2006 Status Reports
for the
Mākua Implementation Plan
and the
Draft O‘ahu Implementation Plan

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MIP Executive Summary and Introduction

The Mākua Implementation Plan (MIP) was finalized in May 2003. In January 2005, the Army submitted an Addendum which emphasized management of three population units (PUs) per plant taxon. Over the past two years, management has been based on the priority actions put forth in this Addendum. This report serves as the annual status report to the Mākua Implementation Team (MIT), and participating landowners on the MIP Year-2 actions that have occurred between 1 September 2005 and 31 August 2006.

Current status of the Mākua Implementation Plan
The Army has been utilizing the MIP Addendum (2005) to direct stabilization efforts of the Mākua rare plant target taxa. The Addendum is a re-prioritized version of the Final 2003 MIP with emphasis on the bottom line requirements for stability as stated in the 1999 Biological Opinion (BO) for training at Mākua Military Reservation (MMR). It was written to guide Army efforts towards achieving stabilization given limited funding and resources. The Army is still awaiting formal comment from the USFWS regarding their concurrence with the MIP Addendum. In the mean time, the Army will continue to meet with the MIT each year to discuss progress and concerns regarding the overall direction of species stabilization and the associated non-native species control efforts.

The Army is also awaiting a new BO that will tie together all previous BOs and cover additional training proposed by the Army for Mākua Military Reservation (MMR). The Army expects this BO to be issued by the end of 2006. Until then, the Army will continue to utilize the MIP Addendum and the guidance of the MIT for direction.

The Army continues to work cooperatively under an Memorandum Of Understanding (MOU) with both the Board of Water Supply (BWS) and The Nature Conservancy of Hawai‘i (TNCH) for work in Mākaha and TNCH's Honouliuli Preserve. The Army and BWS have completed all the necessary paper work for the Mākaha subunit I fence, including the Conservation District Use Permit (CDUP). It is hoped that this fence will be constructed by the end of 2006. There are also several fencing projects that have been approved within Honouliuli Preserve. The Army is working with TNCH to begin construction on the Pu‘u Palikea and ‘Ēkahanui subunit II fencelines in the coming months.

As mentioned in the previous years report, two major changes have taken place regarding Honouliuli Preserve. First, TNCH has decided to focus management on their other preserves in Hawai‘i. Therefore, TNCH is looking for another agency to take over the management of the preserve before the end of 2007. Additionally, at the end of 2006 TNCH plans to reduce the Honouliuli staff to one interim staff member to stay on until the end of 2007. Naturally, the Army is concerned about this upcoming change as the partnership between these two organizations has been mutually beneficial to the goals of both organizations over the past several years. The stabilization of many MIP and OIP taxa will not be successful without the existence of this preserve.

Secondly, the parcels below the Honouliuli preserve that have been leased by Delmonte Corporation for pineapple fields for many years are now for sale by the Estate of James

Campbell. Once these parcels are sold for various forms of agriculture and housing development, we expect an increased risk to Honouliuli from fire. These lands did not previously pose a large threat to the preserve because they were actively farmed. It is anticipated that once these fields go fallow they may create a large fuel base for potential fires in the area.

Currently, the Army Natural Resources Program is working on a long term license agreement with Kamehameha Schools (KS) for natural resource management in Kawailoa, Punaluʻu, Waiʻawa, Waimano, and Waiʻau Valleys. This formal agreement will allow the Army to assist KS land managers with surveys and the construction and maintenance of ungulate exclosures on some of these parcels. NRS expects that this agreement will be completed early next year.

The Army is also pursing an agreement with Waikane Investment Corporation for seasonal predator control for ʻElepaio. This project will help protect the largest remaining ʻElepaio population on the windward side of Oʻahu. NRS expects that this agreement will be completed by the end of 2006.

In April 2006, the Army received a one year State NARS special use permit for most conservation actions described in the MIP. This one year permit is contingent upon 1) a monthly request by the Army by date and place; 2) an approved Final Environmental Assessment (EA) with a Finding of No Significant Impact (FONSI); and 3) all the special conditions of the permit (see Appendix I). Thus far, the Army and the State have been working with this agreement. The Army has published a Final EA with a FONSI. In addition, the Army is currently working with the State Department of Forestry and Wildlife on a long term MOU regarding the Army conducting MIP actions on State land. The Army anticipates this agreement will be approved and signed by both parties sometime in the spring of 2007.

Over the past year, NRS have been working cooperatively with the State Department of Land and Natural Resources (DLNR) on a new greenhouse that will be located adjacent to the State's nursery at the Nike site. Much of the site preparation has been completed, including excavating, grading, and the installation of three separate retaining walls. Greenhouse construction should be completed by December 2006.

Status of fire management

The Army's Wildland Fire Management Crew now consists of 10 field personnel and a crew boss. This fire crew has already assisted in several fires onsite this summer. Additionally, this year the Army Natural Resources Program has trained and certified 11 personnel to Fire Fighter Type 2 level.

In September 2005, a 170 acre fire burned in lower ʻĒkahanui Gulch below and in Honoluiluli Preserve. Only five acres of forest and critical habitat for the ʻElepaio burned. No active territories were affected. The 2006 summer also proved to be an active fire season on the Army ranges. On 15 June 2006, a fire occurred on Schofield Barracks West Range (SBMR). The burned area lies within ʻElepaio critical habitat, however no active territories were affected and the predominant vegetation is non-native. A Memorandum For Record (MFR) about this fire and the response is included in Appendix II.

On 3 July 2006, a fire started along Farrington Hwy near the Kaneana Cave and crossed over the ridge into Mākua Military Reservation (MMR). This fire is thought to be arson related and possibly due to fireworks. Approximately 20.2 acres were burned. The Army Natural Resources Program rpovided approximately $1000 of helicopter time to assist in the suppression of this fire. The fire was stopped 100 meters away from the lower Ohikilolo ridge, *Chamaescye celastroides* var. *kaenana* and 150 meters away from the *Hibiscus brackenridgei* subsp. *mokuleianus* population (see MFR in Appendix III).

On 12 July 2006, there was a fire in the Keawa'ula beach park area that ran uphill towards the Army NRS Kalukauila Management Unit within MMR. This fire is also thought to be arson related. NRS provided approximately $7K for helicopter support, in addition to the support provided by the State, to suppress this fire. More than 200 acres were burned and the Army's Kaluakauila reintroduction of *H. brackenridgei* subsp. *mokuleianus* and a naturally occurring population of *C. celastroides* were both affected (see MFR in Appendix IV).

As always, lessons were learned from this fire season. The Army's wildland fire crew is a much needed entity and is useful in fire suppression and control on Army ranges. The Army's commitment of Natural Resource helicopter time was essential to the suppression of the Keawa'ula fire. This year, the Army also contracted the Center for Environmental Management of Military Lands (CEMML) to develop a Wildland Fire Management Plan for the MUs on Army and adjacent State lands most threatened by fire. This document includes plans for fuel management within Lower 'Ōhikilolo, 'Ōhikilolo, Kahanahāiki, Kapuna, and West Makaleha. The Army hopes to employ some of these fuel management plans in the coming year.

<u>Funding and staffing levels</u>

There are currently a total of 31 staff including, several field staff and field supervisors and three part time technician hires, one fence crew boss, two fence crew technicians, one implementation project manager, one administrative assistant, one horticulturist, one horticulture assistant, one research specialist, one monitoring program manager, one seed conservation program specialist, one seed lab assistant, one *Achatinella* propagation assistant, one tissue culture assistant, and one database/GIS specialist contracted through the Research Corporation of the University of Hawaii (RCUH) to do natural resources work on Army training areas. In addition, the Army will pick up TNC's three remaining field staff from the Honouliuli preserve by the end of 2006. One additional field technician position is currently open. The Army has also awarded two three-year grants to University of Hawai'i graduate students for *Euglandina rosea* and rat density research.

Full implementation of Year 2 actions from the MIP Addendum required $3,161,000 in funding, including overhead. The program received approximately $3,200,000 last fiscal year for MIP projects. This was the first year that MIP projects have been funded to the amount requested. However, NRS are still concerned about the constancy of funding over time. NRS are hopeful that funding will support the existing personnel and will enable a third field crew to be established. NRS continue to deal with the amount of space needed to house three field crews and a fencing crew. The Natural Resource Center in Schofield Barracks East Range is already stretched to the limit. The Army has secured space at the TNC's Kunia baseyard to support the fence crew and several more individuals until the end of 2007. NRS will continue to look for additional space to house new employees and hope to have this issue resolved in 2007.

Fencing Costs
In 2006, the Army decided it was much more cost-effective to hire an in house fencing crew. The addition of the Army's fencing crew will save the program thousands of dollars and will allow fences to be built much faster than in previous years. This crew has already proven to be more economical and more flexible than contract fence construction. Since being hired, the fence crew has constructed three *Eugenia koolauensis* fences in Kahuku Training Area in a matter of weeks and scoped fencelines at ʻEkahanui, Puʻu Palikea, Kapuna subunit III, Mākaha, Kamaileʻunu, and Puʻu Kawīwī. In addition, the Helemano fenceline was completed by the Army fence crew when contract money failed to cover the cost of the entire fenceline. The last fencing contract to be completed by a private company will be the 100 acre Mākaha Subunit I MU. The Army anticipates the Army fence crew will construct a few hundred meters of fence for this unit when contract money runs out.

Reporting
This document reports on all MIP actions for this fiscal year. For this report MIP and OIP actions are presented together and are organized by species/category. The MIP actions are reported in the first section of each relevant chapter (see table below). Some highlights of the Army's Natural Resources Program this year include: the development of a 'weed control database', which tracks ecosystem level weed control efforts within each MIP and OIP MU and in each incipient weed control area; the development of an invertebrate database which tracks the identity and location of invertebrates in MIP and OIP MUs; the reading of several LCTA monitoring plots and analyses comparing this year's data to original data in 1996 and 1999; the establishment of ground shell plots to monitor *Achatinella*; the protection of approximately 10 breeding pairs of Oʻahu ʻElepaio within the Mākua AA; and several research projects on slugs, black twig borer, tropical fire ants, etc.

Chapter	Title	Contents
1	Feral Ungulate Management	Reports a combination of MIP and OIP MUs
2.1	MIP Weed Management	Reports on the incipient weed control and established weed control in Mākua and in MIP MUs (i.e. ecosystem level weed control).
3.1	MIP Rare Plant Management	Reports on all 27 MIP rare plant target taxa.
4.1	MIP Rare Invertebrate Management	Reports on *Achatinella mustelina* management
5.1	MIP ʻElepaio Management	Reports on ʻElepaio management within the Mākua Action Area
6	Research Issues	Reports on the status of NRS research projects and those associated with NRS work.

Oahu Implementation Plan Draft Status Update

Currently, the Draft O‘ahu Implementation Plan (OIP) is still out for review by the O‘ahu Implementation Plan Review Committee (OIPRC). This committee consists of biologists from US Fish and Wildlife Service (USFWS), Hawaii Biodiversity and Mapping Program (HBMP), Board of Water Supply (BWS), The Nature Conservancy of Hawai‘i (TNCH), US Geological Survey (USGS), University of Hawai‘i (UH), and other field experts. The OIPRC meets annually to discuss the Army's progress on the stabilization of the species covered in each consultation.

Reporting
Because the OIP is still in draft form NRS report here on a subset of the OIP rare plant species. These species are those for which NRS have begun stabilization efforts. A subset of the OIP MUs are also discussed in the Weed Management Chapter 2.2. Once the OIP is finalized the Army will report on all the species covered in the O‘ahu consultation. Additionally, this year NRS report the latest population numbers and any relevant updates for the *Achatinella* species in the O‘ahu consultation. For this report the OIP and MIP data are presented together and organized by species/category. Any OIP actions are reported in the second section of each relevant chapter (see table below).

O‘ahu ‘Elepaio stabilization efforts were well underway as of last fiscal year. Therefore, this year's data is presented as an update to those efforts. Major highlights regarding the OIP include: the protection of 75 breeding O‘ahu ‘Elepaio breeding pairs; the initiation of stabilization level protection and management of several OIP rare plant species; the collection of genetic samples of *Achatinella* species throughout the Ko‘olau AA; and the development of Right of Entries (ROEs)/ License Agreements with various landowners for OIP species management.

Chapter	**Title**	**Contents**
1	Feral Ungulate Management	Reports a combination of MIP and OIP MUs
2.2	OIP Weed Management	Reports on the incipient weed control and established weed control on Oahu Training Areas and in OIP MUs.
3.2	OIP Rare Plant Management	Reports on a subset of the OIP rare plant target taxa.
4.2	OIP Rare Invertebrate Management	Reports on *Achatinella* species within Oahu Training Areas.
5.2	OIP ‘Elepaio Management	Reports on ‘Elepaio management as part of the OIP FWS consultation
6	Research Issues	Reports on the status of NRS research projects and those associated with NRS work.

Future of the OIP
When the OIP is finalized, the Army will begin year one of the plan. In the meantime, NRS will continue working on the stabilization of OIP rare plant species with a focus on 1) Tier 1 species (see OIP) and 2) the rarest species and most threatened populations. In the interim, OIP rare plant stabilization work for these manage for stability populations will focus on *in situ* PU

protection and genetic storage collections. *In situ* protection includes fencing, weed control, rat control and general ecosystem management associated with these species. Rare plant surveys will also be conducted in the coming year. The Army is working with Kamehameha Schools (KS) to develop a license agreement that would allow NRS to conduct surveys and conduct some rare plant management on KS land in the coming year.

The Army is awaiting the results of a population genetic analyses being conducted by Dr. Michael Hadfield's lab at UH. It is hoped that these results will provide additional guidance for these species stabilization efforts. Interim, rare snail stabilization efforts in the Ko‘olau Mountains will continue with current predator control efforts, surveys, monitoring, and genetic sampling and analyses. NRS anticipate adapting the preliminary snail stabilization plans outlined in the OIP once genetic analyses are complete (See Chapter 4.2 OIP *Achatinella* Management). NRS also predict OIP *Achatinella* management will be influenced by the results of surveys conducted on KS land in the coming year.

Stabilization efforts for the O‘ahu ‘Elepaio have been conducted for the past two years. This year, approximately 75 breeding pairs of ‘Elepaio received predator control at four sites on O‘ahu (Schofield West Range, Honouliuli, Mākaha, and Moanalua). Currently, the Army is pursuing a year by year agreement with Waikane Investment Corporation, the landowners of Waikane Valley, for an ‘Elepaio predator control program. This population is the largest remaining windward O‘ahu population and an important population to protect for the subspecies (see chapter 5.2)

The Army also obtained a Right of Entry with Moanalua Valley Properties LLC to conduct predator control during the ‘Elepaio breeding season this year and expect to have the same agreement for the next breeding season.

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Chapter 1: Feral Ungulate Management

There are two species of feral ungulates that inhabit O‘ahu, pigs (*Sus scrofa*) and goats (*Capra hircus*). The goal of the Army’s ungulate program is to eliminate the impacts of feral ungulates on endangered species and native habitats by excluding ungulates from the MIP MUs. This is primarily accomplished by constructing large-scale fences. Prior to the construction of the fences, NRS try to reduce ungulate pressure in the MUs using a multitude of techniques. These techniques include neck snares, hunting, aerial shooting using helicopters, and small PU fences. NRS use transects to help ascertain ungulate presence within the MUs. Most of the MIP MUs require a fence, but there are a few that do not. The need for a fence is indicated via shading per specific MU in Table 1.1. The status of ungulate control and fences is also included in this table. See the corresponding section in this chapter for maps of the units and more detailed discussion about the on-going ungulate management projects related to the MIP in the specific MUs. Only MUs with ungulate related issues significant to this reporting year will be discussed in detail.

