery. Some of this stock was used, mixed with Pahole stock, to conduct a reintroduction back into Keawapilau. The NARS Biologist selected the site and NRS worked with NARS staff to fence it. NRS also spent 11.75 hours weeding

Psidium cattleianum, Lantana camara, Clidemia hirta, Stachytarpheta dichotoma and *Schinus terebinthifolius* prior to outplanting. See 'Outplanting' for discussion of success of the reintroduction.

Manuwai Reintroduction: Palikea gulch stock will be used to establish this reintroduction. Manuwai gulch will be fenced to protect the habitat from pigs and goats. Once this protection is in place NRS will select a reintroduction site for *P. kaalaensis* with assistance from NARS staff and NRS will prepare the site by conducting weed control prior to planting. Until this time, stock from Palikea gulch will be maintained in the greenhouse and increased in preparation for this effort.

Makaha Reintroduction : Waianae Kai stock will be used to establish this reintroduction. Appropriate habitat for this taxon will be protected in the coming year through the construction of a 100-acre exclosure. Once protected habitat is available, NRS will select and prepare a site for outplanting. Until this time, stock from Waianae Kai will be maintained and increased in preparation for this effort.

Other PUs:

None of the populations discussed below are extant. NRS will not report on these next year unless the status changes and will instead discuss the three reintroductions planned to capture all available stock. NRS will periodically monitor these sites for regeneration.

Ekahanui: This population has been extripated for over five years. There is no stock available in ex situ collections. No reintroductions will be conducted in the Southern Waianaes unless stock is re-discovered.

Palikea Gulch: In March 2003, NRS monitored the 5 remaining plants at this site. They were in poor condition. At the time, the vascular tissue of these plants was infected by a pathogen that seemed to be spreading along the length of the stem. NRS and Mr. Joel Lau collected five cuttings, one from each of the five plants, and brought them to the nursery for propagation. Four of these cuttings were successfully grown and are represented in *ex situ* collections. NRS monitored this site in the following year and there were no live plants, all that remained were a few of the dead stems. These were identifiable based on their square stems.

Waianae Kai: Joel Lau monitored this site in January 2004, and the plants were gone. Mr. Lau acquired collections from this PU during Genetic Safety Net collections in 1998 and this stock is available for use in reintroductions.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Pahole to Keawapilau	Manage for stability	Partial	Partial	No
Out of AA				
Palikea Gulch	Genetic storage	N/A	N/A	N/A
Waianae Kai	Genetic storage	N/A	N/A	N/A

5.21 *Plantago princeps* var. *princeps*

Requirements for Stability:

- 3 population units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

Only one of the populations designated for management is located in the Makua Action Area. All three of the chosen populations are located on cliffs or steep gulch sides. The Mohiakea PU was not chosen for management since it is located within Schofield Barracks, West Range where access is restricted. One population was selected in the Koolau Mountains in order to capture a site in wet forest habitat. Wild populations of this taxon show good recruitment. Since this taxon prefers cliff habitat, ungulate threats are low. Weed threats are also currently low at all the manage for stability PUs. The largest potential threat to *P. princeps* var. *princeps* is rat predation on mature plants. Rats may have extirpated the Palawai population of this taxon. NRS have been successful in obtaining good genetic storage collections from some populations of this taxon. With adequate rat control, NRS believe that this taxon has a good prognosis for stability.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Ohikilolo	Manage for stability	14	22/0	None	22/0
Pahole	Genetic storage	12	2/2	None	2/2
North Mohiakea	Genetic storage	20/10	20/3	None	20/3
Out of AA					
Ekahanui	Manage for stability	16/7	33/50	None	33/50
Waiawa (Koolaus)	Manage for stability	2/40	16/17	None	16/17
Halona	None	50-100	50-100	None	50-100
North Branch of North Palawai	Genetic storage	7	2/2	None	2/2
South Branch of North Palawai	Genetic storage	25	0	None	0
Nu`uanu	Genetic storage	New Population	1/0	None	1/0

Genetic Storage

Very limited genetic storage testing has been conducted with this taxon. Testing has only been conducted on two lots of seven seeds each collected in 2000. Based on this small sample size, it is impossible to draw significant conclusions. From these small seed lots, there was 100%

germination of two seeds stored at -15°C at relative humidity of 33% after six months of storage. The wild-collected seed of this taxon has been deemed too valuable for genetic storage testing and thus has been placed directly into long-term storage at -15°C at relative humidity of 33% for now. NRS will maintain greenhouse plants grown from cuttings of wild stock in order to collect more substantial amounts of seed for testing.

Genetic Storage of *In Situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of plants with rep.'s ex-situ
In AA						
Ohikilolo	Manage for stability	22/0	9	0	3	0
Pahole	Genetic storage	2/2	0	0	0	0
North Mohiakea	Genetic storage	20/3	0	0	0	0
Out of AA						
Ekahanui	Manage for stability	33/50	22	0	0	0
Waiawa (Koolaus)	Manage for stability	16/17	1	0	0	0
Halona	None	50-100	0	0	0	0
North Branch of North Palawai	Genetic storage	2/2	0	0	0	0
South Branch of North Palawai	Genetic storage	0	0	0	0	0
Nuuanu	Genetic storage	1/0	0	0	0	0

Propagation/Germination Techniques

Lyon Arboretum Staff observed that initial germination rates of *P. princeps* var. *princeps* seed before storage ranged between 75-100%. Also, this taxon can be propagated successfully from cuttings. Based on observation made by Stephanie Dunbar from the University of Hawaii at Manoa, *P. princeps* can be grown to maturity in a greenhouse. NRS will use this approach to seed collections for PUs that are difficult to access.

Unique Species Observations

NRS have observed that *P. princeps*. var. *princeps* has a distinct fruiting season in the spring. Rat predation has been noted in Honouliuli. Rats attack stems and leaves of mature plants.

Outplanting Issues

NRS have not yet conducted an outplanting with this taxon nor have any other agencies attempted to reintroduce it. To reach stable numbers, NRS will need to conduct outplantings. NRS will use the upper edges and lower ends of cliffs to limit the amount of rope work required. If a site with these characteristics is not available, NRS will rappel with small plants and search

for ledges on cliffs where holes can be dug. NRS conducted a trial cliff reintroduction at Ohikilolo with good success using *Lysimachia hillebrandii* and do not expect *P. princeps* var. *princeps* to be much more difficult.

Research Issues

A substantial seed storage trial should be conducted with this taxon. Stephanie Dunbar from the University of Hawaii is conducting genetics testing along with common garden experiments for *P. princeps* and other *Plantago* species. Her research will shed light on the phylogenetic and taxonomic relationships between all *Plantago* species with special attention to the varieties of *P. princeps*. NRS will incorporate any information from her research that relates to management of this taxon.

Surveys

NRS and the Hawaii Natural Heritage botanist, Joel Lau, conducted surveys in the Waiawa drainage for additional sites of this taxon. No new plants were found. NRS conducted surveys within the vicinity of the *P. princeps* var. *princeps* population on Ohikilolo ridge and discovered a number of additional plants. In the Koolaus, the Oahu Invasive Species Committee (OISC) staff discovered a lone individual plant of this taxon in Nuuanu Valley. The plant was observed while the OISC crew was conducting invasive species control work in the area.

Taxon Threats

Rat damage to mature plants has been observed at the Palawai and Ekahanui populations at Honouliuli. Rats may be responsible for the near disappearance of the Palawai PU of this taxon. NRS consider rats to be one of the largest potential threats to this taxon. NRS will closely monitor populations and if any rat damage is observed, NRS will deploy rat bait stations and snap traps to reduce the threat. Weed threats to *P. princeps* var. *princeps* and its habitat include *Erigeron karvinskianus, Schinus terebinthifolius* and *Rubus argutus*. At Honouliuli, NRS have observed *S. terebinthifolius* change cliff habitat. This tree can root into cliffs and when it grows too large for the substrate to support, it rips away a portion of the cliff side. No slug predation has been observed to this taxon. Goats and pigs threaten portions of some PUs of this taxon.

Population Unit Level Discussion

Manage for Stability PUs:

Ohikilolo: Last year, NRS rappelled in new areas and found more individuals of this species. The plants were monitored this year and substantial genetic collections acquired. NRS have been controlling ungulate threats to this population since 1995, beginning with the construction of a perimeter goat fence along Ohikilolo ridge. Since 1995, over 1,500 goats have been removed from MMR. It is estimated that less than 20 goats remain. NRS recently released two satellite-collared goats into MMR to assist in locating the remaining herd in Makua. Weeds that affect the Ohikilolo cliff where this taxon occurs include *Schinus terebinthifolius, Ageratina*

riparia and *Melinus minutiflora*. NRS have not spent time weeding at this site since the direct weed threat is low. No rat predation has been observed at this site.

Ekahanui: Neither one of the two Ekahanui sites of this taxon is within a fence but both will be included in the large Ekahanui fence planned for year three of the MIP. Pigs and goats do not directly threaten most of the plants in Ekahanui since they are on cliffs. Both *P. princeps* sites are included in the additional MIP fencing planned for year three of the plan. NRS, working with TNC, have drafted an Environmental Assessment for the construction of this fence. TNC and NRS have conducted weed control in the vicinity of the southernmost *P. princeps* cliff. TNC deployed rat bait stations in the vicinity of *P. princeps* var. *princeps* sites in Ekahanui following rat predation on some of the mature plants in the population. This rat baiting overlaps with baiting around *Achatinella mustelina* sites. NRS have assisted in re-stocking these bait stations. NRS will work with TNC to maintain and expand rat baiting if necessary.

Waiawa: Joel Lau surveyed the area with NRS this year. The plants occur on steep gulch walls and small waterfalls. The habitat surrounding this population is very native and no ungulate sign was observed. NRS plan to include this population in an ecosystem-sized fence which will protect it and other species that the Army must manage under the Oahu Implementation Plan. No weed threats were observed, although the habitat as a whole is threatened by *Psidium cattleianum*. NRS collected a total of 125 seeds from 11 plants in this PU. No cuttings were collected. Threats to this PU are low, therefore NRS are not as concerned about acquiring genetic storage collections from this PU as for Waianae PUs.

Other PUs:

Pahole: The number of individuals reported in the final Makua IP was based on Ken Wood's 1996 observations. NRS monitored the PU this year, and found 2 mature and 2 immature plants and 9 seedlings. Further surveys will be conducted as more plants may be in the area, although most of the available habitat for this taxon has been surveyed in the past. It is unlikely that many more plants will be found. Based on this latest monitoring, and the limited habitat available in Pahole for this taxon, NRS have decided to change the management designation for this PU from 'manage for stability' to 'genetic storage'. Instead, NRS have chosen to manage the Ohikilolo PU for stability. This PU is fenced so ungulates are not a threat. There are very few threats to the Pahole plants. Rat predation has not been observed at the site, the cliff habitat is very intact and the area is fenced and ungulate free.

North Mohiakea: The North Mohiakea PU is located within Schofield Barracks, West Range. The *P. princeps* plants at this site are restricted to a steep cliff. Only pigs are present at the site, therefore, the ungulate threat to this PU is low. The weed threats are significant. The most abundant ecosystem altering weeds present at this PU are *Rubus argutus* and *Erigeron karvinskianus*. NRS have acquired some genetic storage collections from this PU but hope to acquire cuttings on the next visit, since access is unpredictable and unreliable.

Halona: The number of individuals reported in the final Makua IP was based on Steve Perlman's 1992 observations. NRS have not visited this site. NRS will visit the site in the next month to determine threat to the PU and collect.

North Branch of North Palawai and South Branch of North Palawai: TNC and Army staff monitored both these sites in the last year. Only one seedling of *P. princeps* was observed at the southern site and only two mature and two immature plants were observed at the northern site. These numbers are a significant decline since Steve Perlman first observed the sites in 1996. TNC staff attribute the decline in these PUs to rat predation on mature plants. NRS and TNC are maintaining rat bait stations around the Northern site to address this rat threat. Additionally, the habitat at this PU is overrun with *Erigeron karvinskianus*. At the northern site, *E. karvinskianus* forms dense mats up to one meter tall and simply smothers any native plants on the cliff.

Nuuanu: OISC staff only recently discovered this PU. No management has been done yet, nor have collections been made. NRS will work with OISC and State staff to visit this site in the next year to obtain collections. The plant only had one growing tip, and is not suitable for cuttings. Therefore, NRS will try to visit when seed is available.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Ohikilolo	Manage for stability	Yes	No	No
Pahole	Genetic storage	Yes	No	No
North Mohiakea	Genetic storage	No	No	No
Out of AA				
Ekahanui	Manage for stability	Partial	Partial	Yes
Waiawa (Koolaus)	Manage for stability	No	No	No
Halona	Monitor/ Genetic storage	No	No	No
North Branch of North Palawai	Genetic storage	No	No	Yes
South Branch of North Palawai	Genetic storage	No	No	No
Nuuanu	Genetic storage	No	No	No

5.22 *Pritchardia kaalae*

Requirements for Stability:

- 3 population units (PUs)
- 25 reproducing individuals in each PU (long-lived perennial)
- Threats controlled
- Complete genetic representation of all PUs in storage

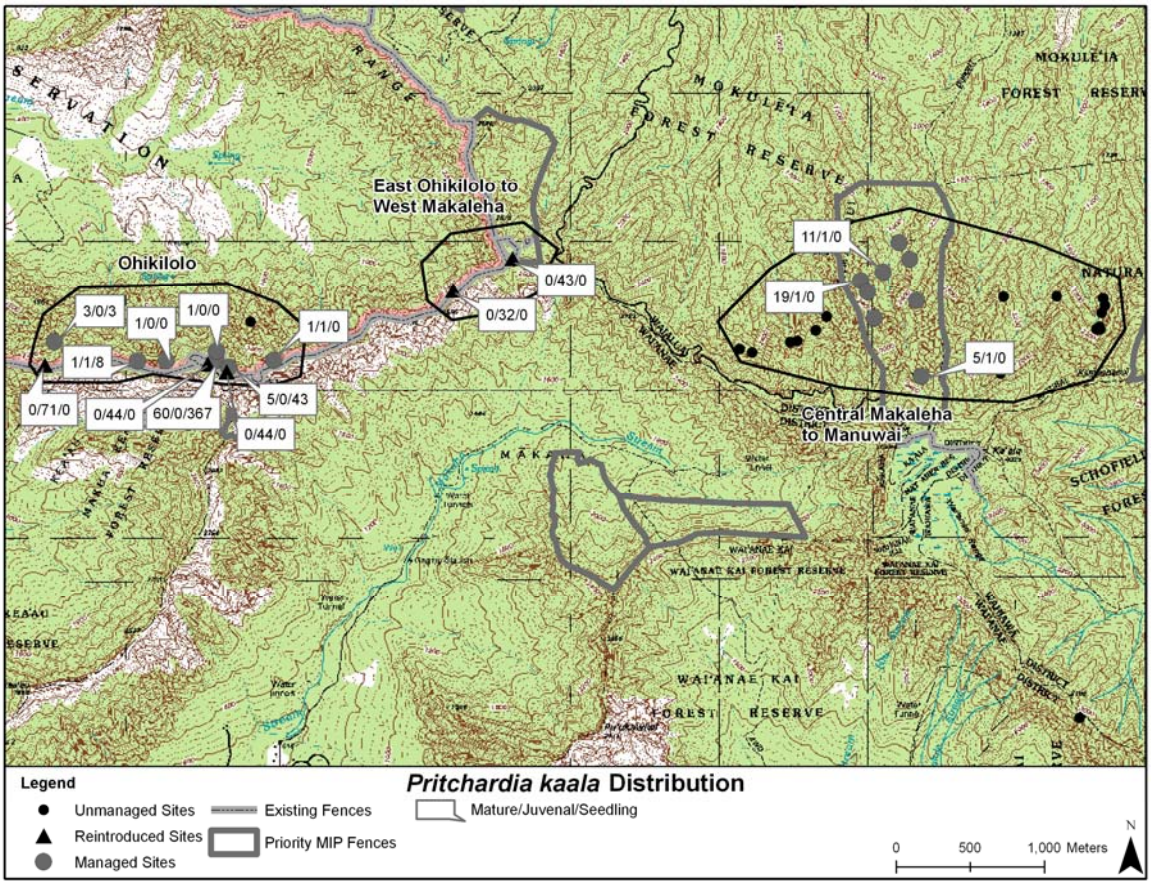
Taxon Level Discussion

Pritchardia kaalae is found in large numbers in two regions in the Waianae Mountains, Ohikilolo ridge and Makaleha gulch to Manuwai gulch. The Makua Implementation Team (MIT) determined that these remaining sites are parts of what once was a population that stretched from Ohikilolo ridge to the Kalena-Kaala ridge. Therefore, the MIT established a modified goal for this taxon of 3 groupings, with 25 individuals each, spread across this historical belt of habitat. This means managing at least 25 mature individuals at each of the Ohikilolo and Makaleha to Manuwai PUs, and also establishing a third site of 25 individuals between these two. This third site has been established at the boundary between Mokuleia Forest Reserve and Makua via reintroductions at West Makaleha and East Ohikilolo. The separation between PUs that was required for other taxa was waived for this species to avoid creating an artificial separation that the MIP does not believe existed historically. Protection of *P. kaalae* across this broad area affords it protection from one single catastrophic event. *P. kaalae* is easy to grow from seed and outplantings have been extremely successful. As long as habitat level protection is in place (ungulate control, weed control and rat control) the prognosis is good for reaching stability for this taxon. The major challenge for *P. kaalae* management is that outplanted or naturally recruiting young plants may not mature for decades. On the other hand, the long lifespan of this taxon may be a significant benefit to its stabilization as extant populations represent a very old genetic make-up.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Ohikilolo	Manage for stability	65/100	72/3	0/308	72/310
Out of AA					
Makaleha to Manuwai	Manage for stability	138/3	39/3	None	39/3
Makaha	Genetic storage	1	1/0	None	1/0
Waianae Kai	Genetic storage	7/2	7/2	None	7/2
Reintroductions					
East Ohikilolo and West Makaleha	Manage for stability	N/A	N/A	0/75	0/75

Figure 5.12 *Pritchardia kaalae* Distribution



Genetic Storage

P. kaalae has a very large seed. NRS consulted A. Yoshinaga from Lyon Arboretum regarding the potential for *P. kaalae* to store successfully. He was skeptical that traditional storage methods in refrigeration or freezing would be successful. Based on Mr. Yoshinaga's recommendation, NRS collected a large batch of fruit to send to the National Seed Storage Lab (NSSL) for further seed storage research. NSSL has the capability to store seed in liquid nitrogen and Mr. Yoshinaga thought this might be required for *P. kaalae*.

NSSL staff report that excised embryos accept drying well. (Lisa Hill, pers. comm. 2004). *P. kaalae* is a good candidate for embryonic storage at –80ºC or in liquid nitrogen at –150ºC. Ms. Hill also recommend trying storage via freezing at 4ºC but only after letting seeds dry substantially. She recommends drying them at a relative humidity of 35-55% for one week. When withdrawing embryos she recomends warming them rapidly (not slowly) in warm water. NRS will act on these recommendations and begin to build the seed bank at Lyon Arboretum.

Genetic Storage of *In-situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Ohikilolo	Manage for stability	72/2	1	1	19	34
Out of AA						
Makaleha to Manuwai	Manage for stability	39/3	0	0	0	0
Makaha	Genetic storage	1/0	0	0	0	0
Waianae Kai	Genetic storage	7/2	0	1	2	0

Propagation/Germination Techniques

Germination of *P. kaalae* seed is conducted in moist sphagnum moss. The moss and shucked seeds are placed in gallon-sized Ziploc bags and placed in a warm location. NRS place this bag on the top of a refrigerator for warmth. Heat stimulates germination. In approximately two months, some germination can be seen, but not all seeds germinate at once. Some take many months to germinate. Seedlings are removed from the bag as they appear and are planted in groups into vermiculite and perlite until more substantial leaves are produced. Seeds have also been germinated with traditional methods in vermiculite and perlite. Larger seedlings are placed individually in potting media. *P. kaalae* seedlings grow very slowly. *P. kaalae* plants that are two years old may often only have 2-3 small leaves.

Hector Perez, a graduate student at the University of Hawaii, conducted seedling establishment studies with *P. remota*. He has yet to formally analyze the data, but based on anecdotal observations, seeds buried in the soil can survive for a significant period of time. Although these species grow in different habitats, Mr. Perez feels that the results apply to *P. kaalae*.

NRS have never tried to propagate this taxon from vegetative material. There is only one meristem and if collected would result in the death of the plant. It is unlikely that this approach would be successful if material were collected. Seed germination is a very reliable means of propagating this taxon.

Unique Species Observations

NRS visited the Foster Botanical Garden and observed a *Pritchardia sp.* individual in their collection that was planted almost 100 years ago. The plant was mature but did not have a substantial trunk yet. The trunk was less than one meter tall. This observation may indicate that large-trunked *P. kaalae* trees in the wild could be over 100 years old as many of them have trunks that are 3-4 meters tall. It has been documented that *P. munroi* plants take 15 years to mature in garden setting (M. Brueggman pers. comm.). NRS have also observed the slow growth of reintroductions of known age. The reintroduced plants are about six years old and are not expected to become reproductive for decades.

Outplanting Issues

P. kaalae reintroductions have been conducted with high success. NRS tried planting seedlings that were only one year or less but their survivorship was only 75% after one year. Since that time, NRS started using plants at least two years old for outplanting. Plants that are at least this age upon planting seem to adjust better than younger plants. NRS planted 264 individuals of *P. kaalae* into five sites, and 234 plants are still surviving (89% survivorship). Most are healthy. Most of the mortality occurred at two sites, one that was impacted by feral pigs and another that had windy habitats in which the plants faired poorly.

Research Issues

Mr. Hector Perez and colleagues at the University of Hawaii have simulated seed damage in *P. kaalae* by removing endosperm to see how it affects seed germination. Results showed that removal of up to 42.5% of the endosperm for actually stimulated germination; agermination happened twice as fast as in untreated seeds. Any damage to the endosperm over 42.5% and up to 72.5 % decreased germination of *P. kaalae* seeds. This research shows that limited damage to the fruit may facilitate recruitment by breaking seed dormancy early. Also rapid and complete germination may be an adaptive response to predation.

Mr. Perez is also conducting seed dormancy research for *Pritchardia kaalae*. Preliminary results show that *P. kaalae* seeds exhibit both physiological and morphological dormancy. (H. Perez, pers. comm.).

Surveys

No additional surveys have been conducted for this taxon. NRS would like to re-visit the *P. kaalae* in Makaha and will schedule surveys within the next year.

Taxon Threats

NRS have been monitoring the Ohikilolo population of *P. kaalae* for almost 10 years. Based on this monitoring, NRS believe the largest threats to *P. kaalae* are goat predation of seedlings and rat predation of fruit. For many years, wild populations have shown little or no recruitment because the impacts of both these predators partically stoped reproduction. The wild populations are primarily composed of mature trees with very few immature plants. NRS have not observed impacts to this taxon from slugs. Pigs have an impact on young *P. kaalae* plants. In one area NRS preformed a reintroduction into an area with pigs. Many plants where ripped out of the ground. NRS believe the pigs were attracted to the potting soil as the plants where not destroyed just uprooted. NRS is presently seeking permission to fence this site. Most of the wild populations are restricted to steep areas where pigs are either not present in high numbers or not present at all. Where pigs are a threat, they should be controlled. In the Koolau Mountains *P. martii* fruit are often eaten by pigs.

Population Unit Level Discussion

Manage for Stability PUs:

Ohikilolo: NRS monitored all of the Ohikilolo wild populations this year. In addition to the 72 mature and 3 immature plants there are approximately 400 seedlings. Management began with the construction of a perimeter goat fence along the Ohikilolo ridge crest in 1998. This fence separated the formerly large Makua goat population from neighboring populations. Since the fence was constructed nearly all the goats have been removed within MMR. There may still be less than 20 goats remaining and NRS are employing satellite collared Judas goats to try and located the remaining few. In addition, the largest concentration of *P. kaalae* on Ohikilolo is protected by a goat exclosure that encompasses approximately two acres.

NRS have also conducted weed control in the habitat around wild and reintroduced individuals of *P. kaalae*. This past year seventeen hours of weed control were conducted around reintroduced plants and five hours were spent weeding around wild plants. This year, helicopter access restrictions limited the number of work trips conducted to Ohikilolo ridge and as a result the amount of weed control conducted for *P. kaalae* was reduced. Some of the most problematic weed species in *P. kaalae* habitat include, *Schinus terebinthifolius, Blechnum appendiculatum* and *Erigeron karvinskianus*. Both *B. appendiculatum* and *E. karvinskianus* are difficult to control but do not seem to affect *P. kaalae* recruitment.

NRS administer rat bait and deploy snap traps around three wild sites of *P. kaalae* on Ohikilolo. NRS re-stock 28 rat traps quarterly. The presence of ripe fruit increased dramatically once predator control began and subsequently the number of seedlings has also increased at all three sites.

Makaleha to Manuwai: The number of individuals reported in the final Makua IP was based on Joel Lau's estimates of trees observed, many from afar, between 1991 and 2001. NRS have monitored some of the more accessible trees in the last year. The 39 reported reflect these areas monitored by NRS. There are still substantial numbers of inaccessible plants on the cliffs. NRS plan to manage the portion of this PU that is accessible within the East Branch of East Makaleha. This falls within the proposed East Makaleha MU.

NRS have just recently begun working at the East Branch of East Makaleha site. Weed control at the site will begin once a plan is developed with NARS. NRS administer rat bait twicw a quarter to protect the fruit of *P. kaalae*. Fourteen bait stations are currently deployed in 2 grids around two groups of accessible trees at this site. There are 31 mature and 2 immature trees encompassed in the baiting grid. This area is planned to be fenced in year two of the MIP. NRS will work with the State of Hawaii to develop fencing plans for East Makaleha and implement those once permissions are in place. In the meantime, NRS have been conducting control hunts in the adjacent Mt. Kaala NAR, which is likely also reducing goat numbers within East Makaleha. This control will continue and NRS will pursue acquiring permission to implement more directed goat control in the vicinity of the *Pritchardia kaalae* plants in East Makaleha as goat sign has been observed at the site.

Ohikilolo East to West Makaleha (reintroduction): Reintroductions were established at two sites mid-way between the two core wild populations. One reintroduction was established in 2002 at West Makaleha within a two-acre exclosure which was constructed to protect *Cyanea grimesiana* plants. Forty-six plants were outplanted into the exclosure and only three of them died. Although survivorship was high at this site, it is windward-facing and exposed. During windy periods the *P. kaalae* outplants experience more wind than they would in a more forested site. If NRS supplement this planting, it will be done in a more forested portion of the fenced area. An additional site was established in exceptional habitat along the eastern portion of Ohikilolo ridge. However, it is not protected from pigs. Plantings were successful at first and then experienced severe predation by pigs. NRS set snares around the reintroduction site but this was not enough to prevent pig damage to plants. NRS believe this site is very viable but will not reintroduce again until a pig fence is erected. NRS have scoped such a fence and are in the process of seeking permission for construction.

Other PUs:

Makaha: NRS have not been to this site but will schedule a day to visit the site with Mr. Joel Lau, the botanist from the Hawaii Natural Heritage Program. Genetic collections will then be acquired and possibly used to augment the Ohikilolo East to West Makaleha reintroduction sites.