Table 1.1 MIP Management Unit Status

Management Unit	Fenced	Ungulate Control	Threats
ARMY MANAGED LANDS			
Kahanahāiki	Partial	The 90 acre Subunit I has been ungulate free since 1998. Subunit II is proposed for construction in Year 3. In the meantime, snaring is performed in this unit to keep pig pressure off of the Subunit I fence line and to protect the native resources in Subunit II.	Pigs
Kaluakauila	Yes	This MU is fenced and ungulate free.	None
Lower ‘Ōhikilolo	Yes	The ‘Ōhikilolo ridge fence and the strategic fence are both complete. In July 2006 four small goats were able to penetrate a hole in the fence. NRS is currently working to remove them from inside the fence.	Pigs Possibly
Lower ‘Ōpae‘ula	No	The Ko‘olau Mountains Watershed Partnership has acquired partial funding for fence construction. A Final EA has been approved with a Finding of No Significant Impact. Also, a 10-15 year license agreement must be obtained prior to construction of the fence.	Pigs
‘Ōhikilolo	Partial	‘Ōhikilolo ridge fence is complete along with five smaller PU fences and all are ungulate free. A sixth PU fence was completed in 2006. The Lower Mākua fence is slated for construction in Year 7.	Pigs
Pu‘u Kumakali‘i	No	None needed	None
STATE OF HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES			
East Makaleha	No	A 230 acre fence is proposed for construction in Year 4. Limited goat control is currently underway in Central and East branches of Makaleha and Lower Ka‘ala NAR under the direction of the NARS Specialist.	Pigs Goats
Haili to Keālia	No	None	None
Ka‘ena	No	None	None
Kea‘au and Mäkaha	No	Small PU fence slated for construction in year 5 awaiting approval.	Pigs Goats
Manuwai	No	MU fence is slated for construction in Year 8. An urgent action fence for *Neraudia angulata* is awaiting approval. Nearby goat populations are currently managed via hunting.	Pigs Goats

Management Unit	Fenced	Ungulate Control	Threats
Pahole	Yes	MU perimeter fence is complete and ungulate free.	None
Upper Kapuna	Partial	The final configuration of the MU has been changed to be made up of four subunits. The NARS has funding to construct subunits I, II, most of III, and just recently secured funding for IV. NRS has committed to complete the construction of subunit III and assist as needed.	Pigs
Wai‘anae Kai	Partial	NRS assisted the Plant Extinction Prevention staff with the construction of a PU fence encompassing a population of *Hesperomannia arbuscula*. Three other small PU fences have been proposed to protect two populations of *Neraudia angulata*, and one for *Tetramolopium filiforme* and *Nototrichium humile*.	Pigs Goats
West Makaleha	Partial	Two PU fences were completed protecting populations of *Schiedea obovata* and *Cyanea grimesiana*. A large fence has been proposed for this MU and is awaiting approval from the State. NRS and NARS staff controls a small herd of goats that reside on the boundary between this and the Pahole NAR.	Pigs Goats
THE NATURE CONSERVANCY OF HAWAII			
‘Ēkahanui	Partial	Subunit I was completed by TNCH and is ungulate free. The EA has been completed for Subunit II and the route of the fence is almost cleared. Construction should be completed by summer 2007. Several PU fences were constructed in 2004 to protect at risk species.	Pigs
Kalua‘a and Wai‘eli	Partial/ Pending	Subunit III was completed by TNCH and is ungulate free. NRS assisted TNCH to complete subunits II A and C as one combined subunit. Subunit II B is slated for construction in Year 10.	Pigs
Palikea	Partial	Small PU fences have been constructed in both Subunits IA and IB. Construction of the larger fence around Subunit IA should begin in summer of 2007. TNCH staff will continue to control pig populations until fences can be built	Pigs
BOARD OF WATER SUPPLY			
Kamaile‘unu	No	Approval has been gained for the construction of two PU fences that will encompass two populations of *Sanicula mariversa*. All the material has been purchased and NRS is just awaiting delivery of all the proper tools before construction can begin.	Pigs Goats
Mākaha	Pending	Subunit I is slated for construction in 2006-2007. The line has been cleared and the construction materials have been placed out on the line. Subunits II and III are slated for construction in Year 5. NRS will complete a small PU fence around a population of *Cyanea longiflora* by late 2006.	Pigs Goats
DOLE FOOD COMPANY, INC.			
Kaimuhole	No	Dole is unwilling to give permission for construction of this MU fence. The parcel is leased to a rancher at this time and Dole is not interested in making any changes to the existing lease. A new MU needs to be chosen by the MIT.	Goats
KAMEHAMEHA SCHOOLS, DLNR, HIRAM FONG TRUST			
Waiawā	No	MU perimeter fence is slated for construction in Year 9 but may be built earlier due to the overlap with OIP species. A 10-15 year license agreement must be obtained prior to construction of the fence.	Pigs

Shading in the table above indicates that ungulate management is needed for the MU.

Feral Ungulate Monitoring

Monitoring for ungulate sign takes place along ungulate monitoring transects, through incidental observations of ungulate activity, and scouting expeditions. Placement of transects is dictated by management needs, terrain, and manageability. Monitoring transects do not provide information on ungulate population dynamics or densities. They do help detect major changes in ungulate presence and provide managers with a general idea of changes in ungulate activity for a given area over time. This is especially important along fences where ingress can be immediately detected. It is often difficult to draw clear conclusions from transect data because there are many factors affecting field observations and ungulate activity. These factors may include: inclement weather, observer bias, transect placement, and/or topography. To offset these factors NRS do not read transects immediately after inclement weather, use experienced staff members to read transects, and place transects in habitats favored by the different ungulates. In Mākua, NRS monitor eight transects to help guide ungulate control activities.

Transects are 500 meters long by five meters wide. If the terrain is too rough or steep, transect lengths may be shorter. Monitoring stations are tagged and labeled every 10 meters along each transect. Observers record all fresh/old ungulate sign, including feeding, scat, rubbings, wallows, and trails for both pigs and goats within each of the 10 by 5 meter transect sections.

Scouting expeditions are used to scope for fresh sign and to look at movements of goat herds in the selected areas. Careful notes are taken on the size of the herd and the sex, age and color of individual members of each herd. This is primarily done prior to hunting operations in order to better direct the hunts and catalogue herd reduction.

Additionally, several Land Condition Trend Analysis (LCTA) plots (see methodology discussion in Chapter 2: Weed Management Introduction) are located within feral ungulate control areas. Where there has been less weed management than ungulate control in plot areas the plot discussion and data analysis appear in the appropriate MU discussions in this chapter (three plots, 713, 716 and 702). The discussion of the plot methodology and the individual plot discussions for areas receiving fairly intensive and frequent weed control are located in Chapter 2: Weed Management in the appropriate MU sections.

Feral Ungulate Control Methods

Snaring

NRS utilize snares to control ungulates in areas that are remote and difficult to access. To increase effectiveness, snares are generally placed in narrow sections of well-used game trails and in areas with steep terrain. They have proven to be very successful in drastically reducing ungulate numbers especially when used in conjunction with other types of control methods. In 2005-2006, a total of 64 staff hours were spent checking and resetting snares which resulted in the removal of 16 pigs. This equals about four pigs per trip.

Shooting/Hunting

Shooting operations are mainly used to control goats although; under certain circumstances they have been used to control pigs as well. All operations are preceded by scouting expeditions which have proven to be a very successful method of increasing the effectiveness of control hunts. In 2005-2006, a total of 28 hunts were conducted, resulting in the removal of 36 goats. This equaled roughly 600 staff hours and 1.28 goats removed per hunt. These areas cover over 3,000 acres which are not currently fenced.

Aerial Shooting
Aerial shooting has only occurred at MMR. Aerial shooting has proven to be very effective at removing a significant portion of the goat population in remote portions of Mākua Valley in the past. Due to the huge decline in animal numbers in MMR, the cost effectiveness of this tool has severely decreased. NRS do not plan to conduct aerial hunts in MMR in the near future but will continue to keep it as an option should the need for aerial shooting arise again in the future. A lengthy approval process is required to obtain permission for using this control technique.

Radio-tracking
Radio and satellite tracking has only been used at MMR, see previous year end reports for specific information. NRS would like to explore the option of using these tools in Lower Ka‘ala NAR and Makaleha Gulch in the future. NRS is seeking to work with the NARS Specialist in this effort as it could greatly improve ungulate control efforts in this area.

Hunting with Dogs
The use of hunting dogs has been implemented in Kaluakauila, Ka‘ala and West Makaleha MUs. The use of hunting dogs as an ungulate management tool has proven to be a highly successful method of removing feral pigs from certain areas. This technique can be used as a means of eradicating animals within a fenced area or lowering pressure along a fence line. No dog hunts have been run so far in 2006 but pig sign has been recently seen at Ka’ala and a hunt is being planned.

Fencing
Fencing is the most effective management tool to keep ungulates out of biologically sensitive areas. There are generally two ways that NRS constructs its fences. Enclosure type fences totally enclose an area by way of an unbroken line of fencing. Strategic type fences use a combination of topography and fencing to stop ingress/egress of feral ungulates into the protected area. NRS use a combination of galvanized hog wire fencing and panels when constructing enclosures. Hog wire fencing is an economical and practical product that can be easily erected over a broad range of terrain types. Hog panels are an expensive but very heavy-duty and durable product that performs well in steep terrain. Due to the additional cost of panels, they are only used in very steep or uneven terrain and when there is a very real threat of erosion compromising the fence.

Fencing projects can be very slow to implement because of the associated permitting and contracting work. The Army has published a Final Environmental Assessment (EA) with a Finding of No Significant Impact (FONSI) for MMR. This document includes all the management actions described in the MIP. Currently fence planning is proceeding at the rate of approximately one large-scale fence per year.

Over the past several years contracting costs for fence construction have doubled and tripled. To offset this cost increase, NRS have hired an in-house fencing crew. This action should not only decrease costs but increase the efficiency in fence construction by eliminating the contracting phase of the process. This has the real potential to increase the number of MU and PU fences constructed each year.

MIP Ungulate Control Discussion

Wai‘anae Kai MIP MUs

The scale of the proposed fences for these MUs has been reduced significantly from what was proposed in the MIP. There are three main reasons why NRS feel that the best way to approach the fencing issue is to start off small with PU sized fences rather than MU sized.

- The proximity of these plant populations within a very popular hunting area.
- The fact that the surrounding habitat is heavily degraded by feral goats, considerably impacted by introduced weeds, and would take an unreasonable amount of effort, money, and time to rehabilitate.
- The difficulties and safety issue arising from working in such steep terrains.

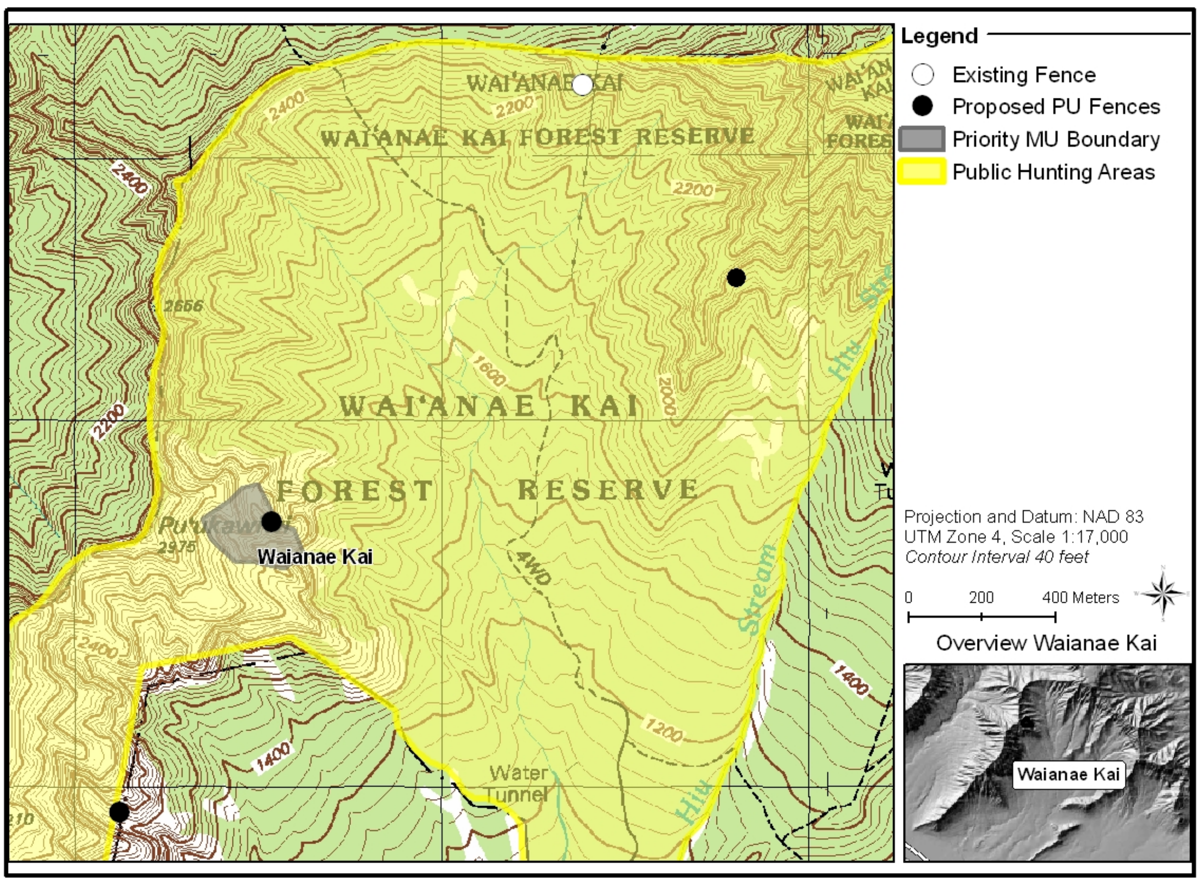


Figure 1.1 Wai‘anae Kai MU

NRS feel that in the short term, the immediate habitat surrounding the populations would be at least protected from further degradation by ungulates. NRS would also be able to gather as much data on the structural changes within the populations once the fences are built and use this data as justification for increasing the sizes of the fences if so desired in the future. At this time, it is unclear whether the proposed PU fences will be large enough to ensure that adequate habitat is managed for the various species to remain viable and reach stability but this is a reasonable first step in management of the populations.

NRS assisted staff from the Plant Extinction Prevention group to erect a small PU fence around a population of *Hesperomannia arbuscula* in April 2006. At this time, there is no PU specific data to show a relationship between a reduction in ungulate sign and an increase in PU size. This was one of four proposed PU fences slated for the area (Figure 1.1). To date, the EA has been finalized for the *T. filiforme* and *N. humile* fence. Due to a minor clerical error NRS has not submitted the EA for the other two PU fences.

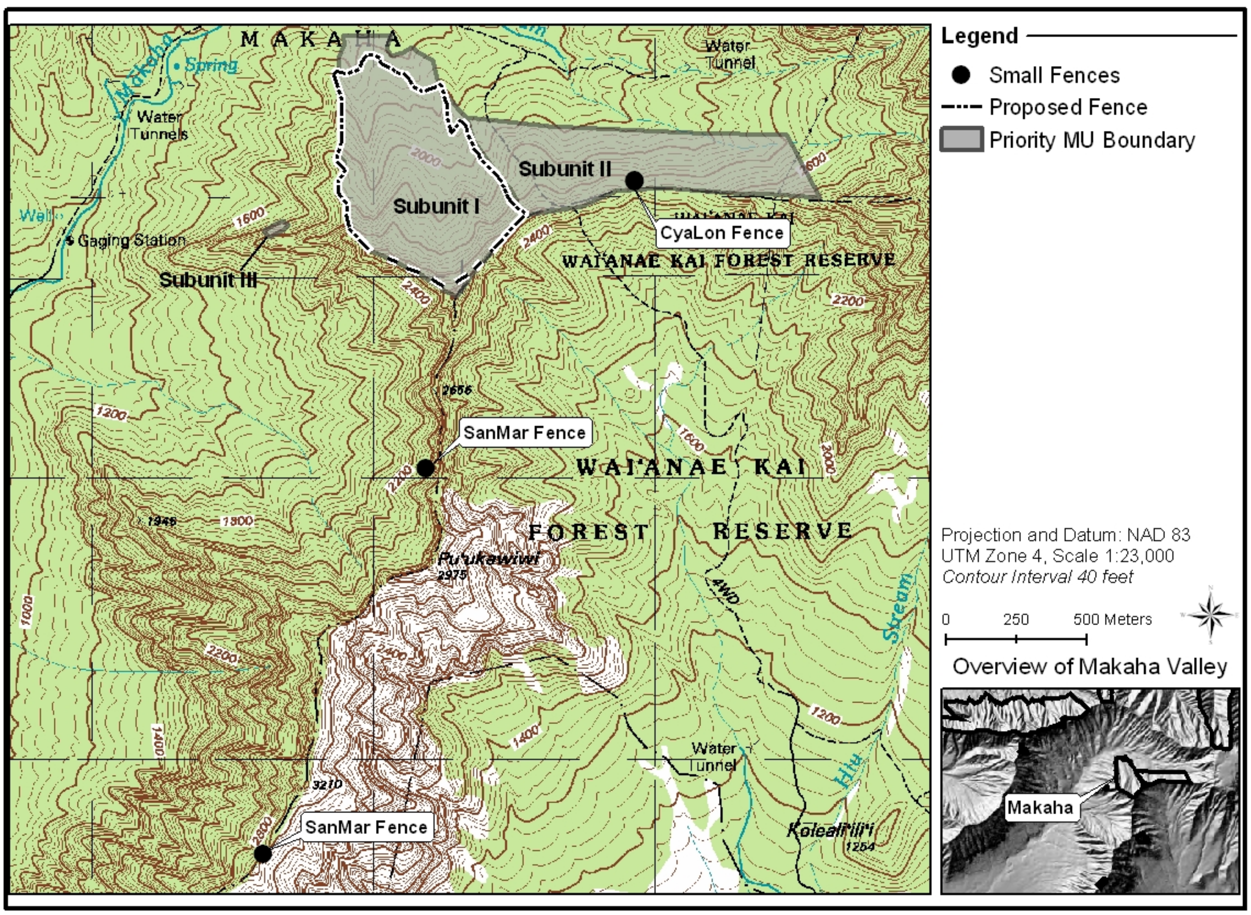


Figure 1.2 Ungulate Control Areas in Mākaha

Kamaile‘unu MU

Two small-scale fences have been scoped to protect *Sanicula mariversa* (Figure 1.2). One fence is near Pu‘u Kawiwi and the other near Pu‘u Kēpau‘ula. The two fences are .04 acres and 4.5 acres respectively. These fences will be constructed concurrently with the larger exclosure in Mākaha in late 2006-early 2007. The scale of the proposed fences for these MUs has been reduced significantly from what was proposed in the MIP because the surrounding habitat is heavily degraded by feral goats, considerably impacted by introduced weeds, and would take an unreasonable amount of effort, money, and time to rehabilitate. At this time, it is unclear whether the proposed PU fences will be large enough to ensure that adequate habitat is managed for the various species to remain viable and reach stability.