Waianae Kai: NRS conducted rat control at this site. Some fruit was collected and put into *in vitro* storage at Lyon Arboretum. Plants were also grown from seed and are healthy. These plants will be planted at Lyon Arboretum in the next year. Rat control at the site is very expensive, as helicopters are needed for access. NRS halted rat control as the population is already represented *ex-situ*. NRS will attempt to gain 100% representation for the wild in the next year. If rat control is deemed necessary to reach this goal, NRS will revisit this as an option.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Ohikilolo	Manage for stability	Partial	Partial	Yes
Out of AA				
Makaleha to Manuwai	Manage for stability	No	No	Yes
Makaha	Genetic storage	No	No	No
Waianae Kai	Genetic storage	No	No	No
Reintroductions				
Ohikilolo East and West Makaleha	Manage for stability	Partial	Partial	Partial

5.23 *Sanicula mariversa*

Requirements for Stability:

- 3 population units (PUs)
- 100 reproducing individuals in each PU (short-lived perennial with infrequent, inconsistent flowering)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

Two of the populations designated as 'manage for stability' are located in the Makua action area and one is located off-site, at Kamaileunu. The largest natural populations were chosen. The U.S. Fish and Wildlife Service expressed concern that two populations are located within the highest fire threat area of the Makua action area. From NRS's perspective, neither the Keeau nor the Ohikilolo *Sanicula* populations should be within the highest fire threat area. Both populations are buffered from fire threat by at least two barriers: first a large band of thick forest, and second, large, sparsely vegetated cliffs. NRS will continue with plans to protect the three selected populations and will reconsider this decision only if the fuel modeling being conducted by Colorado State University Staff for the Makua action area indicates that both these populations are truly at high fire risk. It does not make sense to walk away from a large PU in the action area for a small one outside the action area.

As a taxon, *Sanicula* is challenging to monitor. Changes in population numbers since the final Makua IP do not represent trends. *Sanicula* is a perennial, lying dormant for the summer and becoming foliated in winter. Since plants do not appear each year consistently and they die back to their root, an effective individual plant tagging technique has been difficult to develop. Taproots can divide and send up shoots in a different location than the year before, or can send shoots from multiple growing tips. This taxon flowers inconsistently but when plants flower, they do so in spring. There is no conclusive seed storage data for this taxon. NRS have experienced some success in reintroducing *Sanicula,* both *S. mariversa* and *S. purpurea*. In addition, the Ohikilolo population has responded well to ungulate control.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Keaau	Manage for stability	16/125	7/100	None	7/100
Ohikilolo	Manage for stability	34/109	1/62	0/19	1/81
Out of AA					
Kamaileunu	Manage for stability	26	13/22	None	13/22
Puu Kawiwi	Genetic storage	2	0/32	None	0/32

Genetic Storage

Lyon Arboretum staff have not had success germinating *S. mariversa*. Therefore, seed storage trials have been inconclusive. According to Lauren Weisenberger at Lyon Arboretum, the seeds of this taxon have good storage characteristics. Thus, NRS have been submitting seed for storage and have good representation of the three *in situ* manage for stability populations. NRS will work with Lyon Arboretum to develop a reliable germination technique so that seed storage data can be acquired.

Genetic Storage of *In Situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in microprop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Keaau	Manage for stability	7/100	27	0	0	0
Ohikilolo	Manage for stability	1/62	36	0	0	13
Out of AA						
Kamaileunu	Manage for stability	13/22	37	0	0	0
Puu Kawiwi	Genetic storage	0/32	0	0	0	0

Propagation/Germination Techniques

NRS have had success germinating *S. marivera* in potting media. Over 50% of the seeds sown germinated. NRS also had success germinating seeds that had been kept refrigerated for approximately six months. The observations were not formally quantified, but based on these results, NRS will assist Lyon Arboretum in performing initial germination and post-storage germination trials.

Unique Species Observations

NRS have observed very unpredictable seasonality in this taxon. One would predict that more plants should be observed at populations following heavy rainfall periods but this has not been the case. In addition, it is unpredictable how long plants will be dormant before they re-sprout but it is evident that they need to emerge many times before they are large enough in size to be reproductive. NRS have never observed a *S. mariversa* plant reproduce twice. They appear to die after flowering.

Outplanting Issues

NRS reintroduced 30 *S. mariversa* into the Ohikilolo fence exclosure in 2001. Since that time NRS monitored the site each year. In 2002, 12 *S. mariversa* were observed. In 2003, 19 *S. mariversa* were observed. In 2004, zero *S. mariversa* were observed. It appears that reintroduction is a viable management technique for this taxon. Although no plants were observed in the last year, NRS do not consider the population extirpated. The dormancy cycle of

Sanicula makes it difficult to rate reintroduction success. NRS will use this reintroduction to develop better population estimate formulas for the taxon and to better estimate the age of plants in the wild when they flower.

NRS also initiated two seed sowing trials in 1999 at two different sites. Only one plant was ever observed. NRS have not monitored the seed sowing sites consistently since the initial planting and thus do not have reliable data on their results. NRS will re-monitor the sites in the coming wet season.

Research Issues

The number one research issue for this taxon is determining wild plant seasonality. It seems that on very rainy years, *S. mariversa* would sprout from taproots more than in dry years. This prediction is not supported by observations made by NRS at wild sites and at the reintroduction where in 2004 (an extremely wet year) no leaves were observed. Fluctuations in population numbers may be due more to the maturation of plants than linked to high seed production years.

In addition, the complications related to the lifecycle of this taxon should be investigated in order to improve population monitoring protocols.

Surveys

During urgent actions surveys in 2002, NRS and botanists from the National Tropical Botanical Garden discovered two sizable populations on Kamaileunu ridge. These populations have been incorporated into management plans.

Taxon Threats

The largest threat to this taxon is goats. Goats traverse areas that contain *S. mariversa* populations, destroying habitat and causing erosion. NRS have not observed direct goat browse on *S. mariversa* but suspect that they may browse plants. Because this taxon has a large carrot-like taproot, it tends to grow in areas with deep and soft soil. Therefore, *S. mariversa* habitat as a whole is one of the most susceptible to goat-induced erosion. Aside from goats, weeds also invade *S. mariversa* habitat successfully. In particular, alien grasses such as *Melinus minutiflora, Setaria gracilis, Andropogon virginicus* and *Rhynchelytrum repens* are well established to varying degrees at all the populations of this taxon.

Population Unit Level Discussion

Manage for Stability PUs:

Ohikilolo: There are two sites on Ohikilolo where *S. mariversa* is found. The Makai site has been monitored since the inception in 1995 of the Army program. The Makai site has many more plants than the Mauka site. The most current and accurate monitoring number for the

Makai site is one mature and 50 immature plants. The table below illustrates monitoring numbers since 1998 for this site.

Monitoring Date	March 1998	May 1999	March 2001	March 2002	March 2003	April 2004
Mature/Immature/Seedling	0/12/0	27/35/0	80+ total	48/60/30	10/0/0	1/50/0

The most current and accurate monitoring number of the Mauka site is zero mature plants and 12 immature plants. In addition there are at most 19 immature plants in an Ohikilolo augmentation. Substantial collections have been made from the Makai site in 1999 and 2002. In other years, in between these, NRS monitored the population but very few or no reproductive plants were observed. Population numbers vary drastically by year. It is difficult to determine actual population size for reporting purposes but NRS are working to better understand population trends for this taxon.

NRS have been controlling ungulate threats to this population since 1995, beginning with the construction of a perimeter goat fence along Ohikilolo ridge. Since 1995, over 1,500 goats have been removed from MMR. It is estimated that less than 20 goats remain. NRS recently released two satellite-collared goats into MMR to assist in locating the remaining herd in Makua.

NRS also installed erosion control materials at a site within the Makai population where there was severe goat-induced erosion. NRS used chain link fence in combination with coconut jute fibers to stabilize the site. The vegetative cover has slowly increased as a result of these erosion control measures and *S. mariversa* is utilizing this newly stabilized habitat.

NRS have spent four hours controlling alien grasses around the Ohikilolo Makai population. Focus has been on *Melinus minutiflora* and *Setaria gracilis*. NRS have had mixed results in controlling *S. gracilis* and thus, have initiated control trials at Ohikilolo. Once a proven control technique is developed, NRS will implement more extensive control.

Kamaileunu: This population of *S. mariversa* was discovered just before the MIP was finalized. Since that time NRS have acquired a substantial collection from the site. The most significant threat to the Kamaileunu population is goats. Goats have made many trails through the population. NRS flagged some flowering plants in the spring of 2003 so that the fruit could be more easily located upon return in the summer. Goats had trampled the dried peduncles and disturbed the ground so much that even these flags were difficult and in a few cases impossible to find. NRS scoped a fenced exclosure to protect this population. Due to permitting issues, construction is not yet approved. NRS will continue to pursue fencing at this site and once fencing is completed, will initiate some grass control.

Monitoring Date	May 1999	June 2001	June 2002	July 2004
Mature/Immature/Seedling	16/13/0	1/7/3	21/22/5	7/100/0

Keaau: NRS have monitored the Keaau population of *S. mariversa* since 1999. As discussed above, monitoring data varies dramatically for this taxon as a whole because of it's life history. No goat control has been conducted in the vicinity of this population because it is located within a State of Hawaii Public Hunting Area. In the Hunting Area, goats are the managed resource. Unfortunately, the *Sanicula* site is at the back of the hunting area and thus is not frequently hunted. NRS will pursue the construction of the Keaau and Makaha management unit, which will protect this population from goat impacts. This population, similar to the others, has been impacted by goat-induced erosion. The Keaau population has the same suite of alien grasses present at other populations, but NRS has not yet conducted any weed control at the site. NRS will acquire permissions necessary to fence this population and conduct weed control at the site.

Other PUs:

Puu Kawiwi: NRS monitored this population in 2004 and many immature plants were observed. No mature plants were seen this year. Most of the plants observed are on cliffs. A few of the plants observed are on a ledge between cliffs, within reach of goats. NRS has proposed installing some strategic fencing to block this ledge, but this is pending appropriate permitting. Fencing as a whole at this population will be extremely difficult because of the steep terrain. NRS will continue to visit this population for seed collection.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Keaau	Manage for stability	No	No	No
Ohikilolo	Manage for stability	Yes	Yes	No
Out of AA				
Kamaileunu	Manage for stability	No	No	No
Puu Kawiwi	Genetic storage	No	No	No

5.24 *Schiedea kaalae*

Requirements for Stability:

- 3 population units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

NRS chose the two Waianae PUs and one Koolau PU to manage for stability. These PUs were selected in order to capture the range of this taxon. Other PUs will be used as propagule sources for augmentations and for genetic storage. Small-scale threat control may be required to secure material for storage from the Koolau Mountains. TNC has had good success with outplantings of this taxon. This taxon responds well to ungulate and weed control and grows well from seed and cuttings. The largest threat to this taxon is slug predation. NRS are currently working with a graduate student from the University of Hawaii to better understand and control this threat. Once a slug control technique is available, NRS feel this species can be stabilized.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Pahole	Manage for stability	3	1/0	None	1/0
Out of AA					
South Ekahanui	Manage for stability	10/0	5/0	0/75	6/75
Kahana	Manage for stability	New population	11/0	None	11/0
Huliwai	Genetic storage	1-2/0	0	None	0
Kaipapau	Genetic storage	New population	2/0	None	2/0
Maakua	Genetic storage	4	4/0	None	4/0
Makaua	Genetic storage	2	2/0	None	2/0
Mohiakea	Genetic storage	New population	1/0	None	1/0
North Kaluaa	Genetic storage	2/0	0	0/53	0/53
North Palawai	Genetic storage	1/0	1/0	None	1/0

Genetic storage

Sufficient collections for genetic storage have been difficult for this taxon. Large seed collections are difficult to secure as plants often do not produce high numbers of mature seed at the same time. Rather, seeds mature in slow succession over a period of months. In addition,

many of the Koolau PUs are in remote areas that are difficult to access and frequent visitation is impractical. From the seed collections that have been made, the Lyon seed storage lab indicates that germination rates are low with stored seed as well as with fresh seed. Seed storage testing at Lyon Arboretum has not been conclusive but Dr. Stephen Weller from the University of California at Irvine has stored seed in a refrigerator for up to several years. Cuttings have been collected when available but often, plants are not large enough to allow for collection of cuttings. Plantlets have been observed on this taxon, which may also serve in genetic storage. Vegetative propagules are a viable approach to achieving genetic storage for this taxon.

Genetic Storage of *In situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Pahole	Manage for stability	1	1	0	1	0
Out of AA						
South Ekahanui	Manage for stability	5/0	2	3	3	1+
Kahana	Manage for stability	11/0	0	1	1	0
Huliwai	Genetic storage	0	1	0	1	0
Kaipapau	Genetic storage	2/0	0	0	1	0
Maakua	Genetic storage	4/0	0	0	3	0
Makaua	Genetic storage	2/0	0	0	2	0
Mohiakea	Genetic storage	1/0	0	0	1	0
North Kaluaa	Genetic storage	0	1	0	0	1+
North Palawai	Genetic storage	1/0	1	0	1	1+

Propagation/Germination Techniques

NRS have only recently begun propagating this taxon. Thus far, NRS have seen high rates of germination with seed collected from the Mohiakea plant after the seeds were stored at room temperature for six months. Dr. Steve Weller recommended this technique. Lyon seed bank reports low germination rates with both fresh and stored seed, however they also do not have much experience with this taxon. TNC has worked with this species for some years and has successfully collected seed, grown plants in the greenhouse, and reintroduced plants. NRS as a result, do not expect any propagation challenges.

Unique Species Observations

NRS observed vegetative reproduction in the form of a plantlet growing off of a mature infructescence in Maakua gulch. Dan Sailer from TNC reported that he had seen this one time previously n the Waianaes.

Outplanting Issues

NRS have not outplanted this species. NRS plan to reintroduce this species into Kaluaa this year with TNC. TNC has worked with this species over the past few years and already reintroduced it to other areas in Kaluaa as well as Ekahanui. There appears to be good survivorship within these outplantings. No seedlings or juveniles have been observed within TNC outplantings.

Research Issues

NRS believe that slug predation has a major impact on seedling survival. TNC has also done some trials to begin to determine the impacts of slugs on this taxon. NRS has begun to work with Ms. Steph Joe, a graduate student at the University of Hawaii, to investigate slug impacts and possible control techniques. A close relative of *S. kaalae*, *Alsinodendron obovatum,* was included in Ms. Joe's study. Preliminary data show that approximately 30% of mortality for *A. obovatum* can be attributed to slug predation.

Surveys

Presently, there are no surveys planned with Hawaii Natural Heritage Programs botanists. However, since the MIP was finalized, Joel Lau found new populations in Kahana and Kaipapau. In addition, NRS found a single plant in Schofield Barracks. This species was not known from this area before this discovery.