Mākaha MU
In an effort to protect a large portion of the 21 threatened and endangered species in Mākaha Valley, Subunit I of the MU was slated for construction 2005-2006. As it stands now, the proposed fenceline has been scoped, surveyed, cleared and all of the materials have been placed along the line on their prospective Drop Zones awaiting the contractor to begin construction. The EA was approved in early 2005 but the CDUA took much longer to process. This forced the contractor to delay construction and apply for continuances on the contract. NRS expect construction to begin in early 2007. Subunits II and III are slated for construction in Year 5 of the MIP (see Figure 1.2). A small-scale PU fence is being erected to protect a population of *Cyanea longiflora* within subunit II and should be completed by November 2006.

Kea'au and Mākaha MU
A proposed five acre PU fence is slated for construction in year 5 of the MIP. It will protect a population of *Sanicula mariversa* inside the Kea'au Game Management Area (Figure 1.3).

'Ōhikilolo MU
A perimeter fence was completed in 2000 that separates the MU from the adjoining 'Ōhikilolo Ranch and Kea'au Game Management Area to the south, which have large populations of feral goats. Five PU exclosures and one ecosystem preserving fence have also been constructed within the MU (see Status Report 2005). All of these exclosures have remained ungulate free and are checked quarterly. A sixth PU exclosure was completed in 2006 that encompasses an outplanted population of *Pritchardia kaalae*. In order to better graphically represent the MU, NRS split the area into eastern and western halves (Figures 1.3 and 1.4).

NRS have employed several different control methods over the years to eradicate goats from this MU and the adjoining ungulate control areas (UCA) to the east and west. These control methods include aerial hunting, hunting, radio-tracking, and snaring. Since control began in 1995, a total of 659 goats and 40 pigs have been removed from this MU. The two UCAs have had 396 goats and 52 pigs removed. To date, NRS believe that feral goats have been eradicated from this MU. This is consistent with the lack of incidental observations, lack of sign on any transect, and the fact that NRS have spent several days scoping different areas of the MU and the adjoining UCAs without detecting any goat sign. Therefore, NRS have opted to remove all of the snare groups except for those in the more remote regions of the western half of the MU.

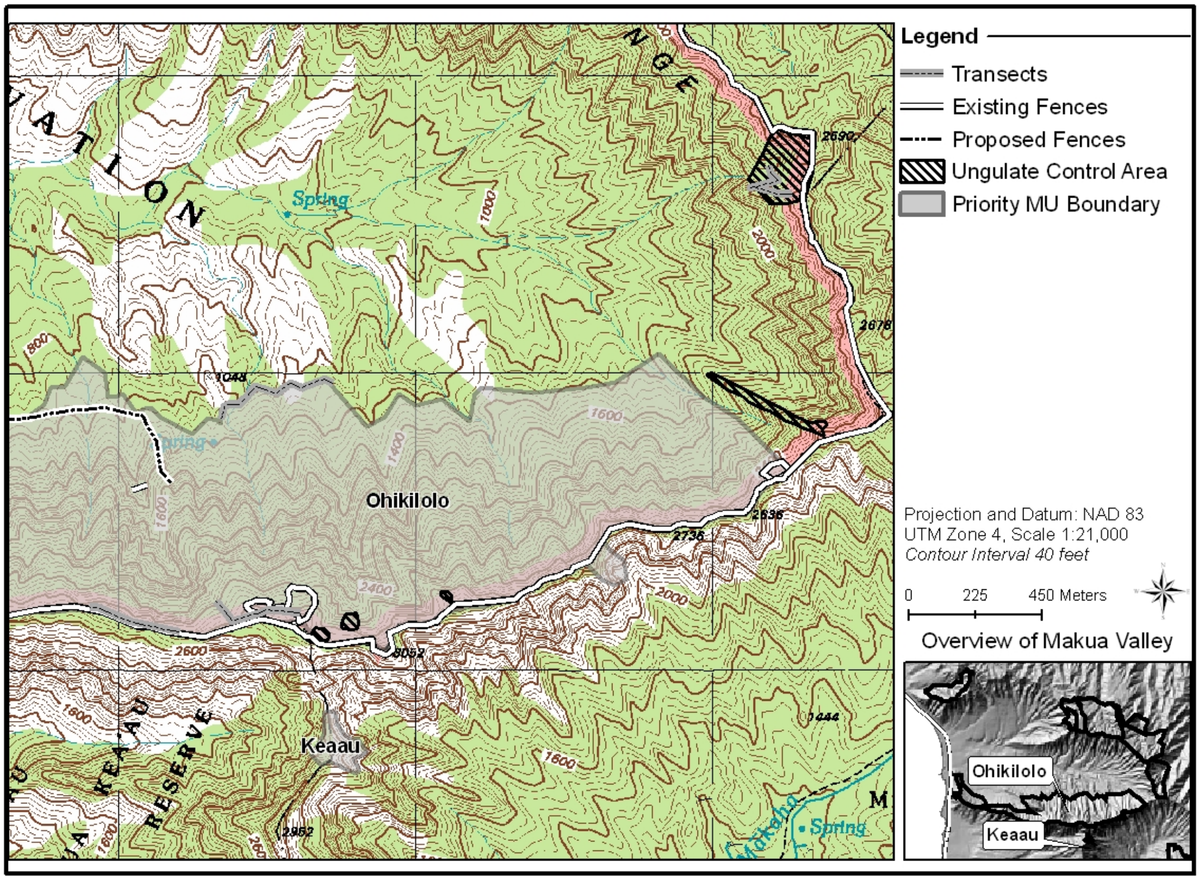


Figure 1.3 Eastern half of ʻŌhikilolo MU

Monitoring of ungulate activity in the ʻŌhikilolo MU coincides with quarterly inspections of the perimeter fence. There have been at least two breaches in the perimeter fence since its completion in 2000, once in 2003 and again in March 2005. NRS were able to repair the breaches and the goats were removed. During the quarterly inspections, NRS has noted that the perimeter fence is being undermined in several areas do to erosion. The NRS fence crew will work this year to reinforce the fence in these areas.

NRS was able to regain access to the Lower Makua portions of the ʻŌhikilolo MU this year. The Army's Safety Office redrew the boundaries of the Improved Conventional Munitions (ICMs) Area after an official investigation uncovered the origin of the ICMs in the area and safety concerns were evaluated. A 1,200 m strategic fence is slated for construction in Year 7 of the MIP. NRS is also looking at either constructing another strategic fence or adding onto the proposed one to enclose larger portions of the intact native forest.

At this time, statistical data does not show a clear relationship between a reduction in ungulate sign and an increase in overall MU native vegetation cover (see Chapter 2 for further discussion). Data does exists however showing significant increases in native species' cover in some areas, but the dataset lacks sufficient spatial structure to allow for extrapolation to larger areas.

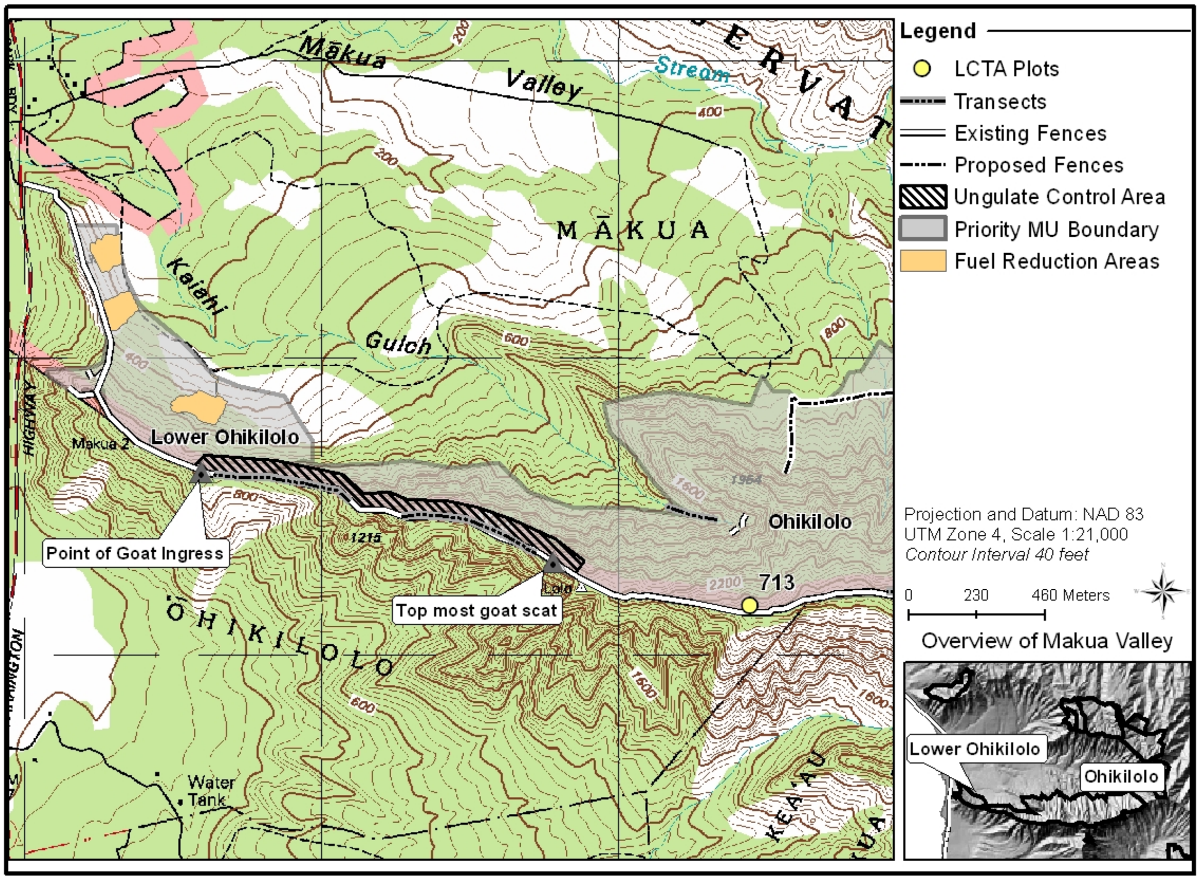


Figure 1.4 Western half of ‘Ōhikilolo MU

Monitoring

LCTA Plot 713

This plot showed significant changes in both native and non-native species’ mean number of interceptions over time (p=0.0061 and p=0.0036 respectively). Native species’ mean number of interceptions (χ) increased steadily over the lifetime of the plot (χ=1.46±0.63 in 1996, χ=1.95±0.98 in 1999 and χ=2.10±1.55 in 2006) while non-native species’ χ showed no clear pattern (χ=1.81±1.06 in 1996, χ=2.69±1.53 in 1999 and χ=2.00±1.29 in 2006) but may be increasing slightly. The data from 1999 appear to be having a strong effect on the significance of changes in χ for non-native species as the 1996 and 2006 data are fairly similar. The ‘Ōhikilolo fence was completed in February 2000. Goats remained in the area until 2005 though detections were less frequent and associated impacts were likely diminishing beginning in 1998. There is only one growth form that showed a significant response to one year of goat removal. Native vines, including species like *Alyxia oliviformis*, increased almost 2 fold upon goat removal (p=0.0010, goat pressure χ=2.06±0.68 no goat pressure χ=4.4±2.37). While other growth forms did not show significant changes, several groups’ mean count did increase slightly including native sedges, and shrubs, and non-native ferns, shrubs, and grasses. Both native and non-native trees’ mean count decreased slightly after goat removal likely due to canopy weeding efforts, the only weeding in this area, conducted in July 2003 and June 2004 (native tree prior to goat removal χ=1.8±1.03 post goat removal χ=1.73±0.98 compared to non-native tree prior to goat removal χ=2.37±1.41 post goat removal χ=2.18±1.48). There does appear to have been a slight decline in *Myrsine lessertiana* and *Nestegis sandwicensis* since the plots' creation (*M. lessertiana* pre goat removal χ=1.94 post goat removal χ=1.76, *N. sandwicensis* not detected post goat removal). This time period coincides with an unexplained period of severe die back of *M. lessertiana* observed in the area by NRS.

These data suggest that the forest's response to goat removal in the absence of understory weed removal is an increase in cover of all species both native and non-native. This is what would be expected and supports the need to remove ungulates from areas in order to restore the vegetation community. In this area the native species may benefit from more intensive understory weeding to remove some of the non-native grasses and shrubs that have benefited from goat removal.

Lower ʻŌhikilolo MU

There is a perimeter fence that was completed in 1998 that separates the MU from the adjoining ʻŌhikilolo Ranch to the south, which has large populations of feral goats (Figure 1.4). A strategic fence protecting an endangered population of *Melanthera tenuifolia* was erected in June 2002. No breaches have been observed since 2002. On 3 July 2006, a malicious fire originating along Farrington Highway burned close and the heat possibly impacted plants (See Appendix III). This fire ended up burning approximately 20.2 acres. Fortunately, only alien grasses and other introduced weedy species dominated a very large portion of the area burned. Unfortunately, the fire may have compromised the galvanized coating on the perimeter fence in this MU, which can make the fence more susceptible to corrosion. NRS are still unsure how much damage fire will do to the galvanizing. This portion of fence has burned twice before in 1998 and 2003 and appears to be still in working condition. In an effort to protect the *Chamaesyce celastroides* var. *kaenana* and *Hibiscus brackenridgei* ssp. *mokuleianus* PUs from fires, NRS conduct fuel reduction operations throughout the year (see Chapter 2 for further discussion).

In July 2006 a small hole was discovered along the perimeter ridge fence and goat sign was reported inside the fence (Figure 1.4). On a subsequent scoping trip, four small goats were observed uphill of the *H. brackenridgei* ssp. *mokuleianus* population. NRS has submitted all of the necessary paperwork to gain permission to hunt in MMR again. In the meantime, NRS has repaired the fence and installed a snare line along the fence in order to expedite the eradication of these individuals.

At this time, there is no statistical data that shows a direct relationship between a reduction in ungulate sign and an increase in MU native vegetation cover at Lower ʻŌhikilolo MU.

Kaluakauila MU

A 110 acre pig free exclosure was completed in June 2002 protecting the priority Kaluakauila MU (Figure 1.5). Monitoring for ungulate activity takes place quarterly along two permanent ungulate transects which run alongside the fence. There appears to be a frequent influx of animals to the area which puts recurring pressure on the fence. This is probably due to a natural seep that occurs in the gulch and in association with the fruiting season of *Psidium cattleianum*.

NRS recently visited the portion of fence that was damaged in the past by a rock slide (see Status Report 2005). Although large rocks and boulders have smashed into the panels, causing damage that would have destroyed hog wire fencing, the stock panels have remained intact. Pig sign has been observed in the fence since repairs were completed but only from very small pigs that did not remain inside. Hunting with dogs is used on a limited basis to lessen the pressure along a portion of the fence during times of major influx of animals.

Monitoring

There is one LCTA plot, 702 established in 1996, in this area. NRS Monitoring Program Manager (MPM) and NRS read this plot in 2006, and collected all relevant historic data that could be found from this plot. Ongoing management began in 2002 and has included baiting for rats (began in 1999), fencing and weeding along with plant reintroductions. No augmentations (weeding or planting) have been done within the plot boundary however; therefore any changes are due to the natural progression as it may have been affected by fencing and other stochastic processes.

When comparing the number of native species hit in the plot and the number of non-native species hit, over time, for all years the plot was read (1996, 1999 and 2006) there was a significant change over time. Both native species counts and non-native species counts differed significantly among years ($p=0.0023$ and 0.038 respectively). The mean counts (χ) for 1999 were much lower than the counts for both other years however, and when the data from 1999 are thrown out, the significant changes disappear. It is not known why the means were lower in 1999, there were different investigators each year, and this could be a function of biases in the way the plot was read, or could represent a real decline in the intercepted vegetation on the line due to a drought that year. Additionally, in 1999 the plot was read in August, compared to April 1996 and May 2006. It could be that the vegetation dies back significantly as the summer progresses. Overall, the 1999 data have very few (<10 total) interceptions of vegetation occurring below 5 m in height while both 1996 and 2006 have many hits under 5 m which would be expected if annuals or herbaceous plants die or diminish in cover in the summer dry season.

The area was not fenced until 2002 and was subject to graze and browse pressure from ungulates until this fence was completed. In fact, when data from prior to fence construction and post fence construction are analyzed there is a significant increase in native tree cover ($p=0.0009$ pre-fence $\chi = 1.79\pm0.94$, post-fence $\chi = 2.58\pm1.56$). No other growth form group showed any significant change in response to the fence, but there were a great deal more groups represented in the 2006 data (post-fence) than earlier data including the first detections of non-native grass ($n=2$), herbs ($n=6$) and vines ($n=1$) and native herbs ($n=3$). The depauperate understory in 1999 could be a reflection of intense grazing pressure, and the 2006 data seem to show some recovery evidenced by a great deal of understory cover. This area has not experienced much weed control and may have only been weeded several years prior to the fence construction. This further suggests that any changes observed in vegetation are related to ungulate removal and stochastic processes.

Overall the trend is for native species interception to increase over time (1996 $\chi = 2.02\pm1.02$, 2006 $\chi = 2.47\pm1.6$) and non-native species to decrease over time (1996 $\chi = 1.78\pm1.06$, 2006 $\chi = 1.64\pm0.71$) however these changes are not significant without including the 1999 data ($p=0.1296$ and 0.4495 respectively)

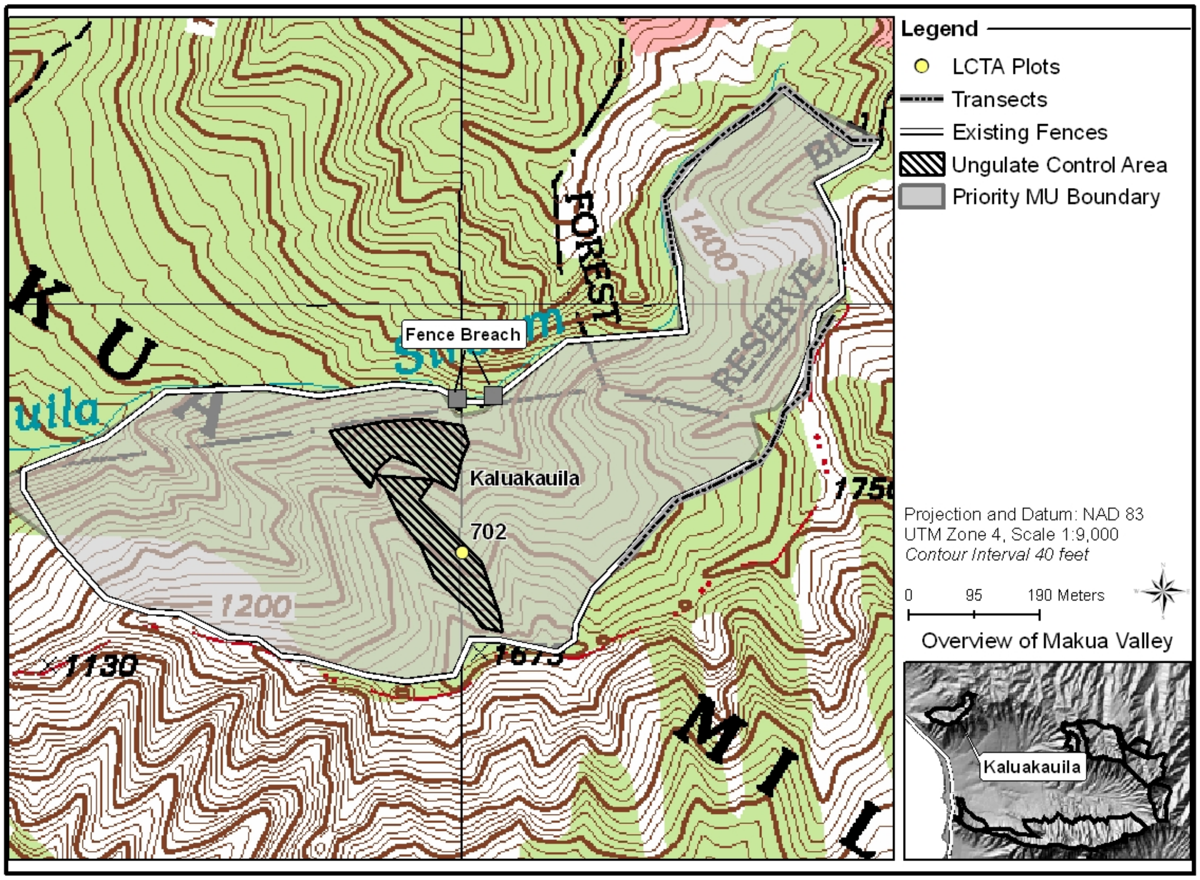


Figure 1.5 Kaluakaulia MU

Kahanahāiki MU

Subunit I has been ungulate free since 1998 (Figure 1.6). Ungulate sign is closely monitored along two permanent ungulate transects which run alongside the fence. Subunit II will be constructed by Year 4 of the MIP. NRS need to scope out the route of this fenceline that will best enclose the associated MIP PUs for *Alectryon macrococcus* var. *macrococcus*, *Cenchrus agrimoniodes* var. *agrimoniodes*, *Flueggea neowawraea*, and *Hedyotis degeneri* var. *degeneri*. In order to protect the resources within Subunit II and alleviate ungulate pressure along the fence of Subunit I, a total of four snare groups have been installed. These groups have been very effective, removing 191 pigs since August 1998. There is also an ungulate control area that is adjacent to the Kahanahāiki MU where snares and aerial hunting have been successful at removing 202 animals (120 goats and 82 pigs). One LCTA plot, 716, located in Subunit II, has received only moderate and infrequent weed control and is more representative of the impacts of ungulate management. It is discussed below.

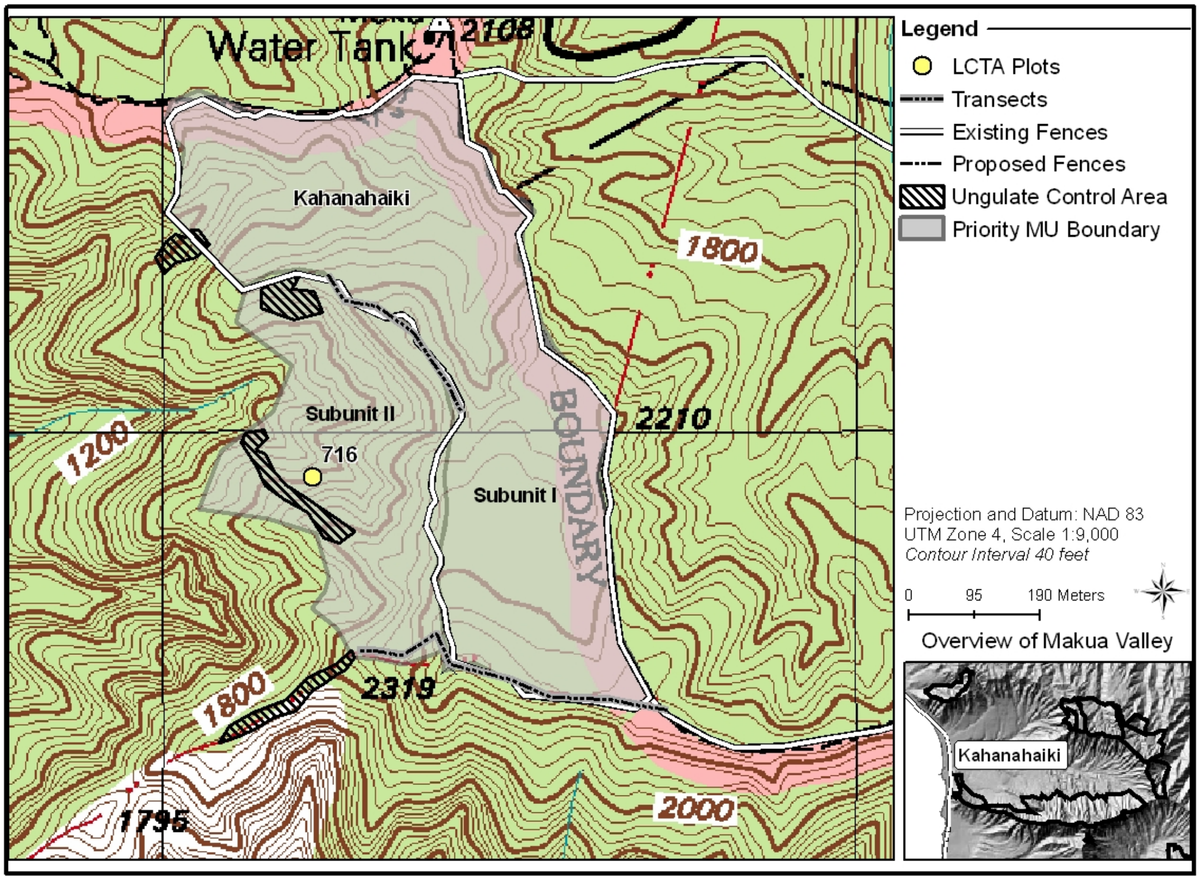


Figure 1.6 Kahanahāiki MU

Monitoring

Plot 716

This plot showed no significant change non-native species' mean interception (χ) (p=0.5664) however native species' mean interception did vary significantly from year to year (p=0.0003). There is no clear pattern in either the native or non-native species changes over time however the non-natives seem to be gradually increasing. The data from all years for native species is highly variable, in 1996 χ=2.97±1.6, 1999 χ=4.47±2.7, 2003 χ=2.84±1.6 and 2006 χ=3.32±2.1. This area is not ungulate free and feral pigs are regularly caught in the area. The variation observed in this plot could be a result of variable precipitation, grazing pressure or other stochastic processes not directly measured. There have been no recent weed control efforts in this area. One species, the native tree *Diospyros hillebrandii,* showed significant variation among years but again there was no clear pattern. The variation for this species' mean interception is very similar to that described above for all native species and may be responsible in large part for driving that difference. It is interesting to note that no native fern has ever been detected in this plot indicating that this group has very low cover in the area likely due to continued disturbance by pigs. It is unclear if additional weed control efforts would make a large difference in the community structure in this area without also removing the pigs.

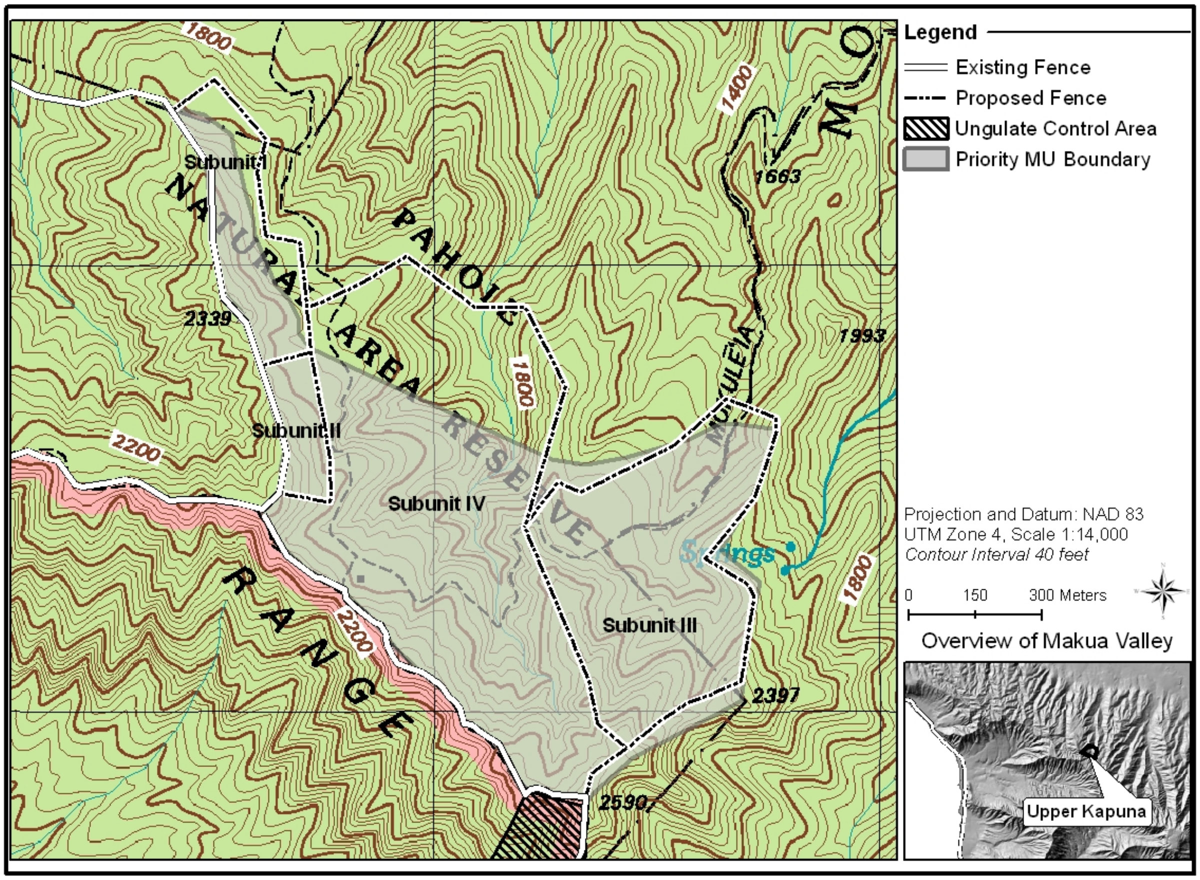


Figure 1.7 Upper Kapuna MU

Upper Kapuna MU

Originally the Kapuna MU was planned to be built as two subunits. Due to the increased cost of fencing contracts, NARS staff opted to alter the proposed subunits into four subunits (Figure 1.7). The NARS has funding to construct subunits I, II, most of III, and just recently secured funding for IV. In early 2006, NRS assisted NARS staff with fence line clearing and fence line scoping for Subunits I, II, and III and construction has begun. NRS has committed to complete the construction of subunit III and assist with any of the other units as needed.

West Makaleha MU

Two small PU fences were constructed to protect populations of *Cyanea grimesiana* subsp. *obatae* and *Schiedea obovata* prior to the construction of the MU fence (Figure 1.8). Completion of the MU perimeter fence is slated for Year 4 of the MIP. In the meantime, NRS and NARS staff try to control ungulate damage around the MU by reducing population numbers. From October 2004 – August 2006 NRS worked closely with NARS staff to remove a resident herd of feral goats from the boundary ridge of the Pahole NAR. To date, a total of 19 animals have been removed and the remaining six animals are believed to have moved onto a neighboring ranch. Close monitoring of this area will continue because the goats have been known to travel back and forth from the ranch to state lands. This goat population is critical to eliminate as it poses a serious threat to Pahole NAR. Currently, the Upper Kapuna MU fence materials are only 42” which is not tall enough to deter goats from jumping over if stressed.