Taxon Threats

As mentioned previously, NRS believe that slugs are a major threat to the natural recruitment of this species. NRS is working with Steph Joe, a graduate student from the University of Hawaii, to explore the impacts of slugs and determine possible control techniques. Pigs are also a significant threat to most PUs. In other areas topography excludes ungulates from PUs. Some *S. kaalae* PUs are located in poor quality habitat. Rats have not been seen to impact this taxon however they may be a possible threat.

Population Unit Level Discussion

Manage for Stability PUs:

Pahole: NRS have not visited this site. NARS biologist Talbert Takahama monitored the remaining plant and collected seed this year. NRS are germinating this seed in the nursery. The plants grown from this stock will be used to augment the Pahole PU and for collecting seeds for storage. NRS has never been to the site and therefore have not conducted weed control. NRS plan to visit the site soon with Mr. Takahama.

South Ekahanui: The number of individuals reported in the final Makua IP was based on Joel Lau's 1991 observation of 3 plants and TNC's 2001 observation of 7 plants in Ekahanui. TNC staff has been monitoring these plants quarterly. There are currently six mature plants known

from three sites in Ekahanui Gulch. In the past year, NRS has collected from three of these plants and mature seeds have been stored at Lyon. One of the sites has been fenced in the last year, and the others are within the larger existing fence. In the coming year, NRS will assist TNC in monitoring the plants in Ekahanui, collecting mature seed, maintaining the fences and conducting weed control. Propagules collected from these plants will be grown and reintroduced into protected areas in Kaluaa. Currently there are 75 individuals of mixed stock that have been outplanted into the protected areas of Ekahanui. NRS spent 26.5 hours controlling weeds at a site slated for outplanting this winter.

Kahana: In the last year, eleven mature plants were discovered in a side gulch of Kahana Valley. This gulch is fairly intact and has very steep walls. The site is on private land. In the last year, collections were made and cuttings are being grown at Lyon. These will be used as a propagule source in the future and serve as a living collection of these plants. In the coming year, GSN staff, NRS and volunteers will monitor these plants. Pigs are a threat to this site and it should be fenced. Construction of large-scale fencing around this gulch will be extremely challenging and expensive. NRS will work with the Koolau Mountains Watershed Partnership staff to cooperatively fund the fence construction. In the last year, NRS worked with GSN staff to construct a small ungulate exclosure around some *Cyanea truncata* near the Kahana PU of *S. kaalae*. Although *S. kaalae* are not encompassed within this fence, the habitat is appropriate for augmentations. No weed control has been performed at this site.

Other PUs:

Huliwai: The last wild plant was doing poorly in the wild and TNC staff removed it to their greenhouse. This plant is now at the Army greenhouse where it is being kept as a propagule source and living collection. NRS has not been managing the site from which this plant came as it is heavily degraded.

Kaipapau: There are two mature plants known from Kaipapau in the Koolau Mountains. They have been collected from and propagules are being grown at Lyon. They are not within a fence, but are not highly threatened by ungulates. Slug damage has been observed at this site and no doubt impacts seedling survival. In the coming year, volunteers will monitor these plants. No weed control has been performed at this site.

Maakua: In November of 2003, NRS accompanied the Oahu Genetic Safety Net Biologist on a survey of Maakua Gulch on the windward side of the Koolau Mountains. A total of at least four plants were seen. Some of the plants were large beds with many rosettes. It is difficult to say how many plants were in these patches. These large patches are the healthiest representatives of this taxon that NRS have ever seen. NRS also observed a plantlet growing from a fruiting stem. This is the first time NRS have observed this. Access is difficult because there are multiple waterfalls that must be scaled to get into this zone. NRS will strive to visit the site on an annual basis for monitoring.

Makaua: There are two mature plants known from Makaua. There is substantial pig damage to the general area where this plant occurs. Last year, NRS worked with GSN staff to construct a small fence around the plants. GSN staff collected cuttings from some of the plants at this site

and they are growing successfully at Lyon Arboretum. These propagules will be used as a source for mature seed to be stored in the seed storage facility. Currently, GSN staff and volunteers monitor this PU. Some weed control was performed in conjunction with fence building and subsequently by GSN staff.

Mohiakea: In late 2002, one mature individual was found in SBW. A broken stem was taken as a cutting at the time, but later failed to root. NRS collected mature seed from the plant. Plants grown from these collections are growing vigorously in the Army greenhouse and will be reintroduced into Kalua'ā and used to produce seed for storage. Three and a half hours were spent doing weed control at this site in 2003 and a small fence was constructed. The habitat surrounding this plant is degraded thus NRS do not plan to spend time trying to control weeds.

North Palawai: There is a single *S. kaalae* plant in Palawai. This plant has seeded prolifically in past years. On multiple visits this year NRS worked with TNC to secure stock for storage. NRS also constructed a small exclosure around the plant to protect it from ungulates. Small scale weeding was also conducted. However, the site is almost completely dominated by *Schinus* and weeding will not be done extensively. NRS will continue to work with TNC to monitor this site.

North Kaluaa: This population has not been observed since 1996. NRS surveyed the historical location in Kaluaa this year with HIHNP Botanist, Mr. Joel Lau and no plants were discovered. TNC has reintroduced stock from Ekahanui and Palawai into this Central Kaluaa for a total of 53 individuals. The reintroduction site is within the large Central Kaluaa fence. NRS spent 60 hours doing weed control in this area this year in preparation for reintroduction. NRS plan to do a large reintroduction of mixed stock to in to a neighboring gulch in the coming year.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Pahole	Manage for stability	Yes	No	No
Out of AA				
South Ekahanui	Manage for stability	Partial	Partial	No
Kahana	Manage for stability	No	No	No
Huliwai	Genetic storage	N/A	N/A	N/A
Kaipapau	Genetic storage	No	No	No
Maakua	Genetic storage	No	No	No
Makaua	Genetic storage	Yes	No	No
Mohiakea	Genetic storage	Yes	Partial	No
North Kaluaa	Genetic storage	No	No	No
North Palawai	Genetic storage	Yes	Partial	No

5.25 *Schiedea nuttallii*

Requirements for Stability:

- 3 population units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

S. nuttallii is extremely rare. NRS plan to manage both extant populations, which lie within the portions of the action area with the lowest fire risk . The third PU site slated for management is a reintroduction in Makaha that will be conducted with mixed stock from wild extant PUs. The wild populations are well represented *ex situ*. There is recruitment at wild sites, but individual plants often show sign of invertebrate damage. As a result, *in situ* plants are not vigorous. Reintroductions have been successful for *S. nuttallii* but reintroduced plants suffer from the same invertebrate damage as wild plants. NRS will work on controlling the invertebrate threats to this taxon to improve its chance of reaching stability.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Kahanahaiki to Pahole	Manage for stability	35/12	31/8	13/5	44/13
Kapuna – Keawapilau Ridge	Manage for stability	2/1	3/0	None	3/0
Reintroductions					
Makaha	Manage reintroduction for stability	N/A	N/A	0	0

Genetic Storage

No seed storage testing has been conducted for this taxon because the only seed stock available is from the few wild populations that remain and considered too valuable to conduct testing on. Based on Dr. Steven Weller's incidental observations at the University of California at Irvine, it appears that *Schiedea* seeds store well. NRS will continue to store seed from natural populations, but will conduct testing on seed collected from greenhouse plants and reintroductions.

Genetic Storage of *In Situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of founders with rep.'s outplanted
In AA						
Kahanahaiki to Pahole	Manage for stability	31/8	13	2	15	12
Kapuna – Keawapilau Ridge	Manage for stability	3/0	0	0	1	0

Propagation/Germination Techniques

The Lyon Arboretum seed storage lab has observed an approximately 50% initial seed germination rate. NRS have germinated *S. nuttallii* from seed with a 60-70 % success rate. This taxon is successfully propagated through the use of cuttings. A 30-50% success rate has been observed with cuttings. Either technique can be used based on propagule availability and destination.

Unique Species Observations

No unique species observations have been made for this taxon.

Outplanting Issues

Two reintroductions were conducted with this taxon in Kahanahaiki. One site is referred to as the "Maile Flats Site" and the other is called the "Pink Trail Site". Eight *S. nuttallii* were planted at Maile Flats in 1999. After one year, all plants were still alive. After 1.5 years 75% of the reintroduced plants were alive, and after two years only 50% still survived. It is difficult to determine whether the reason for this survivorship trend is poor site selection, poor outplanting techniques, or post-planting arthropod attack. It is likely that a combination of these three factors influenced the survivorship observed at this reintroduction site and it would be difficult to determine for certain which had the largest influence. The second reintroduction site at the pink trail had initial survivorship of 76% eight months post-planting. Later, a landslide through the site took another four plants. NRS believe that in general the sites chosen for reintroduction are suitable and that *S. nuttallii* is surviving the initial outplanting transition but are subsequently weakened by other threats, namely invertebrates. NRS will continue to augment the Kahanahaiki and Pahole population. The next reintroduction that is conducted will be done with mixed stock in hopes of improving vigor. NRS will also vary site characteristics in future reintroductions. NRS will continue to pursue arthropod control measures to increase survivorship of both reintroduced and wild plants.

Research Issues

Development of control techniques for invertebrate threats is a top research priority. Developing control techniques must also address any special use permitting required.

Surveys

NRS and Mr. Joel Lau conducted a number of surveys for this taxon but no new populations were discovered. NARS staff discovered a new location of *S. nuttallii* in Pahole Gulch with one new individual. This lone plant is healthy but in degraded habitat dominated by *Schinus terebinthifolius*.

Taxon Threats

S. nuttallii is threatened by feral pigs, weeds, slugs and arthropods. Feral pigs do not directly target this taxon but seriously impact its habitat. Major weed threats to this taxon include *Melinus minutiflora* and *Schinus terebinthifolius*. One of the largest threats to *S. nuttallii* is slug predation. Stephanie Joe, a graduate student from the University of Hawaii, accounts one third of *Alsinodendron obovatum's* (a close relative to *S. nuttallii*) seedling mortality to slug predation. It is not proven, but likely, that slugs impact *S. nuttallii* to the same degree. In order to investigate causes of leaf and stem damage, NRS have collected samples of the infected parts of these plants and submitted them to the Agricultural (Ag.) Extension Service at the University of Hawaii for threat identification. In addition, an Ag. Extension Agent, Mr. Desmond Ogata, accompanied NRS into the field to see the damage first hand. Some of the damage observed was attributed to the black twig borer (*Xyolsandrus compactus*). Also, Mr. Ogata identified some *Lepidotera* larvae eating the leaves of *S. nuttallii*. A comprehensive control strategy for slugs and arthropods needs to be developed. Recently, NRS observed slugs actively eating the leaves of this taxon. This may account for a large portion of the leaf damage observed at all wild and reintroduced sites.

Population Unit Level Discussion

Manage for Stability PUs:

Kahanahaiki to Pahole: This is by far the largest extant population and represents over 90% of the total plants in the taxon. This is the only PU where ecosystem level habitat protection is in place. Both wild sites are within fenced exclosures where habitat quality is high. In the last year, NRS controlled *Melinus minutiflora*, *Clidemia hirta* and *Psidium cattleianum* at the Kahanahaiki and Pahole sites. NARS and NRS spent eight hours weeding at the PAH-A site. The PAH-B site is entirely weed-dominated and control actions are not planned. NRS augmented this PU (see outplanting section above) and plan to conduct a supplemental augmentation with more substantial numbers of plants this winter. NRS and NARS staff collected cuttings from all sites within Pahole Gulch this year.

Kapuna-Keawapilau Ridge: This year, NRS assisted the State NARS biologist with monitoring and collecting from these plants. This population is within the area slated for fencing by the Division of Forestry and Wildlife next year. Construction of an ungulate fence is the single most important management step for this population. Once the fence is constructed, adequate habitat will be protected to stabilize this taxon in Kapuna and Keawapilau. NRS spent 7.5 hours weeding in the vicinity of this population. Weeds targeted include *Clidemia hirta*, *Psidium cattlelianum* and *Stachytarpheta dichotoma.* When invertebrate control techniques are developed they will be used to protect this site.

Makaha Reintroduction: NRS are working to construct an ecosystem-sized fence in Makaha. A contract has been awarded to construct a 100-acre exclosure, which contains appropriate *S. nuttallii* habitat for reintroductions. Once the fence is complete and pig free, NRS will select reintroduction sites and prepare them for outplanting. In the meantime, NRS will maintain clones of all Kahanahaiki and Pahole wild plants to ensure that stock is available to conduct a Makaha reintroduction.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Kahanahaiki to Pahole	Manage for stability	Yes	Partial	No
Kapuna – Keawapilau Ridge	Manage for stability	No	Partial	No

5.26 *Tetramolopium filiforme*

Requirements for Stability:

- 3 population units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

Tetramolopium filiforme has a restricted range. The center of abundance for this taxon is around Ohikilolo ridge. The populations in Waianae Kai and Puhawai but both are small and appear peripheral. The populations in the Makua action area are very prolific and have good recruitment. The Waianae Kai population is on a very steep cliff, somewhat out of reach. The Puhawai plants are on a small cliff and the numbers there have remained small over time. This taxon is easy to store via seed and grows well from cuttings. With threats controlled, this taxon should not be difficult to stabilize although the Puhawai population will need to be augmented.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Ohikilolo Mauka	Manage for stability	2500+	2500+	None	2500+
Ohikilolo Makai	Manage for stability	2500+	2500+	None	2500+
Kahanahaiki	Genetic storage	50	34	None	34/0
Keaau	Genetic storage	25	16/4	None	16/4
Out of AA					
Puhawai	Manage for stability	6/6	2/0	None	2/0
Waianae Kai	Genetic storage	New population	20/2	None	20/2

Genetic Storage

No bulk collections of *T. filiforme* seed have been collected and submitted for seed storage trials to Lyon Arboretum. Seed storage trial information is based on two test lots of 25 seeds each. These storage tests have been running for five years. The initial germination rates from these lots were very low, approximately 5%. Germination rates actually increased following storage at room temperature and 10% relative humidity for this taxon, reflecting the seeds' physiological dormancy. After five years, the two lots have germination rates of 15-20%, which indicates that *T. filiforme* stores relatively well for up to five years. To supplement this information, bulk collections should be acquired. More germination trials should also be conducted prior to storing this taxon. *T. filiforme* seeds are very easy to acquire from greenhouse plants. For wild collected

seed NRS should determine our expected initial germination rate in order to predict when supplemental collections need to be submitted for storage. The same should be determined for greenhouse plants.