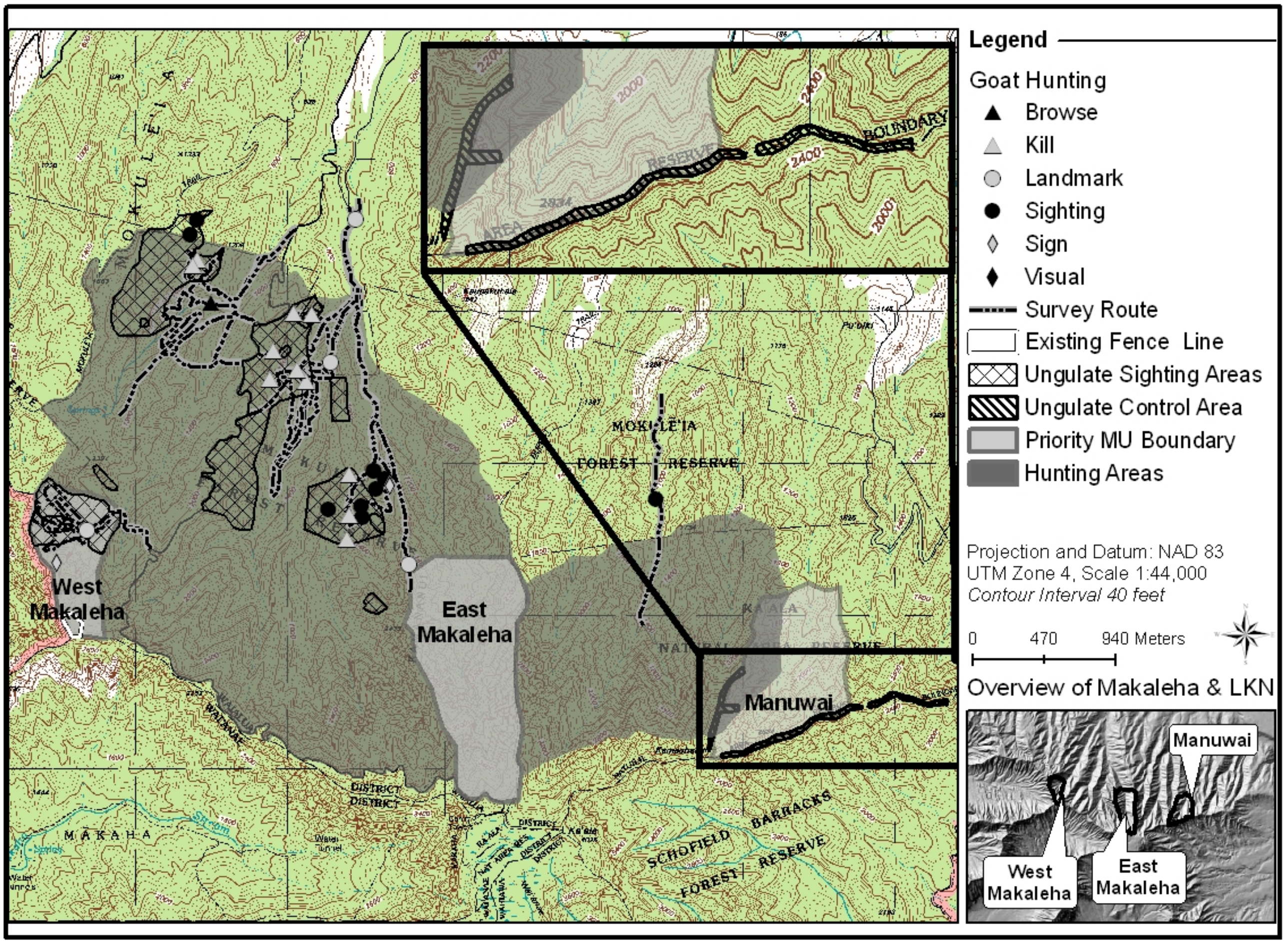


Figure 1.8 East and West Makaleha and Manuwai MU's

East Makaleha MU

A 230 acre MU fence is slated for construction in Year 4 of the MIP (Figure 1.8). An EA and approval from DLNR must first be secured. In the meantime, to lessen the impacts of feral ungulates on the target species of the MU, limited hunting is underway in Central and East Makaleha and Lower Ka'ala NAR (LKN). Central Makaleha and LKN directly border on the East Makaleha MU to the West and East respectively. Observations by NRS and NARS staff indicate that goat herds travel back and forth between all of the areas. All hunting efforts are directed by and done in cooperation with NARS staff. Since 2000, a total of 240 animals have been removed from the LKN. Since October 2004, 35 goats have been removed from Central and East Makaleha. In the past, NRS and NARS focused more effort on scoping for ungulates in these areas to get an idea of the movements and composition of the herds. As a result of all this compiled data, NRS and NARS have been doing more control hunts. These areas continue to pose a major challenge for control work as the herds are quite small and discreet. These herds also have a tendency to spend more time down in the forest, as opposed to the more open ridge tops, which is more typical behavior. NRS plan to continue working with NARS staff doing control hunts in these areas to keep populations in check. NRS has recently contacted DOFAW about the possibility of doing alternative methods of control in this area (radio/GPS collars). The data on goat movements in these area's will help NRS plan hunt's accordingly.

Manuwai MU
A MU fence is slated for construction in Year 8 of the MIP. In the meantime, to lessen the impacts of feral ungulates on the target species of the MU, limited hunting is underway in LKN and a snare line is maintained by NRS along the border with Schofield Barracks West Range (SBW). All hunting efforts are directed by and done in cooperation with NARS staff. Since 2000, a total of 240 animals have been removed from the LKN (Figure 1.8). The snares have removed 74 goats but have not caught since September 2004. Since September 2005, only nine goats have been removed through hunting because NRS was awaiting a permit to continue management in all of the NAR. A three day hunt is scheduled for October 2006.

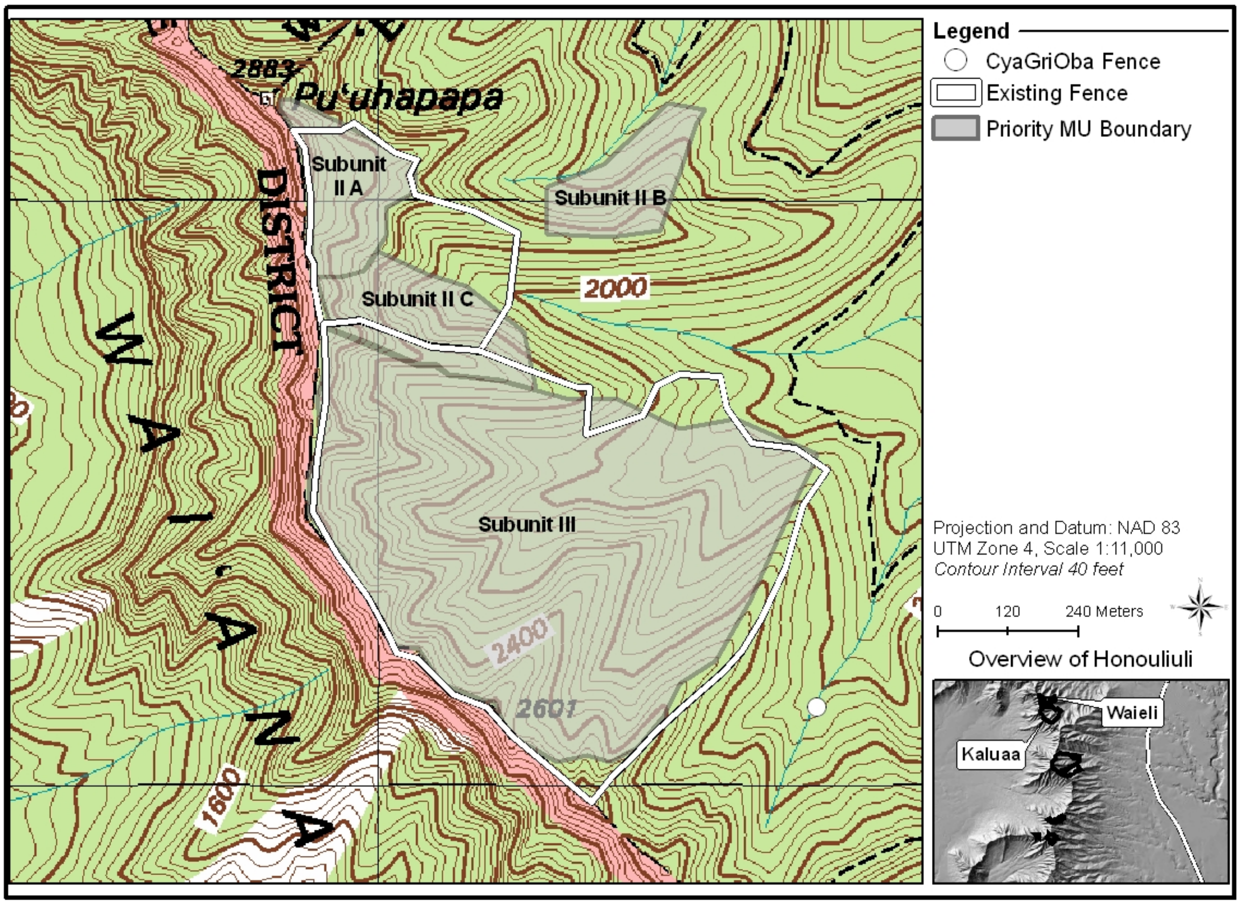


Figure 1.9 Kalua'a and Wai'eli MU

Kalua'a and Wai'eli MUs
Subunit III was completely fenced by TNC in 2001 and is ungulate free (Figure 1.9). In May 2004, a small PU fence was constructed around a single *Cyanea grimesiana* subsp. *obatae* along the stream bank of South Kalua'a gulch. Subunits II A and C were completed in December 2005 as a combined unit and is pig free. TNC staff and volunteers conduct ungulate control in the area outside the fence to ease pressure on the fence from feral pigs. Subunit II B is slated for construction for Year 10.

‘Ēkahanui MU

The Nature Conservancy of Hawaii (TNC) completed the Subunit I fence in 1999. Construction of Subunit II is set to begin in November 2006. The EA has been completed, the line has been scoped, and clearing has begun. This new perimeter fence will encompass about 159 acres (Figure 1.10). Both NRS and TNC staff conduct fence maintenance. There is some public hunting that occurs outside the fenced subunit but it is unknown how effective this is at reducing feral pig impacts on other target taxa. There is a population of goats located in the Lualualei Naval Magazine from the Pu‘u Kaua area. This is believed to be the last population located in the Southern Wai‘anaes. NRS is currently working with the Navy on gaining permission to do a scoping/hunting trip in this area to assess the current state of the goat population at this location.

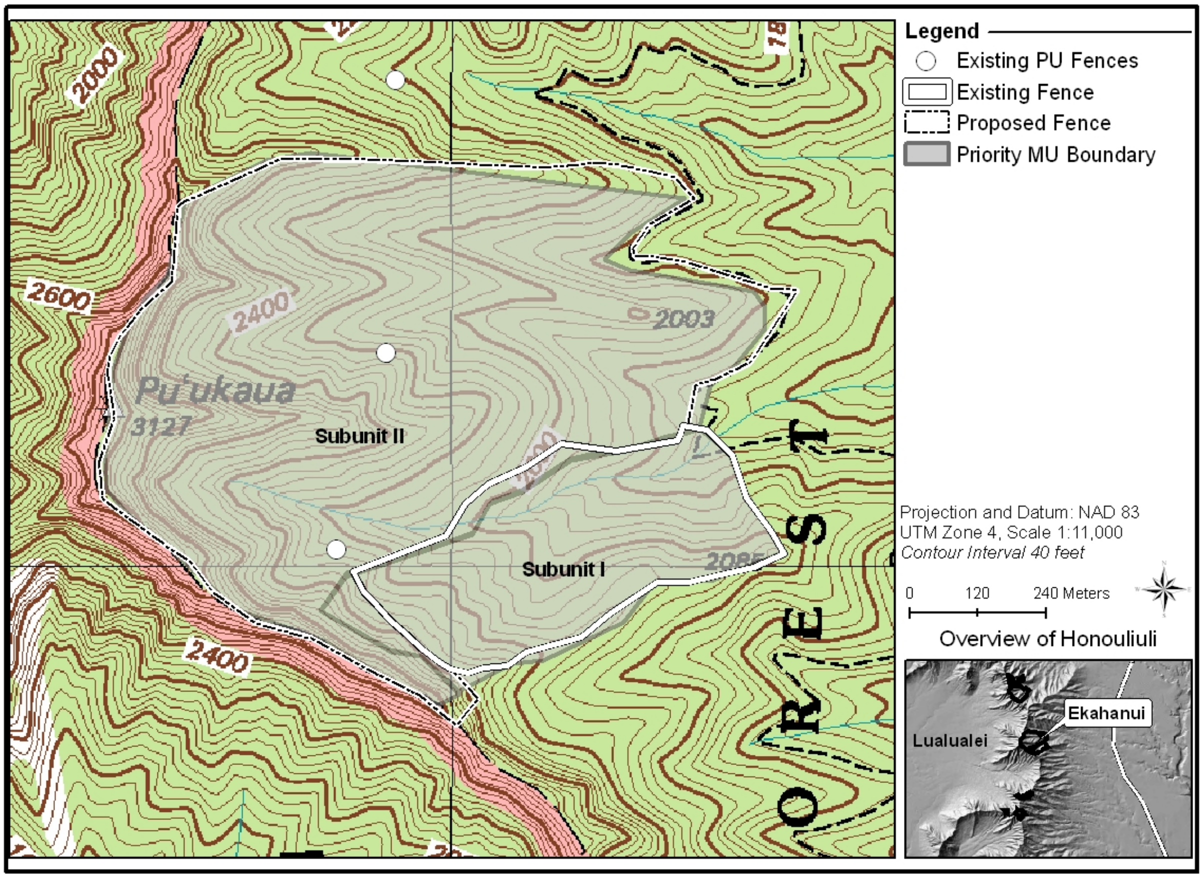


Figure 1.10 ‘Ēkahanui MU

Palikea MU

A small PU fence has been completed around a population of *Cyanea grimesiana* subsp. *obatae* in Subunit I A. Several PU fences were built in Palawai gulch during 2003 and 2004 to protect *H. arbuscula* and *D. subcordata*. Both Subunits I A (21 acres) and I B (11 acres) were slated for construction in Year 5 but with the reduction in active management by TNC staff in the Honouliuli Preserve forthcoming there is a perceived urgency to complete as many of the fences as possible before 2008. At this time, the EA is completed for all the proposed fences but accurate routes have yet to be determined (Figure 1.9). NRS shall determine the route for Subunit I A in late 2006 or early 2007 and begin clearing the line in order to expedite the construction of the fence. TNC staff are controlling pig populations until fences can be built. At this time, there is no data to show whether the reduction in pig sign equals an increase in either PU sizes or MU native vegetation cover.

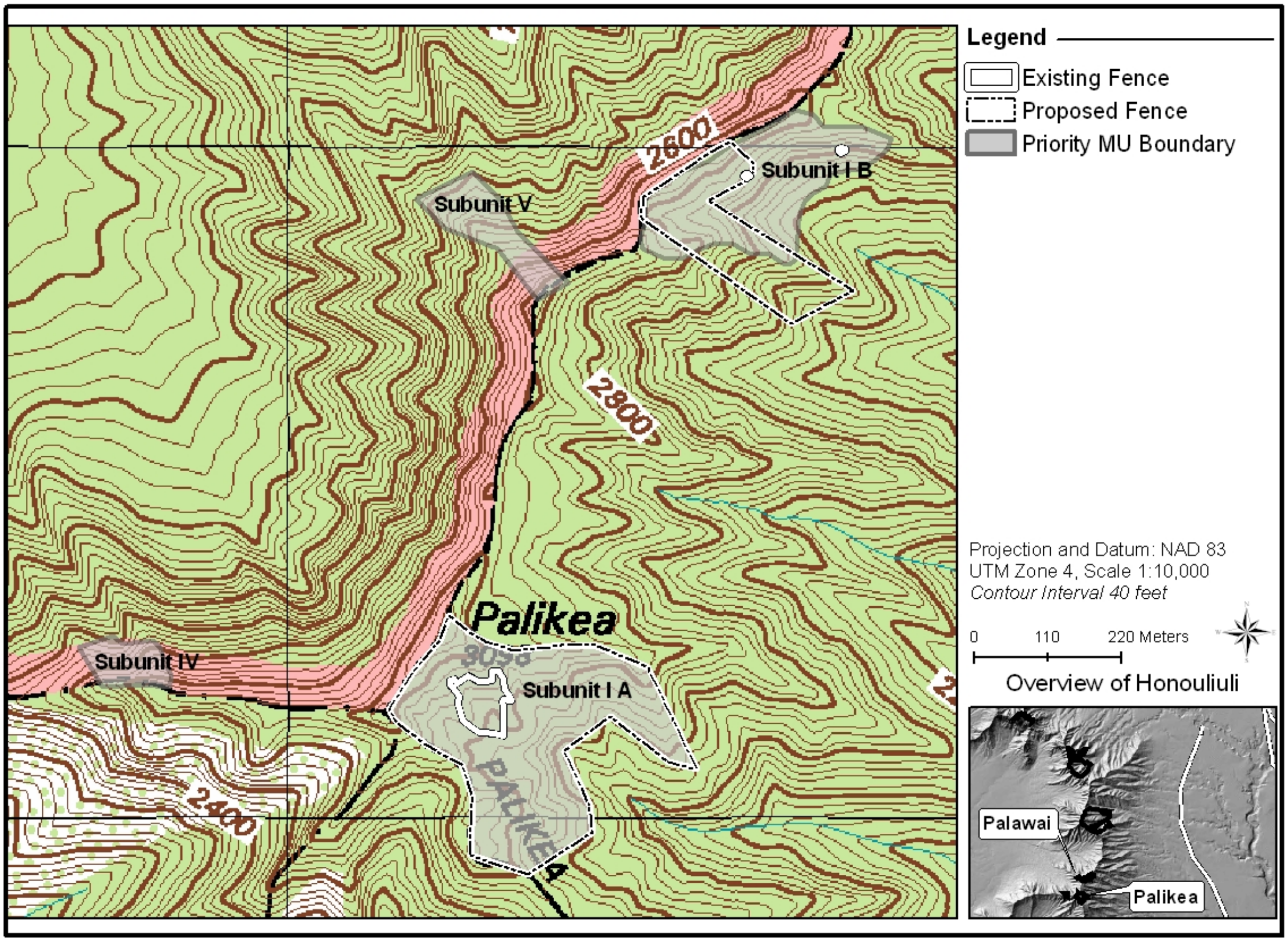


Figure 1.11 Palikea MU

Kaimuhole MU

A 100 acre fence was proposed for construction in year 6 of the MIP. At this time, Dole Food Company, Inc. leases the land to a rancher and because the land is leased to another party they are uninterested in entering into any management agreement with the Army to construct a fence or do any kind of management at all. Thus, the Army will need to work with the MIT to determine another suitable site to manage *H. brackenridgei* ssp. *mokuleianus* (see Chapter 3).