Genetic Storage of *In Situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of plants with rep.'s ex-situ
In AA						
Ohikilolo Mauka	Manage for stability	2500+	23	0	0	0
Ohikilolo Makai	Manage for stability	2500+	35	0	0	0
Kahanahaiki	Genetic storage	34	54	0	0	0
Keaau	Genetic storage	16/4	0	0	0	0
Out of AA						
Puhawai	Manage for stability	2/3	5	0	4	0
Waianae Kai	Genetic storage	20/2	0	0	0	0

Propagation/Germination Techniques

As was stated above, *T. filiforme* exhibits physiological dormancy. Therefore, seeds that are stored prior to germination will germinate at higher rates than those not stored. Germination of this taxon from seed is a viable propagation technique. Propagation from cuttings is extremely successful, showing over 90% success rate. Since *T. filiforme* is such a small plant, greenhouse plants can be used as ex situ seed sources without placing a huge burden on greenhouse staff and space. Plants grown in the greenhouse can grow to be at least three times the size of wild plants and fruit year-round.

Unique Species Observations

Joel Lau from the Hawaii Natural Heritage Program made detailed observations about leaf morphology of *T. filiforme*. He investigated patterns in leaf morphology within and between populations. He suggests that all *Tetramolopium* on Oahu show morphological characteristics that range between *T. filforme* and *T. lepidotum*. He postulates that the *T. filiforme* var. *polyphyllum* are plants of mixed *T. filiforme* and *T. lepidotum* ancestry. However, the biogeography argues against this theory as *T. filiforme* and *T. lepidotum* currently occupy allopatric ranges.

Outplanting Issues

NRS have not yet attempted to outplant *T. filiforme* but predict that site selection will be a key factor in the success of reintroductions for this taxon. *T. filiforme* grows in very exposed, open and rocky slopes which are rather dry. In many cases they are rooted very shallowly. When outplanting is conducted attention should be given to planting depth and substrate. It may be

difficult to transition plants that are grown in large pots with plenty of root space to wild sites that are mainly rock and little soil. Seed sowing is another possible technique for establishing new sites of this taxon. TNC staff have sown seed successfully with *T. lepidotum*. This approach allows for the seed to germinate at a favorable spot and is less labor-intensive.

Research Issues

Seed germination trials should be conducted for *T. filiforme*. In addition a comparison of germination rates between wild and greenhouse-collected seed will be conducted to determine if greenhouse propagation may improve the viability and storage characteristics of seeds.

Surveys

NRS contracted Mr. Joel Lau to re-visit the Keaau population of this taxon. The results of his surveys showed a small increase in observed individual plants. Surveys have been conducted in the lower portion of Ohikilolo ridge to determine the extent of and threats to *T. filiforme* there. This site represents the plants that are most at threat from military training-caused fires. NRS have also discovered *T. filiforme* on steep cliffs where fire from military training is not a threat. In addition, surveys in Waianae Kai have been conducted in an attempt to re-find plants from that region. The first population documented in Waianae Kai no longer has extant plants. As a result of surveys conducted by NRS this year, two new sites near the known site have been discovered. Most of these plants are located on steep cliffs and are very difficult if not impossible to access.

Taxon Threats

Goats are the number one threat to this taxon. *T. filiforme* grows on very steep slopes and cliffs and goats are the only ungulates on Oahu that are capable of climbing to sites with these characteristics. Weeds have very little impact on *T. filiforme* habitat because it is too open and exposed in most cases for weeds to become established and successful. *P. maximum* is present at some lower elevation *T. filiforme* sites and is the largest weed threat because of it's ability to carry fires. NRS have not observed any impacts from rats or slugs but will monitor for any new threats to *T. filiforme*.

Population Unit Level Discussion

Manage for Stability PUs:

Ohikilolo Mauka: The Ohikilolo Mauka population of *T. filiforme* has numbers well over the 50 required for stability. Since full funding has not yet been committed to the MIP, NRS have focused time controlling ecosystem threats to *T. filiforme* instead of systematically monitoring this population. NRS have been controlling ungulate threats to this population since 1995 beginning with the construction of a perimeter goat fence along Ohikilolo ridge. Since 1995, over 1,500 goats have been removed from MMR. It is estimated that fewer than 20 goats

remain. NRS recently released two satellite-collared goats into MMR to assist in locating the remaining herd in Makua.

The threat of weed competition to this taxon varies at Ohikilolo based on the specific site but in general the threat from weeds is low. *T. filiforme* grows generally in open and exposed rocky slopes and cliffs. This habitat is not as susceptible to weed invasion as other ecotypes in MMR. NRS found a small *Panicum maximum* plant within the Ohikilolo Mauka population. It was probably introduced to the site by NRS during fence monitoring or construction. This plant was removed and NRS will monitor the Ohikilolo Mauka population to ensure that *P. maximum* does not get established and to detect any new threats. NRS will implement threat control if necessary.

Ohikilolo Makai: The ungulate threats and control discussion for the Ohikilolo Mauka population also applies to the Ohikilolo Makai population. The weed threats are similar for both populations also except for a site between 900 and 1,100 feet in elevation, which is subject to a different suite of threats. This area has hundreds of *T. filiforme* plants located on small cliffs with flat shelves in between. The shelves below and above these cliffs are dominated by *Panicum maximum*. Although some of the cliffs may serve as fuel breaks, NRS are concerned that a fire outside the south firebreak could travel up through the *Panicum maximum* and burn *T. filiforme* plants in the vicinity. As a safety net for this group of plants, NRS is collecting seed for genetic storage focusing on this section of the Ohikilolo Makai population first. NRS have >50 seeds from 35 different individuals at Ohikilolo Makai.

Puhawai: This year 8 seedlings were observed in addition to three immature and the 2 surviving mature plants. Since 1999, this population has declined steadily. The table below shows monitoring numbers.

Monitoring Date	Mature	Immature	Seedling	Total Plants
November 1999	6	6	0	12
January 2001	4	7	2	11
October 2001	9	0	3	9
May 2003	5	0	8	5
March 2004	2	3	8	5

Observer bias does influence the number of immature plants versus seedlings. It is difficult to determine the difference between a seedling and immature plant for this taxon. In the future NRS will standardize the definitions for these categories. In general, true seedlings have much softer growth and have stems that are not at all woody. In addition, the rosette of leaves in the seedling class has a smaller diameter than immature plants. The rosette for a seedling is about the size of a quarter or smaller. While the maturity level of smaller plants is often difficult to ascertain, larger many branched plants are easy to identify. These larger plants usually have some evidence of reproduction and are counted as mature by all observers. What can be considered a true trend in the Puhawai population is that the number of larger plants has generally decreased over the years. NRS have observed the Puhawai site to be much drier than Ohikilolo ridge. There are no other obvious limiting factors to the Puhawai population. As stated above, the size

of the north-facing cliff habitat present at Puhawai is limited. Therefore, NRS propose augmenting the Puhawai site nearby to the east, below Puu Kumakalii. This is a chosen MIP reintroduction site. NRS will select specific augmentation sites over the next year and plan to outplant next winter. NRS have large clones in the greenhouse representing four wild founders, which can be used as reintroduction stock. NRS may use the greenhouse produced seed to conduct this augmentation.

NRS have collected thousands of seeds from Puhawai *T. filiforme* greenhouse clones. These seeds are being stored and tested at Lyon Arboretum.

Other PUs:

Kahanahaiki: The Kahanahaiki population of *T. filiforme* is located on a small cliff surrounded by *Diospyros sandwichensis* forest. This cliff is fairly devoid of vegetation. Only small and sparse shrubs are present on the cliff. This population is located in an area affected by the July 2003 fire. This fire burned within 20m of the Kahanahaiki *T. filiforme* population, which is now buffered by only a small strip of forest. Subsequent fires could wipe out this population. NRS monitored the area after the fire, and monitored it again this summer. NRS have secured substantial genetic storage collections from this population and genetic storage is complete for this PU. NRS have over 25 seeds from 54 separate individual plants in this PU. This site is not fenced as ungulates are not a threat to this population. There are really no weed threats present on the *T. filiforme* cliff in Kahanahaiki so NRS have not spent time controlling weeds at this site. NRS have spent 13.5 hours conducting weed control in the forest above and below the *T. filiforme* cliff over the last two years. NRS may begin controlling fuel in the forest closest to the *T. filiforme* cliff in Kahanahaiki to minimize the possibility for fire-related impacts.

Keaau: Joel Lau monitored this population in 2002. He noted that goats threaten the site. The site is not fenced. No significant weed threats were observed. This population is not a priority for management as it is located in such close proximity to the larger Ohikilolo populations. Monitoring and collecting from the site has not been a high priority because it is assumed to be genetically similar to the Ohikilolo stock.

Waianae Kai: The Waianae Kai population as a whole is not robust and most plants are not accessible for management. This area is also very under-surveyed. NRS will conduct more surveys for this taxon with Mr. Joel Lau in the coming year. NRS will attempt to secure genetic stock from any plants that are accessible but do not expect to acquire complete genetic representation from this population. NRS will attempt to develop creative collection techniques for plants that are out of reach.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Ohikilolo Mauka	Manage for stability	Yes	No	No
Ohikilolo Makai	Manage for stability	Yes	No	No
Kahanahaiki	Genetic storage	No	No	No
Keaau	Genetic storage	No	No	No
Out of AA				
Puhawai	Manage for stability	No	No	No
Waianae Kai	Genetic storage	No	No	No

5.27 *Viola chamissoniana* subsp. *chamissoniana*

Requirements for Stability:

- 3 population units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

Viola chamissoniana is found on cliffs in the Waianae Mountains from Ohikilolo ridge in the north to Halona in the south. This taxon seems to prefer cliff habitat, unlike *Lipochaeta tenuifolia*, which NRS believes has been restricted to cliffs because of goat predation and will spread into flatter habitats when browse pressure is removed. Two of the three populations selected for management are located within Action areas. The Ohikilolo PU is included within the high fire risk area designated in the MIP. NRS does not believe there is a high fire threat to this PU. In addition, the Kumakalii PU is located in the Schofield Barracks Action area far south of the direction of training fire and there are large stands of *Schinus terebinthifolius* between the PU and the impact area. Although it is in the Action area, NRS believes that the site is not at high risk from training. Therefore, NRS will not replace either one of these on-site PUs with an off-site population. Fuel modeling is underway for the Makua Action area, which will determine the true risks from fire to sites within Makua. If the *V. chamissoniana* PUs are deemed highly at risk from military fire, NRS will reconsider the management approach for this taxon.

Taxon Status

Population Unit	Management Designation	No. of plants in final IP (mature/ immat.)	NRS monitored plants (mature/ immature)	Augmen-tation (mature/ immature)	Total number of mature/ immature
In AA					
Ohikilolo	Manage for stability	250	250/0	None	250/0
Puu Kumakalii	Manage for stability	19/1	53/0	None	53/0
Out of AA					
Makaha	Manage for stability	50	50/0	None	50/0
Kamaileunu	Genetic storage	38	38/0	None	38/0
Halona	Genetic storage	3	32/3	None	32/3
Puu Hapapa	Genetic storage	10/3	10/0	None	10/0
Keaau	Genetic storage	New population	40/10	None	40/10

Genetic Storage

A collection made in 1999 from Ohikilolo has undergone testing. Sixty percent or 15 of 25 seeds stored at 0°C germinated after five years. A batch of this seed was also stored at room temperature without success. The recommended see storage technique for this taxon is frozen.

The storage challenge for this taxon is collecting ample seed. In the wild plants produce very few flowers at a time and each capsule contains less than 10 seeds. In order to overcome this hurdle, NRS have collected cuttings from many of the smaller wild populations and these are in the greenhouse. NRS will attempt to encourage mass flowering and then collect bulk seed for additional testing and storage purposes.

Genetic Storage of *In Situ* Plants

Population Unit	Management Designation	Total number of *in situ* mature/ immature	Number of plants with >25 seeds in storage	Number of plants with rep.'s in micro-prop	Number of plants with rep.'s in the nursery	Number of plants with rep.'s ex-situ
In AA						
Ohikilolo	Manage for stability	250/0	0	0	11	0
Puu Kumakalii	Manage for stability	53/0	0	0	23	0
Out of AA						
Makaha	Manage for stability	50/0	0	0	0	0
Kamaileunu	Genetic storage	38/0	0	0	0	0
Halona	Genetic storage	32/3	0	0	0	0
Puu Hapapa	Genetic storage	10/0	0	0	6	0
Keaau	Genetic storage	40/10	0	0	0	0

Propagation/Germination Techniques

This taxon is easy to propagate from both seeds and cuttings. With cuttings NRS have observed an approximately 60% success rate.

Unique Taxon Observations

NRS have not observed any particularly unique taxon traits.

Outplanting Issues

NRS have not yet conducted an outplanting with this taxon. If outplanting is conducted, NRS will use the upper and lower ends of cliffs to limit the amount of ropes work required. If an appropriate spot is not available, NRS will look further down cliffs for spots where holes can be dug. NRS conducted a trial cliff reintroduction at Ohikilolo with good success using *Lysimachia hillebrandii* and do not expect *V. chamissoniana* to be much more difficult.

Research Issues

Seed storage testing should be conducted using greenhouse stock.

Surveys

Surveys are underway in Makaha to re-find the 50 individuals that are reported from that site.

Taxon Threats

Threats to this taxon include pigs and goats. Since this taxon grows mainly on cliffs it is naturally protected to some degree from feral ungulates. Weed species that affect the habitat of this taxon include, *Erigeron karvnskianus* and *Melinus minutiflora.* These weeds are not abundant immediately around *V. chamissoniana* but could proliferate and become more of an issue in the future. NRS will continue to monitor all potentially ecosystem-altering weeds in the vicinity of this taxon, but hypothesize that the spread of these weeds may be tied to ungulate movement through areas. NRS are hopeful that in areas where ungulate control is in place, the weeds may not expand their distribution within cliff habitats. NRS have not documented any slug or rat impacts to this taxon.

Population Unit Level Discussion

Manage for Stability PUs:

Ohikilolo: In the last year, NRS have not observed any major declines in the abundance or distribution of this taxon on Ohikilolo. NRS have attempted to visit two sites of this taxon each year, rotating sites through the years. This means each site within each PU will be monitored once every two years. Since these plants are on cliffs and the habitat is fairly stable, this seems like a reasonable visitation rate. NRS have been controlling ungulate threats to this population since 1995 beginning with the construction of a perimeter goat fence along Ohikilolo ridge. Since 1995, over 1,500 goats have been removed from MMR. It is estimated that less than 20 goats remain. NRS recently released two satellite-collared goats into MMR to assist in locating the remaining herd in Makua. Ohikilolo cliffs, as a whole, are not extremely weedy. Both *E. karvinskianus* and *M. minutiflora* are present at some *V. chamissoniana* sites along Ohikilolo ridge. NRS spent four hours in the last year controlling *M. minutiflora* and *Setaria gracilis*.

Puu Kumakalii: NRS made three visits to this PU in the last year to obtain full genetic representation. During collection work, additional plants were located. The table below shows monitoring data for this population since 1998.

Monitoring Date	May 1998	June 1999	January 2001	October 2001	May 2003	March 2004
Mature/Juvenile/Seedling	4/0/0	10/1/0	15/0/0	19/0/0	24/0/0	53/0/0

Although the genetic storage table in the genetic storage section above only indicates that we have partial representation. This population is peculiar for the taxon, as many of the plants found here are not located on a cliff. Large portions of the plants at this PU are found on steep slopes just above cliffs. NRS have never observed ungulate sign at this PU. No goats are known from the area. Pigs do use the main ridge trail on occasion, but pig sign has never been observed amongst the *V. chamissoniana* plants. Therefore, ungulate threat is not highlighted for this population in the threats table below. NRS will continue to monitor this PU, and will respond with control if threats are observed. There is *Melinus minutiflora* is present at the Kumakalii PU,

but NRS have yet to implement grass control. NRS will investigate the extent of the weed threats at this PU and will implement control as feasible.

Makaha: NRS revisited two sites in Makaha where *V. chamissoniana* subsp. *chamissoniana* had been reported by NTBG botanists in 1999. NRS was unable to find any subsp. *chamissoniana* at either site, though both sites had subsp. *tracheliifolia.* Recently, NRS discovered three *subsp. chamissoniana* plants in this taxon in an area where it had not been reported. NRS will commit more time to conducting surveys around this new site. A fence exclosure encompassing 100 acres will be constructed at Makaha this year. This fence will protect the Makaha PU from goat and pig predation. *Erigeron karvinskianus* is present at the recently discovered Makaha site and there is *Rubus argutus* nearby.

Other PUs:

Kamaileunu: The number of individuals reported in the final Makua IP was based on Ken Wood's 2000 observations combined with NRS and HIHNP observations that same year. NRS have been unsuccessful in re-locating one of the three sites at Kamaileunu where Ken Wood discovered plants. The other two sites have not been remonitored. The most significant threat to all the Kamaileunu sites is goat predation. Goats are present in high number along the ridge. In addition, the forest surrounding the cliff habitat on Kamaileunu is infested with *Schinus terebinthifolius* decreasing the overall habitat value. The vegetation on cliffs ranges from fairly intact to severely degraded habitat.

Halona: NRS monitored this population last year. NRS believe that with additional surveys, more *V. chamissoniana* can be found. This habitat is vulnerable to goat predation. However, the Navy eradicated the goat population from Lualualei, which includes Halona gulch. Therefore, there are no ungulate threats at the present time. The same compliment of weeds present at other populations of this taxon is present at Halona. However, these weeds are not as abundant at the Halona Site. NRS consider the weed threat to this site low.

Puu Hapapa: NRS monitored this population two years ago, and found 10 seedlings in addition to the 10 mature plants. The site is not threatened by ungulates and the weed threat is low. *Erigeron karvinskianus* is present around this PU but it is not having a direct impact on *V. chamissoniana* at this time.

Keaau: Joel Lau discovered this population in 2002. He noted that goats threaten the site. No significant weed threats were observed. This population is not a priority for management as it is located in such close proximity to the larger Ohikilolo populations. Monitoring and collecting from the site has not been a high priority because it is assumed to be genetically similar to the Ohikilolo stock. NRS will collect for genetic storage from this PU if it is determined to be at a high fire risk from military training. This decision will be based on the results of fire simulations being conducted by Colorado State University fire ecologists.

Population Unit Management

Population Unit	Management Designation	Fenced	Weeds managed	Rats controlled
In AA				
Ohikilolo	Manage for stability	Yes	No	No
Puu Kumakalii	Manage for stability	No	No	No
Out of AA				
Makaha	Manage for stability	No	No	No
Kamaileunu	Genetic storage	No	No	No
Halona	Genetic storage	No	No	No
Puu Hapapa	Genetic storage	No	No	No
Keaau	Genetic storage	No	No	No

Appendix 1: Lyon Arboretum Seed Storage Trials

Written by Lauren Weisenberger, Lyon Arboretum Seed Storage Facility

1. Alectryon macrococcus var. *macrococcus*

None tested - ~30 seeds stored at 4C/ 20% RH

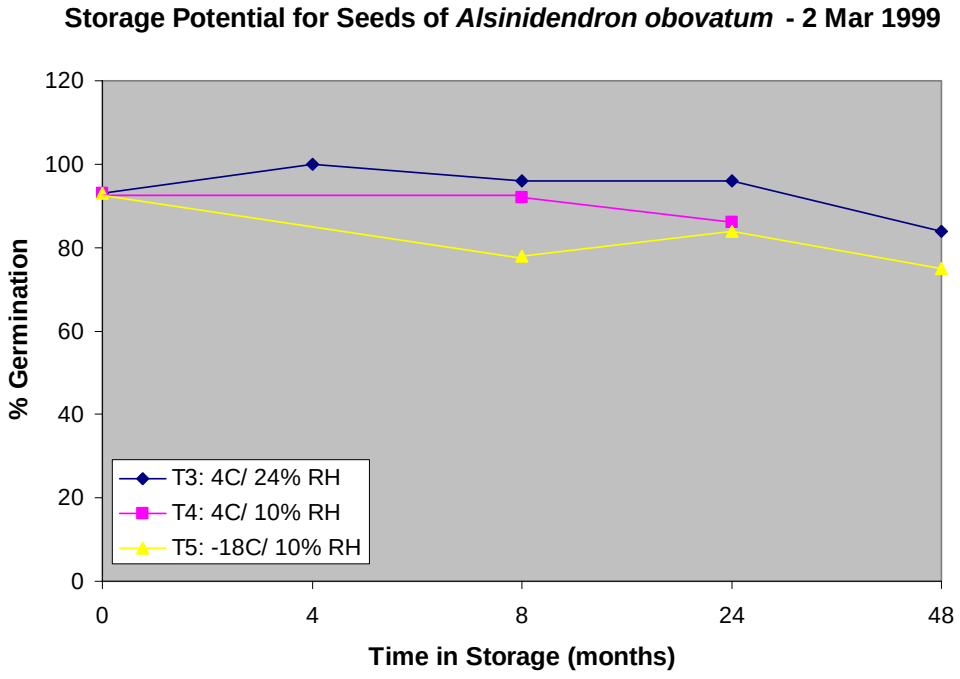
ALSINIDENDRON

Collection: Fruits are best collected when they become less fleshy and dry out and begin to open on their own. Seeds can be squeezed and scraped out from the fruit. Seeds should be black, and unripe seeds are tan. Seeds without embryos are smaller and thinner. Fruits, especially ones still fleshy, will stain skin purple.

2. Alsinidendron obovatum (Caryophyllaceae) – ma‘oli‘oli

Collection Dates: 2 Mar 1999; 9 May 2000

Summary: (ND) The percent of seeds germinated on agar and also on paper wetted with H2O2 are significantly higher than the percent of seeds germinated on paper wetted with water or KNO3. Storage results are for treatments 3, 4 and 5. Only one 2-year test was conducted. Viability was the same for all three, with refrigerated seeds having only slightly higher % germination. Recommended storage: 4C at 20% relative humidity (RH).



3. Cenchrus agrimonioides var. *agrimonioides* (Poaceae) – kamanomano

Collection Dates: 31 Oct 2000; 4 May 2004

Collection: Seeds are brown, large (2.6mm long) and bristly; easily removed from the plant when mature.

Summary: (PD) – no significant germination recorded due to lack of an adequate amount of seeds to test. Fresh seeds were tested only on agar (60% germination). Stored seeds (treatments 2, 3b and 5a) tested after 4 mos. had 20-80% germination, 20-40% germination after 14 mos. All tests used only 10 seeds. Seeds initially are germinating more successfully on agar and paper+GA3 than KNO3 or H2O for the 2004 collection. Recommended storage: 24C at 20% RH

CHAMAESYCE

Collection: Fruits in drupes containing 1- 3 grayish seeds (1-3mm long) each. Fruit should be dry and open on own to release seed when mature. Recommended storage: 4C at 20% RH

4. Chamaesyce celastroides var. *kaenana* (Euphorbiaceae) – ‘akoko

Collection Dates: 1 Nov 2001

Summary: (PD) Two of 10 fresh seeds germinated. Only 34 seeds stored in treatments 2 & 5a. One of 10 seeds from T2 and 2 of 10 from T5a germinated after 6 months of storage; none of the remaining seeds germinated.

5. Chamaesyce herbstii (Euphorbiaceae) – ‘akoko

Collection Date: 18 Jan 2001

Summary: (PD) Twelve seeds total were received. 1 of 3 germinated as fresh seeds. 2 of 3 T2 seeds and 1 of 3 T5a seeds germinated after 4 months of storage. Seeds that did not germinate appeared rotten or hollow. It is uncertain if seeds were initially collected hollow or decayed in storage.

CYANEA

Collection: Seeds are round or oval and slightly flattened. Ripe seeds are light tan to black. Fruits are spherical berries 5-10 mm in diameter for *C. longiflora*, and 16-30 mm for *C. grimesiana* & *C. superba*. Ripe fruits are orange or purple, with soft, orange pulp. Seeds can be extracted by scraping out inside pulp and seeds and mashing through a small-size sieve into a large beaker of water (wet-sieving). Seeds usually sink and pulp can be gently poured and

stirred off. Seeds that float may be oily and will sink if misted with a spray bottle before pouring off pulp. Dry the seeds on filter paper or a coffee filter. Recommended storage: 4C at 20% RH

6. Cyanea grimesiana subsp. *obatae* (Campanulaceae) – haha

Collection Dates: 1 Dec 2000

Summary: (ND) This collection is very small; larger collections are necessary to substantiate results. Germination for all treatments tested is not high, but GA3+ agar or paper is recommended. Only storage treatments 2 and 5a have been tested, and only T2 showed any germination after two years.

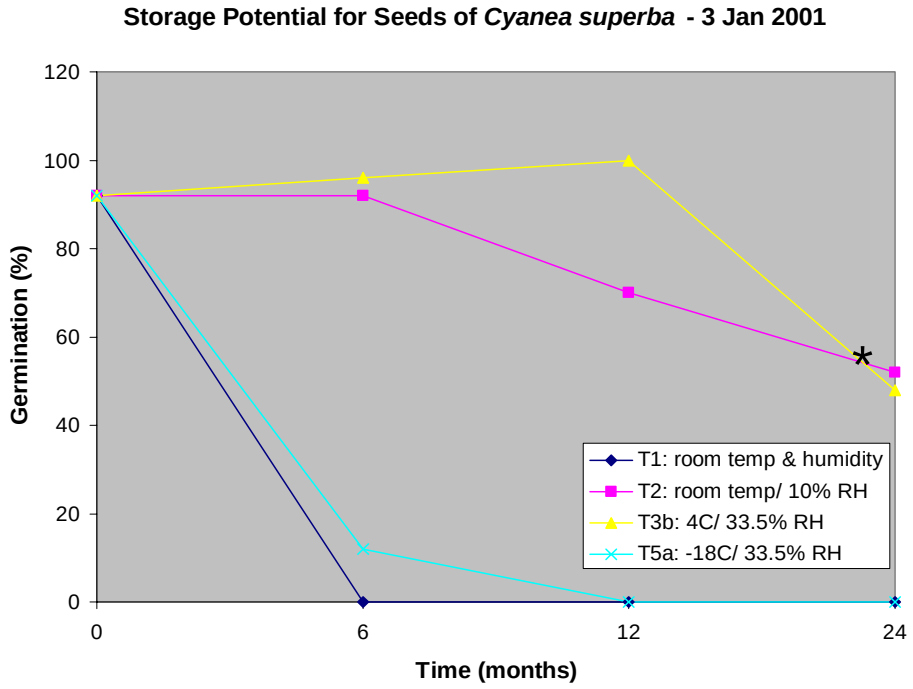
7. Cyanea longiflora (Campanulaceae)

Summary: Seed Bank species only; no storage tests were conducted. Initial viability varies among collections, though most have 55-85% germination. Seeds must be mature (flesh of fruit should not be all green, seeds should be dark brown) for good germination. Seeds appear to germinate best on agar and GA3 may increase germination or at least speed to which seeds germinate.

8. Cyanea superba (Campanulaceae) – haha

Collection Dates: 11 Jan 1998; 1 Apr 1998; 11 Jan 1999; 3 Jan 2001; 20 Dec 2002

Summary: (PD/ND) Seeds germinate best with GA3 on paper, though agar + GA3 may yield even higher germination. Storage treatments 1, 2, 3b, and 5a have been tested for two years. T1 and T5a yield 0% germination while T2 and 3b yield similar germination, around 50%. Seeds may be intolerant to freezing. Storage potential beyond two years has not yet been established.



9. Cyrtandra dentata (Gesneriaceae)

Collection Dates: 8 Oct 2003; 10 Mar 2004; 21 July 2004-10-04

Summary: Fresh germination on agar is 100%. Seeds have only been tested after 6 months of storage. After 6 months, refrigerated seeds have the highest germination, ~ 90%.