Lower ‘Ōpae‘ula MU

A 17 acre MU fence is proposed to protect a population of *Cyrtandra dentata* and will include several OIP species in the mid-elevation Ko‘olau Mountains (Figure 1.12). This fenced was proposed to be built in Year 1 of the MIP. In the past, NRS used snares to reduce feral pig populations in the MU, but hunters complained so ungulate management was halted until something could be worked out with the landowner. In order to come up with publicly acceptable method to control feral pig populations, the Ko‘olau Mountains Watershed Partnership (KMWP) has created a hunter liaison position to escort hunters into selected areas.

As a way to assess the effectiveness of this method, KMWP is working with the Army to gain access into the portion of Kawailoa Training Area (KLOA) above Waimea Falls Park, which is owned by The Audubon Society. In the future, both NRS and KMWP staff feel that this hunting program would be very beneficial to other areas within KLOA that are owned by Kamehameha Schools if the Army can get permission from the landowner.

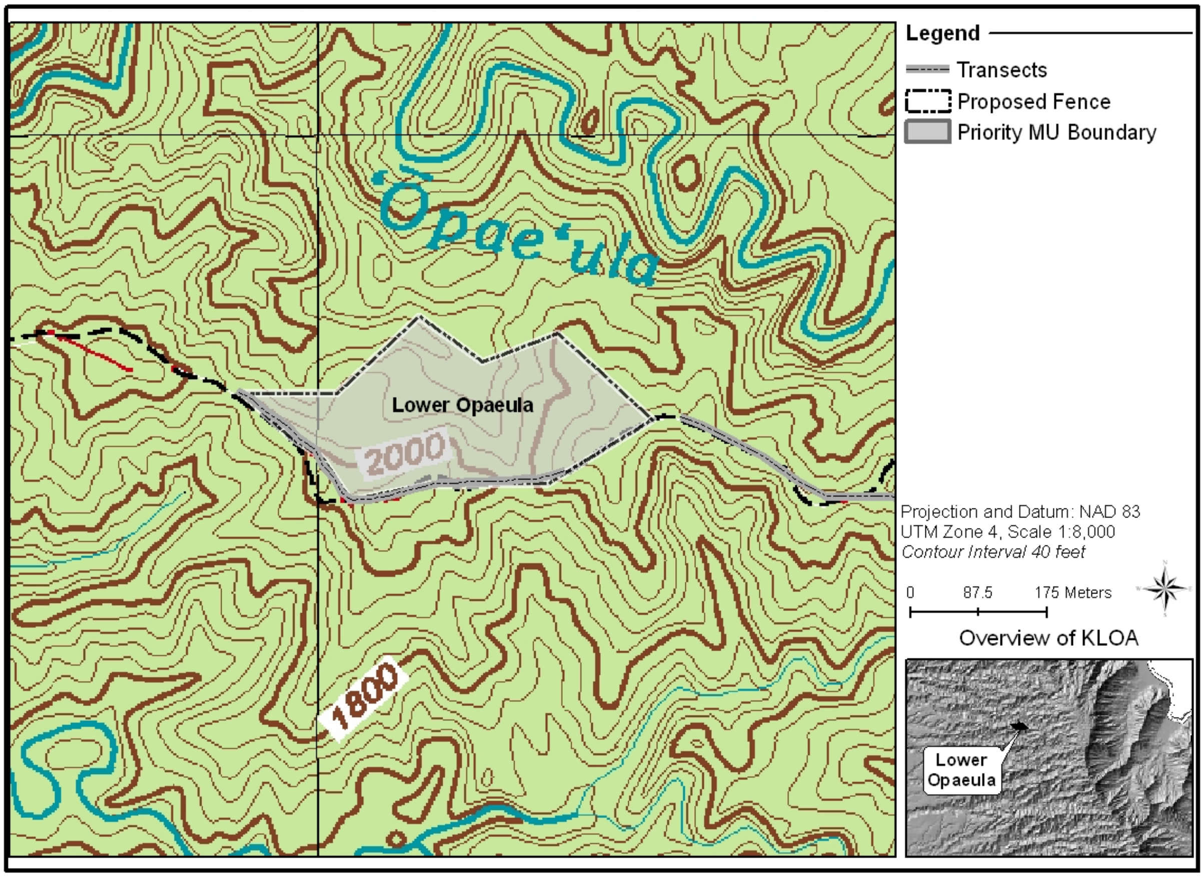


Figure 1.12 Lower ‘Ōpae‘ula

OIP Ungulate Control Discussion

Helemano MU

The Helemano fenceline will be adjacent to the existing ‘Ōpae‘ula MU fenceline. This fenceline will enclose another 175 acres. Construction began in June 2006 and should be completed by November 2006. Federally listed endangered species protected by the ‘Ōpae‘ula /Helemano fencelines include: *Achatinella lila*, *A. sowerbyana*, *Chamaesyce rockii*, *Cyanea koolauensis*, *C. st.-johnii*, *Cyrtandra viridiflora*, *Phyllostegia hirsuta*, and *Viola oahuensis*. Other rare species within the existing and soon to be built fenceline include: *Arachnoides insularis*, *Anoectochilis sandvicensis, Cyanea calycina, C. humboldtiana*, *Joinvellia ascendens* subspecies *ascendens*, *Lobelia gaudichaudii* subspecies *gaudichaudii*, and *Zanthoxylum oahuensis*.

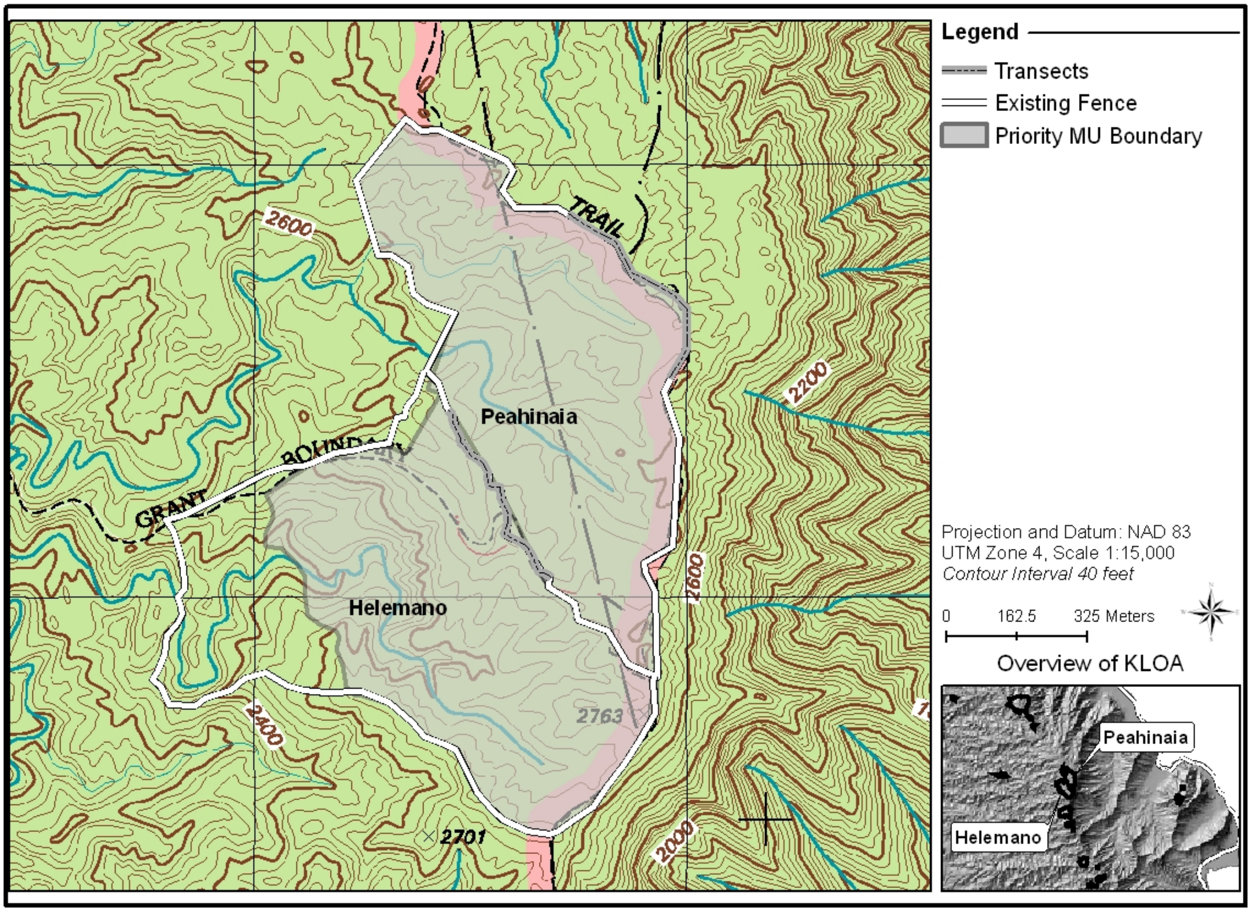


Figure 1.13 Peahinaiʻa & Helemano

Chapter 2.1: MIP Weed Management

Introduced plant species (weeds) threaten endangered species and native ecosystems by altering habitat and disrupting community structure. Weedy species out-compete native plants for light, space and nutrients. NRS has been conducting weed control on Army land for ten years, and the level of this weed control has increased dramatically over the years, especially with the execution of the MIP.

Explanation of Weed Control Reporting Format

Reporting format was revised to better reflect MIP requirements. First, Makua Section 7 requirements are discussed. Weed actions and relevant discussions are separated into three sections: Survey Report, Incipient Weed Report, and Management Unit (MU) Weed Control Area (WCA) Report.

Notes on Partners

The scope of the MIP necessitates NRS coordination with other agencies. Weed control efforts on land not controlled by the Army are made possible only by the support of the various offsite land owners. Primary partner agencies include The Nature Conservancy (TNC), Plant Extinction Prevention (PEP) staff, Kamehameha Schools (KS), the Board of Water Supply (BWS), and various State of Hawaii agencies, including Natural Area Reserves System (NARS), State Forest Reserves, and State Parks. NRS rely on partner agencies for guidance on the locations of weed control areas as well as types of weed control projects. In particular, NRS work closely with TNC staff to supplement weed control efforts they already conduct throughout the Honouliuli preserve. Hours spent weeding and area weeded by TNC staff are not reported in this document, however both are very valuable in achieving MIP goals and should be considered as such. In general, NRS again expanded the scope of weed control projects across all Management Units. However, negotiations with the State to finalize an MOU limited NRS access to State lands from October 2005 to April 2006. No weed control was done on state lands during this time.

Notes on Database

In the past year, NRS expanded efforts to standardize reporting of weed control data for future analysis by developing a database. The Weed Database tracks all weed related data, including surveys, Incipient Control Area (ICA) information, and WCA information. In particular, it organizes field data including weeding effort, pesticide use, field observations, and information gathered by the monitoring program. Improving monitoring and tracking of weed control efforts will help NRS to ensure efficiency and to direct future weed control actions. Almost all tables included in this chapter were generated using the Weed Database.

Mākua Section 7 Weed Management Overview

In preparation of this section, NRS reviewed existing documents related to Mākua Section 7 consultations including the Makua Biological Assessment (BA), the Makua Mitigation/Stabilization Plan, the Makua Biological Opinion, the MIP and Addendum. None of these documents specify in a detailed manner the Army's weed control requirements but rather outline important areas related to weeds. These areas are: (1) Prevention of Weed Spread, (2) Surveys to detect new weeds before they become established, (3) Prioritization of weed control areas and projects, (4) Monitoring of MIP related weed control, and (5) Research.

1. Prevention of Weed Spread

One of the two main threats from military training at Mākua as outlined in the Army's BA was the introduction of weed species. This threat was not only related to inadvertent weed transport between Hawaiian Islands but also from locations beyond Hawai'i. The BA emphasized troop education as an important tool in reducing the number of introductions each year. NRS have prepared educational brochures and have briefed troops upon request regarding this issue, but need to do more. NRS have made great strides in educating support staff working for the Garrison, such as the Range Division road crews, Integrated Training Area Management (ITAM) crew, and contracted road improvement crews, in order to minimize weed spread due to road construction and maintenance. Please see Figures 2.1.1-2.1.3, for examples of media used in briefings. However, this year, staffing changes at ITAM resulted in decreased communication between NRS and ITAM. NRS will seek to reinstitute quarterly meetings to discuss concerns about weed spread between and within training areas. In addition, NRS surveyed the gravel quarry site for noxious pests and no invasive weeds were found. This gravel is being used for Transformation road improvements. In the coming year, NRS plan to review contractor hydromulch and seed use to ensure invasive weeds are not used, continue educational briefings for road crews, and seek out other educational avenues for troops.

Figure 2.1.1 ITAM training card cover.

Arthrostema, *Arthrostema ciliatum*

Incipient Invasive

Known From: KTA, SBE, KLOA.

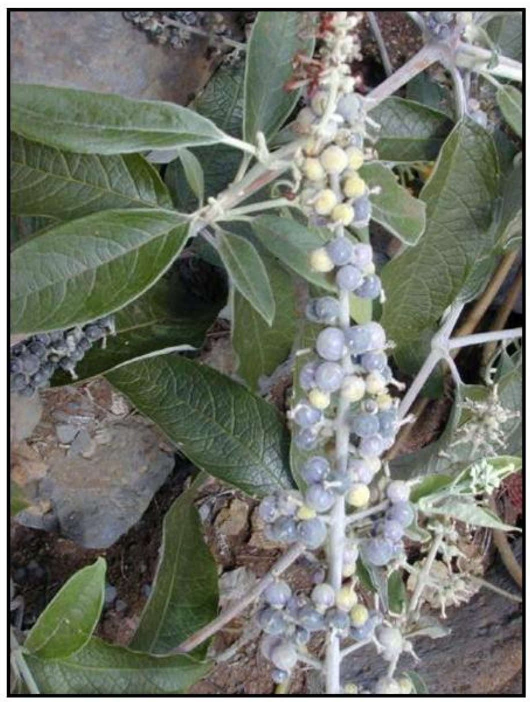
Notify Natural Resources if Find: KLOA

Natural Resources Office: 656-7641

Smoke Bush, *Buddleia madagascariensis*

Incipient Invasive

Known From: SBE. Notify Natural Resources if Find: All Ranges



Figures 2.1.2-2.1.3 Invasive species identification cards.

Mākua related section 7 documents also emphasized gear cleaning infrastructure and procedures for military personnel. This is a weak area for our program and needs improvement. NRS have identified a number of weed species at Army training areas on O‘ahu which may have originated at Pohakuloa Training Area (PTA) on Hawai‘i Island. Many of these introductions may have been prevented if proper cleaning procedures were implemented at PTA. There is a wash rack at PTA for cleaning vehicles, and it is mandated for use prior to shipping vehicles back to O‘ahu. There is a Standard Operating Procedure (SOP) dictating sanitation protocols that the troops are required to follow. This year, the PTA Colonel reissued this SOP at NRS request. A wash rack was recently completed at Schofield Barracks East Range (SBE). It is used primarily by Stryker units training in SBE. The wash rack is well-used, and NRS will seek to ensure that this continues into the future. NRS are pursuing the addition of a settling basin, and in the meantime monitor the site for invasive species. With NRS help, ITAM updated their soldier cards and created posters for the wash racks outlining incipient weed concerns.

In order to reduce weed spread by NRS personnel, NRS have instituted several sanitation policies, described below. Awareness of possible weed problems is the best defense. NRS thinks critically about all field activities and their consequences.

- *Growing and planting.* All plants grown and planted are done so in accordance with MIP sanitization protocols. Sterile media is used to grow all plants and one inch of top soil is removed from plants before outplanting to prevent weed transport.
- *Vehicles.* All vehicles are washed and vacuumed at the end of the week. If a vehicle goes to a site known to have particularly invasive weeds, it is washed at the end of the day. An example of such a site is KTA, which receives heavy military use and is home to a number of habitat-altering invasive weeds.
- *Footwear.* NRS footwear is washed at the end of each work day. Each NRS has two sets of tabis, one dedicated for Wai‘anae and one for Ko‘olau Mountain work.
- *Fencing.* Fencing gear, including panels, posts, and fence rolls, are stored in a weed free storage area until needed. Fencing material is not recycled between management areas.
- *Helicopter operation materials.* Sling nets, straps and swivels are washed whenever they appear dirty. NRS evaluate each Landing Zone (LZ) based on the LZ weed list, and have identified LZs with weeds of concern. They include ‘Ōhikilolo, Ka`ala, and Palikea. After use at these sites, sling nets are washed.
- *Rat bait.* NRS use Ramik, a brand of rat bait that is not formulated with seeds, but rather with cracked corn, milled grain, and wax. None of these components are a potential source of weeds.
- *Personal gear.* NRS frequently wash backpacks, and other personal gear vectors to prevent spreading weeds. NRS avoid setting gear on incipient invasive taxa.

2. Surveys to detect new weeds before they become established

Regular surveys along potential military introduction corridors were identified as important in all Mākua Section 7 related documents. One of the greatest potentials for weed spread by the military is via vehicles along roads. The large vehicles and machinery used for training, and training support, such as road maintenance, are vectors for weed dispersal within and between ranges. NRS survey roads used most frequently by the military and also by NRS, to observe the distribution of weeds within training ranges. This allows NRS to detect and eradicate new weeds, therefore preventing them from becoming established in those ranges. NRS have been conducting road surveys on Army installations for more than five years, and occasionally add new roads to ensure that areas with military use are well surveyed. Offsite roads near MUs are also surveyed. These roads may be used primarily by NRS or by other users, including agricultural lessees. This year, NRS added three offsite roads surveys: Ka‘ena and Makaha (discussed in MIP Survey Report), and Ka‘ala (discussed in OIP Survey Report).

Weed surveys are conducted on LZs for the same reason that they are conducted on roads: military and NRS helicopters serve as vectors for weed spread. NRS conduct surveys on LZs used heavily by military helicopters and at all small NRS LZs when used.

Weed surveys are also conducted along ungulate transects. These transects are generally located along fence lines or major ridges. Pigs and goats are a dispersal vector, and fences are corridors along which vectors like pigs and humans can move. NRS track weed presence along these transects to have a basic understanding of weed distribution. Since ungulate transects are generally monitored quarterly, it is convenient to monitor weeds at the same time along these heavily trafficked corridors.

To combat especially invasive species, NRS perform helicopter surveys to identify the extent of infestations that cannot be mapped from the ground. While performing aerial surveys, a GPS is used to map individual plants. These maps direct plant removal on the ground and greatly facilitate navigation to outlying targets. Detailed information about specific aerial surveys can be found in the MU discussions where these weeds are found.

Unidentifiable taxa are sent to Bishop Museum for identification. Upon identification, survey lists are updated to include these plants, and NRS research the significance of the presence and or spread of this weed. If the weed is incipient, or considered problematic, NRS will work to control it in the same manner as all incipient weeds occurring in MUs. Otherwise, weeds that are new to the survey and are not considered problematic are added to the list, thus tracking the spread of common weeds into new areas.

All survey data is entered into the Weed Database. The database can detect and search for new taxa on a particular survey, and can generate lists of the first observation date for any taxon at any survey location. All data from previous years is in the process of being entered into the database, creating a huge dataset.

3. Prioritization of weed control areas and projects

All the Mākua documents reviewed simply emphasize that weed control projects should be prioritized and plans developed in order to ensure that the projects with the most conservation value begin first. NRS prioritize incipient projects and WCAs containing ‘Manage for Stability’ PUs.

Incipient Weeds

Priorities for incipient weeds are determined based on the extent of the weed, severity of the weed’s potential impact if established, and control possibilities in terms of staff time required and control techniques. The MIP goal for incipient weed control is “total removal”. All incipient weeds controlled by NRS are discussed in the Incipient Weed Report. This year, NRS discuss the results of control by species, rather than area. Each site for each species is defined as an Incipient Control Area, or ICA. ICAs were intentionally drawn to encompass small geographic areas, to better track control efforts, declining plant counts, and eradication potential. Maps of target weed taxa and ICAs are included in the Incipient Weed Report.

NRS reviewed Appendix 3.1, *Priority Weeds for Selected Management Units,* from the Final MIP dated May 2003. In this table, weeds were ranked to express the extent of their distribution by MU. This year NRS reviewed each weed believed to be incipient/targeted for eradication (assigned a number "one" in the table). For a number of taxa, additional information has led to a change in status. For some, the weed management code as referenced in MIP Appendix 3.1 changed because they were found to be more abundant than previously thought and total removal is no longer feasible. In other cases, NRS resurrected particular weed taxa as their threat to rare plant PUs were clarified. Taxa reported as widespread last year are not reported on this year.

A summary of the weeds still believed to be high threats can be found below (Table 2.1.1). The specific sites and or distributions of many of the weeds are still being clarified by NRS. This is mostly the case on offsite areas, where NRS have not seen the species because they have not yet been into the areas where they occur. Where current locations are unknown, NRS aim to work with land managers to determine the locations of all of these weeds, to assess their threat levels, and begin control of the species if determined incipient. Although NRS still strive to achieve a better understanding of the list of weeds in Table 2.1.1, NRS already target several incipient weed species, mostly on Army controlled land. Please refer to the Incipient Weed Report for detailed control discussion.

Table 2.1.1. Summary of Incipient Taxa in Management Units from Appendix 3.1 Final MIP

Management Unit	Incipient Taxa	Comments
ʻĒkahanui	*Chrysophyllum oliviforme*	Locally common, downlist to level 2.
	Dicliptera chinensis	Locations known. Will evaluate and consider control.
	Ficus macrophylla	Locally common, downlist to level 2.
	Heliocarpus popayanensis	Locations known. Will evaluate and consider control.
	Melaleuca quinquenervia	Locations known. Will target in the coming year.
	Pimenta dioica	Common in north and central ʻĒkahanui, downlist to level 2, target only in fence
	Schefflera actinophylla	Locations known. Will seek more info from Joel Lau, HBMPB.
	Sphaeropteris cooperi	Some locations known. Will control within fence.
Haili to Keālia	*Schefflera actinophylla*	Some individuals found. Will control in MU.
Kaʻena	*Agave sisalana*	Currently target within MU boundary. See Survey Report
Kaluakauila	*Casuarina glauca*	Currently targeted along fenceline only.
ʻŌhikilolo	*Aracauria columnaris*	Currently targeted. See Incipient Weed Report
	Axonopus fissifolius	Widespread, not target for control, downlist to level 2
	Morella faya	Treated in the past. Will monitor known sites.
Upper Kapuna	*Ehrharta stipoides*	Locations known. Will target in coming year.
	Rubus argutus	Several locations known and targeted. See Incipient Weed Report.
	Setaria palmifolia	Site controlled, presumed extirpated.
	Sphaeropteris cooperi	Widespread below MU. Will control only in course of regular management.
	Toona cilliata	Some locations known. Will target in coming year.
Kahanahāiki	*Acacia mearnsii*	Currently targeted. See Incipient Weed Report.
	Axonopus compressus	Location known. Treated in the past. Will work towards eradication this year.

	Casuarina glauca	Currently targeted. See Incipient Weed Report.
	Ehrharta stipoides	Currently targeted. See Incipient Weed Report.
	Pennisetum clandestinum	Location known (State land). Population not spreading; no seed produced. Work with State to determine level of control.
	Rubus argutus	Currently targeted. See Incipient Weed Report.
	Sphaeropteris cooperi	Currently targeted when seen. No matures seen for years.
	Triumfetta semitriloba	Currently targeted. See Incipient Weed Report.
Palikea	*Acacia mearnsii*	Locations known, and does not appear to be spreading. Downlist to level 2.
	Ficus macrophylla	Locations known. Work with TNC to determine level of control.
	Juniperus bermudiana	Locations unknown. TNC feels it is not present within the MU.
	Montanoa hibiscifolia	Locations known. Will work with TNC to determine control
	Schefflera actinophylla	Locations unknown. TNC feels it is not present within the MU
	Sphaeropteris cooperi	Locations known. Will work with TNC to determine control
	Toona ciliata	Locations unknown. TNC feels it is not present within the MU
West Makaleha	*Sphaeropteris cooperi*	Locations unknown. Work with State to determine level of control
Wai‘anae Kai	*Chrysophyllum oliviforme*	Locations unknown. Will target if deemed necessary
	Coffea arabica	Locally common, downlist to level 2.
	Fraxinum uhdei	Locally common, downlist to level 2.
	Pimenta dioica	Locally common, downlist to level 2.
	Rivina humilis	Locally common, downlist to level 2.
	Syzygium cumini	Locally common, downlist to level 2.
Kaluaa and Waieli	*Angiopteris evecta*	Known from South Central Kalua‘ā, 200m2 area. Will target.
	Ardisia elliptica	Locally common. TNC has controlled 3 acres.
	Mallotus philippensis	Found in Gulch 3 site C. Will map and control as deemed appropriate.
	Glycine wightii	Locally common, downlist to level 2.
	Schefflera actinophylla	Locations unknown. Work with TNC to determine level of control
Pahole	*Acacia mearnsii*	Currently targeted. See Incipient Weed Report.
	Angiopteris evecta	Location known by State. NRS will control.
	Axonopus compressus	Same site as Kahanahāiki location
	Ehrharta stipoides	Targeted at known sites. See Incipient Weed Report.
	Glycine wightii	Locations unknown. Work with State to determine level of control
	Passiflora suberosa	Will target in course of regular management, esp in Gulch 4.
	Rubus argutus	Locations unknown. Work with State to determine level of control
	Setaria palmifolia	Same as Upper Kapuna site.
	Sphaeropteris cooperi	Targeted by Kay Lynch of O‘ahu Trail and Mountain Club
	Toona ciliata	Some locations known. Will target in coming year.

NRS continue to participate in the Oahu Invasive Species Committee (OISC), attending strategy and prioritization meetings, sharing data, and coordinating effort on joint incipient control projects.

Management Unit Level Weed Control

For weed control projects on the MU level, priority setting criteria include the size of intact native habitats, the overlap of these with MIP PU locations or reintroduction sites, and the feasibility of the control project. The first attempt at this prioritization was made by the MIT when MU boundaries were outlined. During the MIP process, the most appropriate habitat was selected. In addition, the MIT screened habitat by landowner, only selecting MUs where land managers were supportive of MIP related management. Subsequently, the MIP Addendum streamlined the final MIP MU boundaries to remove very heavily degraded habitat and focus initial management on the three best populations per MIP taxon.

In addition to these broad-scale prioritization processes detailed above, NRS have broken up the MIP MUs into smaller units, or WCAs, where weed control has been conducted in the past or in areas that are a high priority for weed control in the future. These areas, in general, focus on ecosystem level weed control in addition to weed control conducted around MIP taxa. In most cases WCAs contain managed PUs and the native habitat surrounding those PUs. Weed control is easier to track over time within WCAs, as weed control issues are generally similar across a particular WCA. All WCA results are discussed in the MU WCA Report; weed control is organized by MU, and then by WCA. Most WCA boundaries are defined for ecosystem-level habitat improvement, but some are defined around fencelines and trails, and others are very small areas defined as a five meter radius around MIP taxa. The purpose of trail WCAs is to prevent weed spread to ecologically significant areas. Weed control in the five-meter WCAs is not likely to be expanded because often the areas are too degraded, and the goal for the MIP taxa is fruit production, rather than 'Manage for Stability'. The Weed Control Summary Tables in the MU WCA Report use six letter abbreviations for most weed and rare plant species. These abbreviations use the first three letters of a plant's genus and species. A list of these codes in their unabbreviated form can be found in Appendix V.

Table 2.1.2 summarizes the MIP MU weed control efforts in Year Two. Due to limitations on personnel, NRS has not been able to conduct weed control in all MUs and fully implement MIP weed control as planned. NRS chose to begin intense MU level weed control where there are exclosures or where ungulates are not considered a threat. Less weed control has been initiated outside exclosures. Also, it is essential that NRS acquire formal permission to conduct MIP management actions. Formal permission has not been granted for a number of sites which therefore are not weeded regularly.

Table 2.1.2. Makua IP Management Units: Weed Effort in Year Two

IP MU	WCA Total acres	Total Acres Covered	# of Visits	Effort (Person Hrs)
IP MU: Ekahanui	17.5	8.83	17	111.00
IP MU: Haili to Kealia	4.02	0.53	3	78.00
IP MU: Kaena	6.02	5.96	4	62.00
IP MU: Kahanahaiki	42.7	22.3	27	345.50
IP MU: Kaluaa and Waieli	32.8	12.4	21	224.50
IP MU: Kaluakauila	26.8	15.6	11	96.50
IP MU: Lower Ohikilolo	14.3	14.3	22	204.40
IP MU: Makaha	25.6	6.36	12	313.90
IP MU: Ohikilolo	167	34.5	30	299.25
IP MU: Pahole	23.5	2.69	10	83.50
IP MU: Palikea	9.99	4.16	15	46.75
IP MU: Puu Kumakalii	2.96	0.32	1	3.00
IP MU: Upper Kapuna	9.66	4.35	10	245.50
IP MU: Waianae Kai	2.40	1	2	21.50
IP MU: West Makaleha	6.61	2.44	5	25.00
Totals	392	136	190	2160.30

4. Monitoring of MIP related weed control

Monitoring is a priority in all documents related to the Mākua consultation and has special emphasis in the MIP. This currently is the area most in need of expansion and development by NRS. A Monitoring Program Manager (MPM) has been hired to oversee all monitoring related to the MIP. Thus far, weed monitoring has mainly been focused on weed control efficacy but not long-term impacts of our weed control on native habitat and rare species restoration. Photopoints have been used in the past as an informal means of monitoring trends. The monitoring program (NRS Monitoring) will incorporate tracking of weed control within the 50 meter buffer around PUs, along with weed control conducted across the rest of the MU outside of this area. The following is a list of high-priority weed monitoring issues:

- Review road survey protocol to determine if sufficient
- Monitor the long-term effects in different habitat types of understory and canopy weed control. Investigate overall impacts of weed control on native species and ecosystems. Use data to guide management frequency and approach.
- Determine the ‘best’ treatment for weed monocultures in varying habitat types.

Monitoring activities this past year have been focused on addressing long term efficacy of weeding and other management on increasing native species cover and limiting the establishment and spread of non-native species. The MPM began work in October 2005 and has since focused on familiarizing herself with the areas managed by NRS. During this year, NRS Monitoring has been revisiting Land Condition Trend Analysis (LCTA) plots that were established by the Army as early as 1996 to collect current data and evaluate the efficacy of this design to detect changes in the vegetation community caused by management actions. The plots were designed for Army Integrated Training Areas Management (ITAM) by the Center for Environmental Management of Military Lands (CEMML) at Colorado State University to reveal information relevant to training activities, such as tactical concealment and soil erosion. However, these plots represent the only dataset containing vegetation community structure information from areas managed by NRS and extending back in time to before significant management activities were undertaken. This makes the data potentially valuable as a baseline. Additionally, the plots have been revisited with some frequency (1-3 times) since their installation and that data has been gathered by the MPM to be used in a time series analysis to detect changes over time.

The records and data from these plots were not kept in any central location and were spotty at times. This led to some confusion about the methodology and resulted in data collection practices that did not exactly match those that were used in the past. The plot consists of a line transect of varied length from 25-100 m, and a belt extending perpendicular to that line of varied width from 1-3 m on each side. Along the line, point intercepts are recorded every 0.5 or 1 m using a range pole extended to 8.5 m in height. The plots were designed to be adaptable to different environments and several had been adapted from the standard plot design, further complicating the methodology. The point intercept data were recorded as hits per species within segments of the 8.5 m pole. The segments were every decimeter from 0-2 m height, and every 0.5 m beyond 2 m height. Initially, NRS thought that the decimeter segments were up to 1 m, and that each species intercepted in the segment was to be recorded. Upon conversing with the investigator who installed the plots in 1996, the MPM learned that they had only recorded the top most species interception in each segment. Since some plots had already been read with the incorrect method, NRS decided to continue collecting information on all species' interceptions within each of the segments and to evaluate the difference in the methods at a later time, presumably this coming winter, when several methods will be evaluated for design of the monitoring network plot.