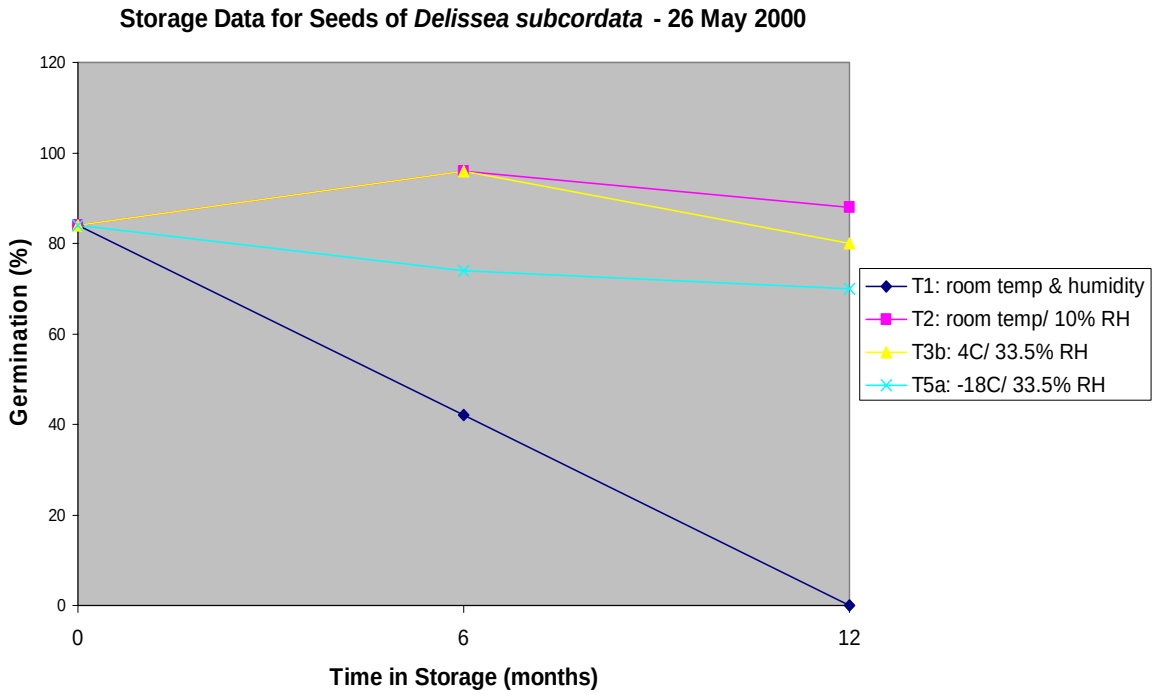
10. Delissea subcordata (Campanulaceae)

Collection Dates: 25 May 2000; 18 Jan 2001

Collection: Fruit are purple and fleshy yet may be still firm at ripening. Fruit can be removed individually or as an inflorescence. Seeds are light in color, slightly tan/yellow and can easily be scraped out of cut fruit. Seeds can then be air-dried to more easily sift/pick out remaining pulp.

Summary: (PD/ND) Seeds germinate best on agar and GA; the agar+GA3 treatment should be tested. Seeds stored imbibed in the dark germinate well when exposed to light (treatment T8), suggesting good potential to form soil seed banks. Storage treatments 1, 2, 3b, and 5a have been tested for one year. After one year, seeds stored in treatment T1 show no viability, but a lack of difference between 2, 3b, and 5a indicates that the best storage temperature and drying relative humidity have yet to be determined. Another collection has tested seeds for only T5 and T5a for

two years. Both -18C treatments yielded low germination after two years. Recommended storage: 4C at 20% RH



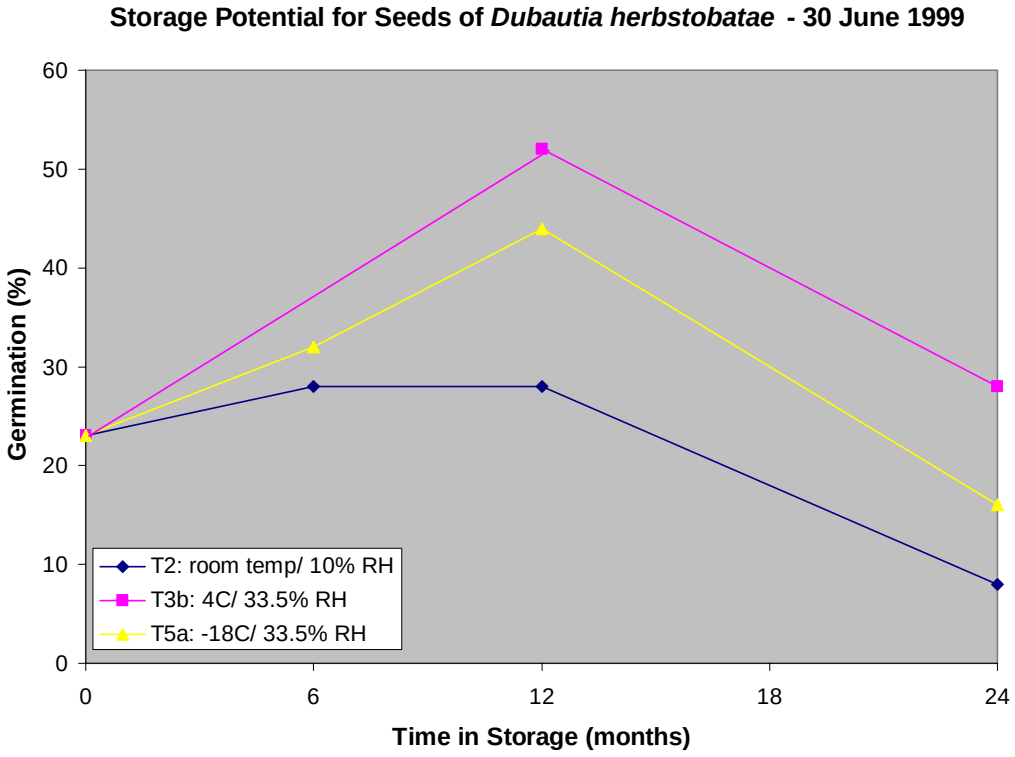
DUBAUTIA

Collection: Collect dried flower heads. Seeds are long and thin with bristles (hairs) on one end.

***11. Dubautia herbstobatae* (Asteraceae)**

Collection Dates: 16 Jun1999; 30 Jun 1999

Summary: (PD) Seeds only germinated on agar. Storage results for T2, 3b and 5a have been recorded for two years. T3b shows best results but not significantly different from 5a and 2. The five-year test is currently running, with no T2 germination and equal yet still low T3b and T5a germination.

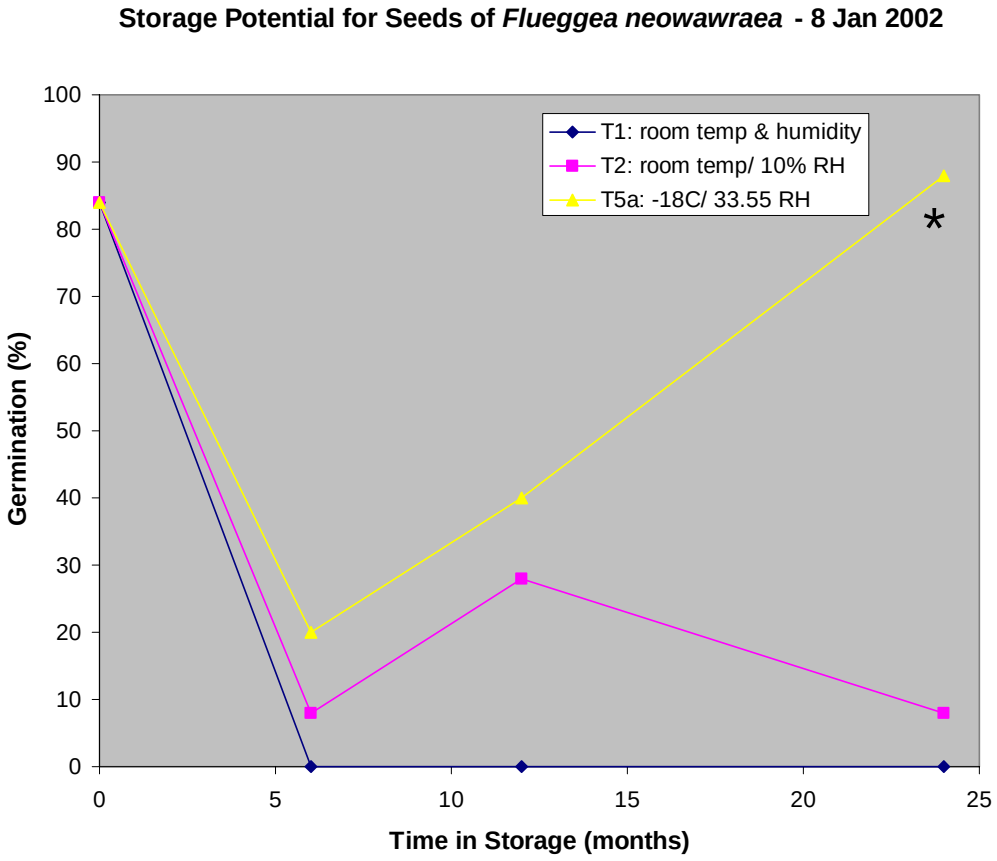


12. Flueggea neowawraea (Euphorbiaceae) – mehamehame

Collection Dates: 8 Jan 2002

Collection: Fruit is dry and capsules pop open when seeds are mature. Fruit must therefore be collected around time of dehiscence. Seeds are ~1mm long and tan. Soak seeds in water to remove floating seeds prior to sowing.

Summary: (PD) Seeds germinate on a wide range of treatments except seeds on paper with water geminated significantly less than the other treatments. Storage treatments 1, 2, and 5a have been tested for two years. T5a yielded significantly higher germination (88%) than the other two treatments (T1 (0%); T2 (8%)). Seeds need to be stored at -18C for successful long-term storage.



HEDYOTIS

Collection (for all species of *Hedyotis* except *H. terminalis*): Fruits should dry out and dehisce when seeds are mature. Seeds are small and numerous in each capsule. Seeds are black and have various shapes.

13. Hedyotis degeneri var. *degeneri*

Only in seedbank. Except for one collection that was not fully mature, initial viability ranges from 65% to almost 100%. Seeds are stored at 4C with 20% RH.

14. Hedyotis parvula

Only in seedbank. Initial viability has a very wide range. Reasons for poor germination for some collections are unknown.

15. Hesperomannia arbuscula (Asteraceae)

Only in seedbank for germination. ~30 viable seeds received; seeds just started to germinate. No storage data.

HIBISCUS

Collection: Seeds are brownish, 3-5mm long. Trichomes are numerous and piercing to skin. Collect at time of dehiscence. If fruit are not open, squeeze to open and scrape seeds out with a pick.

16. Hibiscus brackenridgei subsp *mokuleianus* (Malvaceae) – ma'o hau hele

Collection Dates: 24 Apr 2000; 3 Mar, 21 Apr, 17 May 2004

Summary: (PY) Only tested on agar after scarification. T5 seeds tested after 3 years yielded 40% germination (2000 collection). GA3 tends to speed up germination. Seeds from 2004 collections are mostly inviable. There was very little germination and seeds became very moldy over the first week of being imbibed. Seeds may germinate slightly more when sanded as opposed to clipped, and this may be true for most seeds of Malvaceae, where three species of *Abutilon* also show better germination when sanded instead of clipped.

LIPOCHAETA

Collection: Collect flower heads when completely dry and show no green. Rub heads to separate seeds from debris and sift out seeds.

17. Lipochaeta tenuifolia (Asteraceae) – nehe

Collection Dates: 8 May 2000; 23 May 2000; 7 May 2001; 25 May 2001; 1 June, 6 June 2004

Summary: (PD) Weak fresh germination with agar and GA3. Agar+GA3 needs to be properly tested. No germination with other standard treatments. No germination from stored seeds except from T2 after the 1-year test. T1, 5, and 5a have also been tested. Hot water soaks have also been tested with none to minimal results. Initial seed viability is unknown for all collections except from 2004, where embryos appear healthy and viable. Both 2004 collections will be used for a scarification test (seed coat versus seed coat removed) and a dormancy test (Move-along Experiment).

18. Neraudia angulata var. *angulata* (Urticaceae) – ma'aloa

Collection Dates: 27 Feb 2003; 17 March 2004

Collection: Fruit are dry and reddish when mature; one seed per fruit. Seeds are 1 to 3.5 mm long and pale tan. Seeds that are white are probably immature.

Summary: (PD) Seeds germinate best on agar and significantly more than other germination treatments except GA3. 1-year storage tests are ongoing; seeds may store best at T2, but refrigeration treatments need to be tested. All tests have low germination. The 2004 collection has much higher fresh germination (50% and still ongoing).

NOTOTRICHIUM

Collection: Fruit (2mm long) dry when seeds are mature; one seed per fruit.

19. Nototrichium humile (Amaranthaceae) – kulu'i

Collection Dates: 14 July 2000; 2 Nov 2000

Summary: (PD) One fresh seed (out of 50) germinated in KNO3 treatment. No other seeds germinated in other germination treatments, as well as the 1, 2 and 5a storage treatments.

PHYLLOSTEGIA

Collection: Nutlets have fleshy outside and turn black when ripe, 3-6 mm long.

20. Phyllostegia kaalaensis (Lamiaceae)

Collection Dates: 28 Oct 2002

Summary: No seeds (only 12 tested) germinated on the four (agar, paper, KNO3, GA3) treatments tested.

21 .Plantago princeps subsp *princeps* (Plantaginaceae) – manene

Collection Dates: 11 Jan 2000; 29 Dec 2000

Collection: One to 2 seeds, black to brown or brown/red, are in each dry capsule.

Summary: (PD) None of the 7 seeds from the first collection germinated. They were tested on agar. Seven seeds were also collected for the second collection. Two out of 2 germinated initially on agar. The one seed placed in T1 storage did not germinate at 6 months. One of the 2 seeds placed in T2 germinated after 6 months and both of the seeds placed in T5a treatment germinated at this time. Initial viability for seeds in the seed bank is typically high (75-100%).

22. Pritchardia kaalae (Arecaceae)

One collection received in 2000 for testing. All seeds were given to Ray Baker and Nellie Sugii.

23. Sanicula mariversa (Apiaceae)

Collection Dates: 25 May 1999; 26 May 1999; 29 June 1999; 23 May 2002

Collection: Fruit are 2-6mm long and densely covered in prickles. Fruit are in heads and can easily be collected when dry.

Summary: (MPD) Numerous germination and scarifications treatments have been used with no success. The only time seeds germinated were when they were plated on agar and then re-sown on agar. Others have successfully germinated them on potting mix in pots.

SCHIEDEA

Collection: Fruits are tan, papery capsules when fully mature. Numerous seeds are in each capsule. Squeeze the capsule and pick out seeds. Seeds are small, hard, and black.

24. Schiedea kaalae (Caryophyllaceae) – ma'oli'oli

Collection Dates: 7 June 2002

Summary: Germination is very low overall. GA3 is recommended and agar+GA3 should be properly tested. Paper+H2O yielded significantly lower germination than the other treatments. Seeds do not germinate in T7 and T8 results are unknown. Storage treatments 1, 2 and 5a were tested at 6 months. T1 showed no germination and T2 and 5a showed low germination similar to the initial test on fresh seeds.

25. Schiedea nuttallii (Caryophyllaceae)

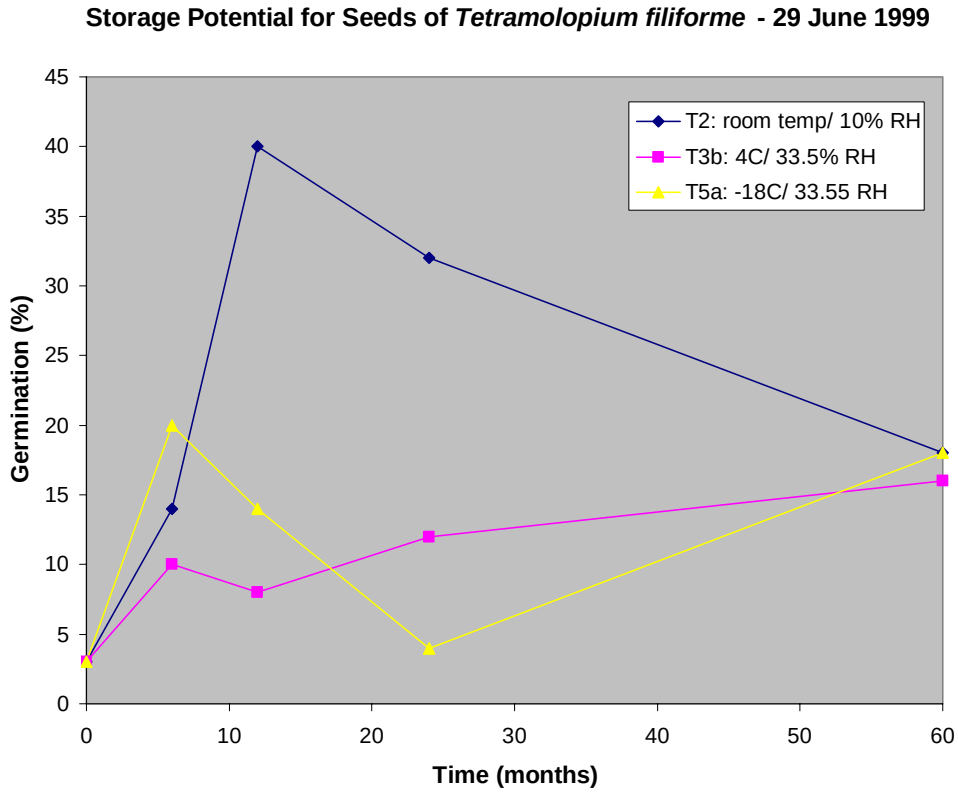
Only in seedbank. Initial germination ~50% or lower for most collections. All collections very small.

26. Tetramolopium filiforme (Asteraceae) – pamakani

Collection Dates: 6 Apr, 16 Jun, 29 Jun, & 30 Jun 1999; 7 Jan 2000

Collection (for all *Tetramolopium spp*.): Collect dried flower heads. Seeds are yellowish tan and flattened in appearance with long bristles at one end.

Summary: (PD) Low germination from all initial germination treatments. Untreated agar or paper in Petri dishes is recommended. Storage treatments 2, 3b and 5a have been tested for five years (5-year test ongoing). Results are similar for all three treatments, overall germination is moderate to low but T2 is recommended. Stored seeds have higher germination than fresh seeds, reflecting the seeds' physiological dormancy.



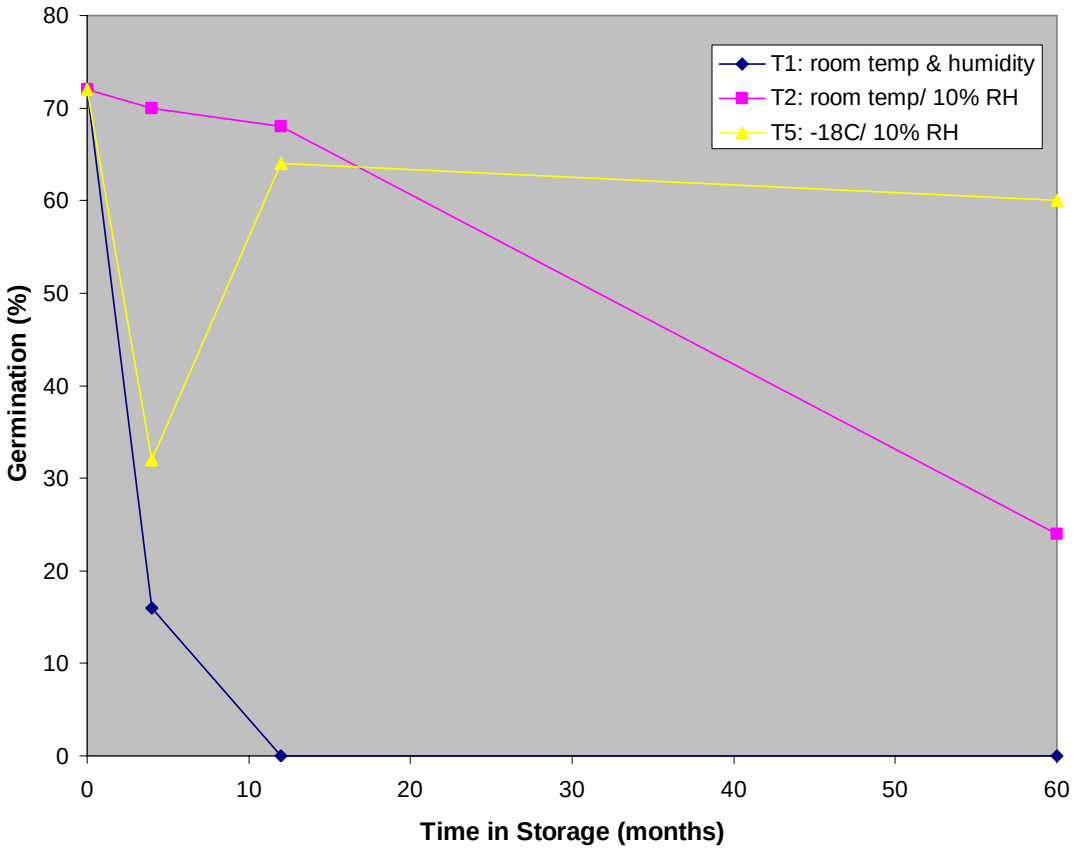
27. Viola chamissoniana ssp. *chanissoniana* (Violaceae) – pamakani

Collection Dates: 29 June 1999

Collection: Numerous black seeds (~2 mm long) are in each capsule (~ 15mm long).

Summary: (PD) Seeds germinate significantly more on agar than on paper + H2O, KNO3, or H2O2. Agar + GA3 should be properly tested. No T1 germination by 1 year. T2 and T5 have been tested for 5 years. After 5 years, T5 seeds (60%) have significantly higher germination than T2 seeds (24%). Another collection is necessary to test other treatments.

Storage Potential for Seeds of *Viola chamissioniana* ssp. *chamissioniana* - 29 June 1999



6.0 MANAGEMENT UNIT STATUS

Based on the April 29, 2004 meeting of the Makua Implementation Team (MIT), management unit (MU) boundaries were revised. At this meeting Natural Resource Staff (NRS) proposed removing severely degraded habitat from the original MU boundaries. In addition, since the U.S. Army (Army) has decided to focus management on fewer and more viable populations, associated MU level work is centered on better habitat where success is more attainable. In general, MU level work consists of ungulate control and weed control across large areas.

Ungulate management
Where ungulate control is necessary a combination of monitoring, fencing, hunting, and snaring is employed. Most of the Makua Implementation Plan (MIP) MUs require a fence, but there are some that do not. The need for a fence is indicated via shading per specific MU in the Table 6.1 below. The status of ungulate control and fences is also included in this table. For more details about on-going projects related to the MIP see Chapter 1 of the PCSU annual report to the Army for 2004.

Fencing
Fencing projects are very slow to implement because of the associated paperwork. In the next year the Army is going to prepare an Environmental Assessment to cover all the actions in the MIP. Additionally, an umbrella Conservation District Use Permit (CDUP) will be sought for management actions planned over the next three years (CDUPs are only issued for three-year time periods). This will speed the process of fence construction significantly. Until that time, fence planning is proceeding at one large-scale fence per year. This year, we focused on getting one large fence constructed in Makaha, in addition to many small population fences. We scoped the Makaha Sub-Unit I fence in February of this year. Army Archaeologists conducted a review of the fence line and consulted with the State Historic Preservation Office in April 2004. Funding was secured and the fencing contract awarded at the end of the fiscal year 2004. Construction may begin as early as the spring of 2005. The small population fences NRS also worked on this year are described in the relevant species reports (Chapter 5: Rare Plant Stabilization Status), as well as in Chapter 3 of the PCSU year-end report.

Weed management
Weed control is conducted across MUs with priority placed on the habitat that is the most intact. In many of the MIP MUs there is a significant amount of alien-dominated forest. It makes sense, then, to focus reintroduction and weed control efforts on those areas where success is most likely. This is not to say that managing weed-dominated areas cannot be done, but it is certainly more time consuming with less guarantee of success. Extensive weed control is conducted in areas within MMR and has begun in offsite MIP MUs. The need for weed control is indicated via shading per specific MU in Table 6.1 below. The weed control conducted over the last year in each of the MIP MUs is also summarized in the table. For detailed specific weed control project discussion see Chapter 2 of the PCSU year-end report to the Army for 2004.

Landowner Issues
Offsite work has been slow to begin, as it requires time to become oriented to projects and new areas. NRS have been working with other conservation organizations on Oahu, including the Nature Conservancy (TNC), the Honolulu Board of Water Supply and the State of Hawaii. Each of these agencies has their own set of management goals and varying management approaches.

For these landowners to coordinate with the Army's Natural Resource Program requires a great deal of their limited time. This has lead to some challenges in initiating management actions. NRS are working to establish reliable and efficient means of communication about projects. Overall, agencies that have a conservation mandate are more than willing to provide guidance to NRS because of the significant workforce we can provide. We have hired a coordinator/liaison for the Nature Conservancy of Hawaii who works full-time at Honouliuli Preserve. This arrangement is working well.

Table 6.1 Management Unit Status

Management Unit	Fenced	Ungulate Control	Weed Control
Alaiheihe to Palikea Gulch	No	Goat control is underway in Lower Kaala NAR nearby.	None
Central and East Makaleha	No	Limited goat control is underway in Central and East Makaleha.	None
Ekahanui	Partial	TNC conducts fence maintenance and pig control outside this exclosure.	31.5 person hours were spent controlling weeds around rare plant reintroductions.
Haili to Kawaihapai	No	None	None
Kaena and Keawaula	No	None	253 person hours were spent conducting weed control over less than two acres.
Kahanahaiki	Yes	Transects monitored 4x/year. Exclosure is maintained as ungulate free. Fence maintenance is on going.	686 person hours were spent controlling weeds over 21 acres.
Kaluaa and Waieli	Partial/ Upcoming	Central Kalua`a is already fenced and an additional fence will be built this year in upper Waieli near Puu Hapapa.	The Army's liason has conducted weed control in Kaluaa and Waieli mainly focused around a core reintroduction site. NRS have also conducted about 50 hours of weed control.
Kaluakauila	Yes	Unit is ungulate free. Transects are monitored 4x/year. Fence repairs were conducted this year after heavy rains. Hunting conducted around the perimeter of fence 2x this year.	101 person hours were spent controlling weeds over 56 acres.
Kamaileunu	No	None	None
Keaau and Makaha	No	The State of Hawaii manages a public hunting program in this area.	None

Management Unit	Fenced	Ungulate Control	Weed Control
Lower Kahanahaiki	No	Snaring is on-going in this unit mainly to keep pig pressure off of the Kahanahaiki fence line and to protect the native resources in the MU.	None
Lower Ohikilolo	Yes	A goat fence is maintained and monitored to ensure no goats from adjacent population get in.	659 person hours were spent controlling weeds over 7 acres.
Lower Opaeula	Upcoming	The Koolau Mountains Watershed Partnership acquired funding construct a fence. Construction will begin after EA approved.	90.5 person hours were spent controlling weeds over less than an acre.
Makaha	Upcoming	None	None
Mt. Kaala NAR	No	Goat control via hunting and snaring is on going.	None
Ohikilolo	Yes	Goat control via hunting and snaring is on going. Monitoring along three transects is conducted to guide management.	55 person hours were spent controlling weeds over 17 acres.
Pahole	Yes	Fence is maintained by the State. Unit is ungulate free.	17 person hours were spent controlling weeds over 5.5 acres.
Palikea	Partial	TNC conducts snaring outside the perimeter of the existing fence.	4 person hours were spent controlling weeds over 7 acres.
Puu Kumakalii	No	None	None
Upper Kapuna	Upcoming	Construction is pending the State acquiring final funding.	48 person hours were spent controlling weeds over 7 acres.
Waianae Kai	No	None	None
Waiawa	No	None	None
West Makaleha	Partial	NRS assisted the State in controlling an incipient goat population 4x this year.	92 person hours were spent controlling weeds over 5 acres.

Shading in the table above indicates that this type of management in needed for the MU.