These differences in the way the data were collected limit what conclusions can be drawn from these data at this time. In the future, NRS will revisit the plots and collect data exactly following the method which was used previously and do another comparison of all plots. Results presented in this document do not attempt to account for any bias introduced by the differing methodology, nor were any corrections made to the data. The 2006 data should have more interceptions overall due to the way the data was collected this year but this was not always the case. In any case, interpretations of these results must be made cautiously keeping these differences in mind.

Several LCTA plots are located in newly delineated WCA's and the results of each plot will be discussed in the relevant portion of the WCA section of the report. Three plots (702, 713 and 716) have not received significant weed control and were discussed in Chapter 1: Feral Ungulate Management. Figure 2.1.4 depicts the location of all the plots and Figure 2.1.5 shows all plots total native and non-native species interceptions. This is the sum of all encounters of all native species versus all non-native species for each plot for each date upon which it was read. In addition to considering the weed control actions that have taken place in the vicinity of each plot, there is some discussion of ungulate management that may have contributed to the results observed especially for those discussed above.

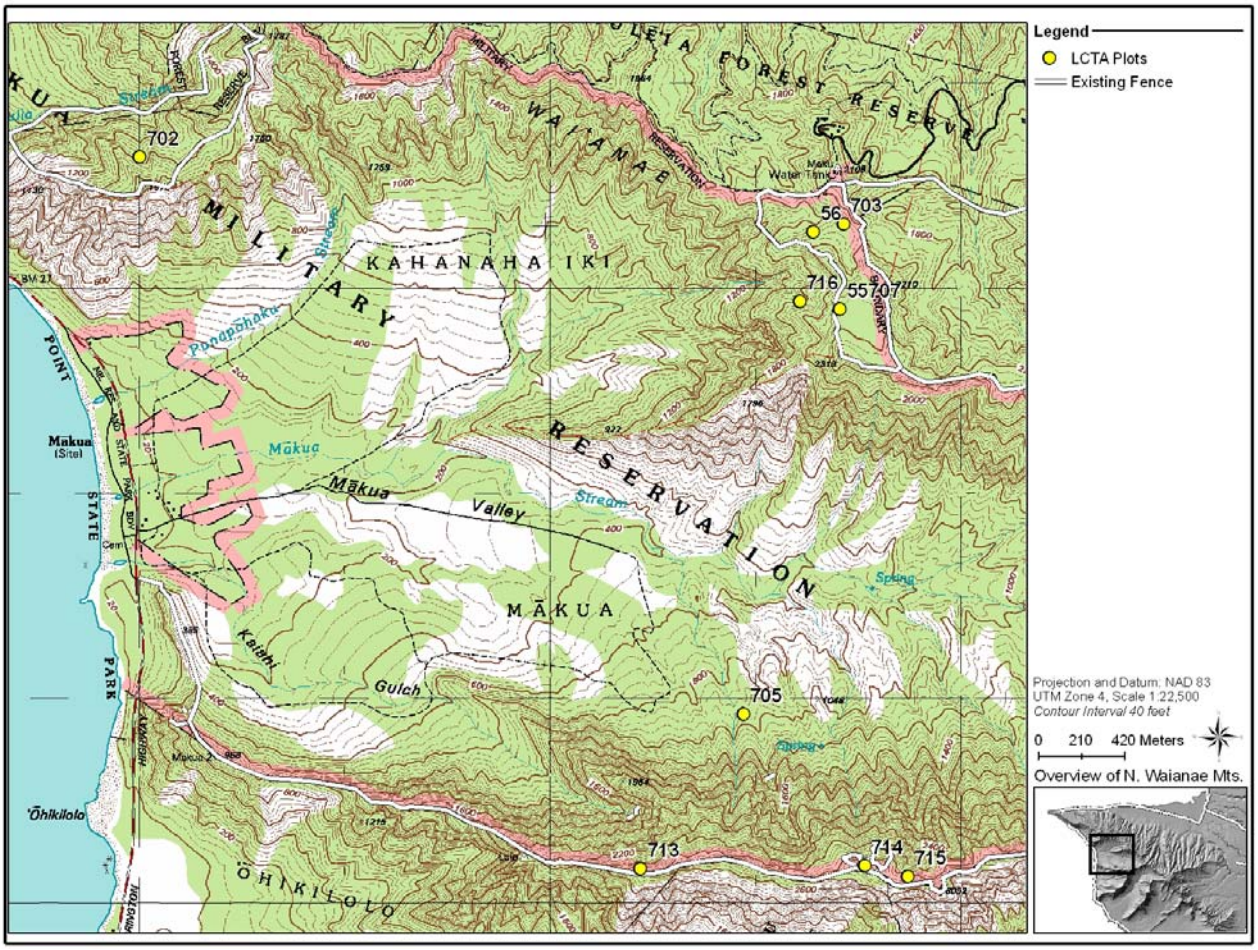


Figure 2.1.4: LCTA Plot Locations

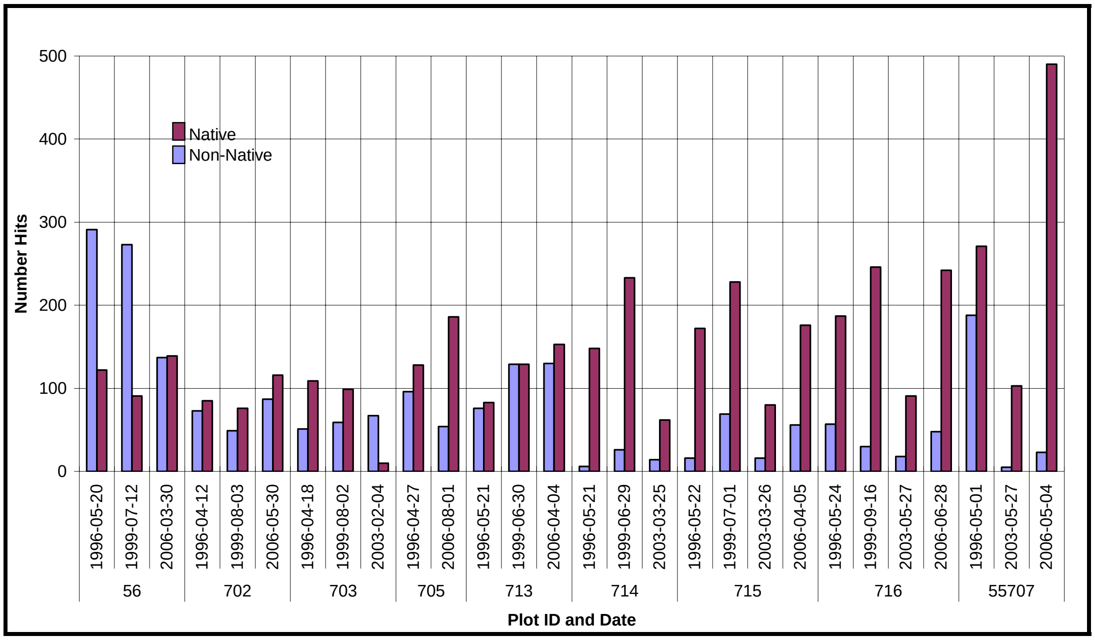


Figure 2.1.5: Sum of native and non-native species interceptions per plot per date

5. Research

There are a few research issues related to weed management. This year a Research Specialist was hired. Along with the Monitoring Program Manager, this person will advise NRS on methodology for testing new weed control techniques, seek out more interest in weed control related topics, and guide NRS in answering research questions. See Chapter 6 for a full account of this year's research activities. At the current time, the Propagule Management Specialist has just begun to look at the longevity of seed banks for incipient species; this will also help to guide management plans. In the future, NRS will identify other such projects and will strive to establish lines of communication with other agencies (especially on neighbor islands) so that findings can be shared between organizations.

Chapter 2.1: MIP Weed Management

Weed management actions are divided into three Reports: Survey, Incipient Weed, and Management Unit Weed Control Area. Only results from the past reporting year, Sept. 1, 2005 to Aug. 31, 2006 are discussed.

Survey Report

Surveys are conducted both on Army land and partner agency land (see Figures 2.1.6 and 2.1.7). Three types of surveys are conducted by NRS: road, landing zone, and transect. Transect survey results are discussed in the relevant discussion in the Management Unit Weed Control Area Report. Road and landing zone survey results are summarized in Tables 2.1.3 and 2.1.4, respectively, and discussed below.

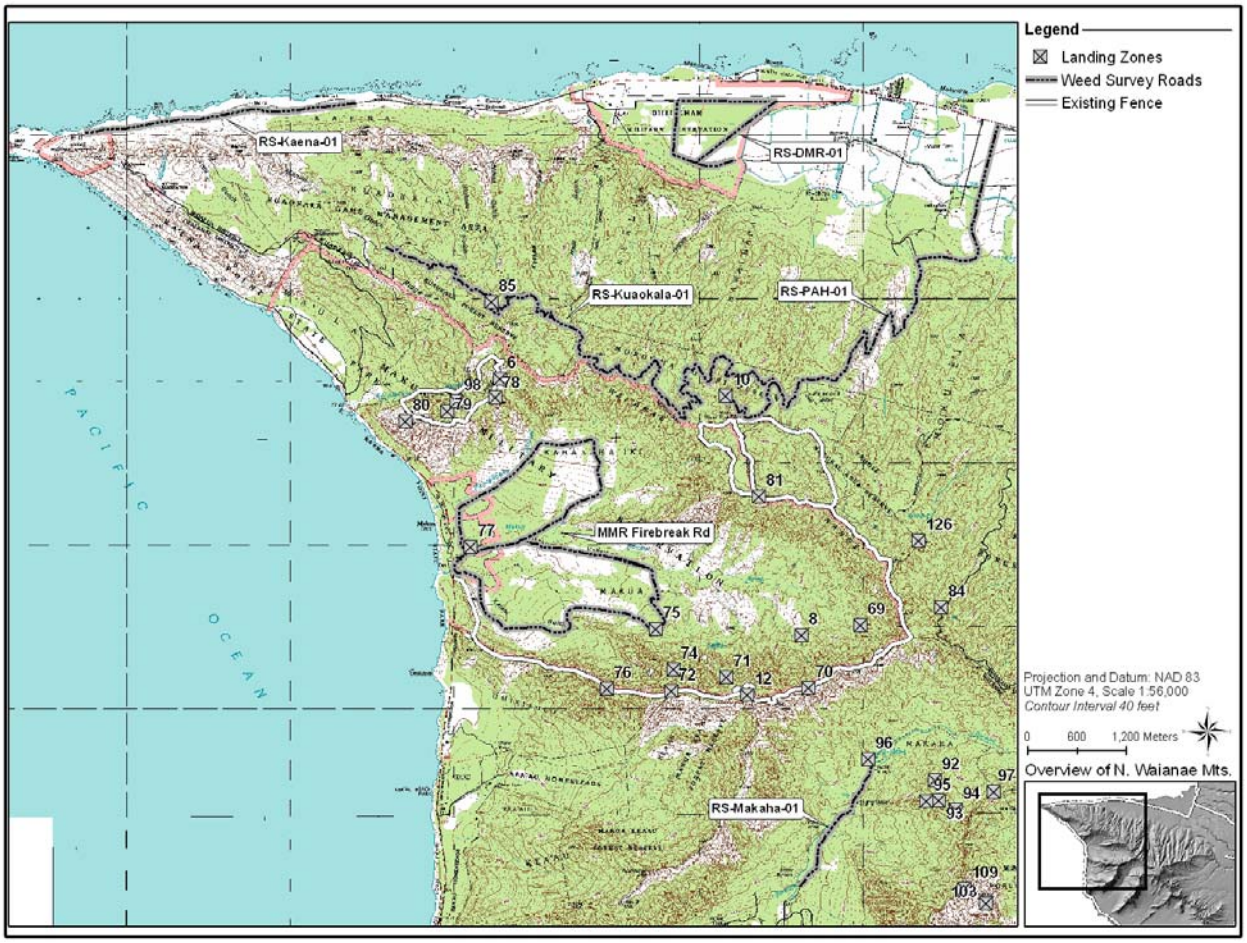


Figure 2.1.6: Northern Wai‘anae Surveys

Figure 2.1.7: Southern Wai'anae Surveys

The tables present results of all surveys done this year. The ‘First Survey Date’ column refers to the first date the survey was ever conducted by NRS. The ‘Significant Pest’ column refers only to significant weed pests found in the last year. Species are listed in the table as 6 letter codes; refer to Appendix V for a definition table for these codes. In some cases, the weed is determined not to be a threat, and no action is taken. In other cases, the weed is monitored and control postponed until the potential threat is better understood. In the remaining cases, the weed is determined to be a threat and control is implemented. An ICA is drawn around the infestation, and control efforts are reported in the Incipient Weed Report.

Road Survey Report

Road surveys are conducted once a year, usually in the first quarter of the year. Some of the surveys are conducted along roads used for military training, and some are conducted along roads used often by NRS. Two new surveys were added this year, Ka‘ena Point and Makaha. Several potential pests were found on these two surveys (see Table 2.1.3). At Ka‘ena, *Casuraina equisitifolia* and *Agave sisalana* were found. Neither is threatening enough to trigger control, but NRS will monitor both species and take action if either appears to begin naturalizing aggressively, or begins to threaten Kaena region MUs. At Makaha, two potential pests were found, *Ficus microcarpa* and *Sideroxylon persimile*. *Ficus microcarpa* is possibly well established in the lower portion of Makaha, and is known from very large trees. NRS will monitor the species and assess its spread into the rest of the valley. If active recruitment is seen near priority MUs, NRS will consider control. *Sideroxlyon persimile* is uncommon in the Wai‘anaes, but appears to have a small established population in the bottom of Makaha. Since it does not currently threaten priority MUs, NRS will recommend to the BWS Watershed Planner to survey the population to determine its extent and invasive potential. If control is deemed necessary, NRS will assist BWS. No new significant pests were found on any other road surveys.

Table 2.1.3: Road Survey Summary

SurveySiteCode	SurveySiteName	SiteLength (km)	Army/NRS Use	Significant New Pest Species
Property Name: Kaena Natural Area Reserve				
RS-KAENA-01	Kaena Point Road	3.477	NRS	AgaSis, CasEqu
Property Name: Kuaokala Forest Reserve				
RS-KUAOKA-01	Kuaokala Road	9.954	NRS	
Property Name: Makaha Valley				
RS-MAKAHA-01	Makaha Road	1.825	NRS	FicMic, SidPer
Property Name: Makua Military Reservation				
RS-MMR-01	Makua Firebreak Roads	12.118	Army and NRS	
Property Name: Pahole Natural Area Reserve				
RS-PAH-01	Pahole Road	8.081	NRS	

Landing Zone Survey Report

LZ surveys are generally conducted quarterly. Some LZs are used by Army aircraft only, and some are strictly used by NRS. If NRS LZs are not used in a given year, then no surveys are conducted at them. There are over 50 LZs associated with MIP actions, so NRS only survey those with the highest use. In the future, NRS plan to implement a policy of completing a survey every time an LZ is used; this will achieve a more consistent weed spread picture across management areas. One new significant weed, *Erharta stipoides* was discovered at the ‘Ōhikilolo campsite, LZ-MMR-12 (see Table 2.1.4). NRS are not sure how this highly invasive grass reached the remote ‘Ōhikilolo campsite, but it most likely was carried on NRS gear. NRS implemented an aggressive control plan for this infestion; it is discussed in detail in the Incipient Weed Report. NRS will strive to be increasingly vigilant about sanitation in the coming year. No other significant pests were found.

Table 2.1.4: Landing Zone Survey Summary

SurveySiteCode	SurveySiteName	SiteLength (km)	Army/NRS Use	Significant New Pest Species
Property Name: Makua Military Reservation				
LZ-MMR -72	Koiahi LZ		NRS	
LZ-MMR-12	Ohikilolo Camp LZ		NRS	EhrSti
LZ-MMR-70	Red Dirt LZ		NRS	
LZ-MMR-8	Lower Makua LZ		NRS	
LZ-MMR-98	Kaluakauila Lower Patch Camp LZ		NRS	

Incipient Weed Report

All incipient species and their general locations are summarized in Table 2.1.5 below. Figure 2.1.8 shows specific locations of each ICA. Discussion of incipient species control and status is arranged alphabetically by species. Control efforts are summarized in a table, and then discussed by ICA. While eradication may not be an option for every species across all managed lands, it is the goal for each ICA. In order to achieve this, NRS generally strive to visit ICAs quarterly.

Table 2.1.5: Overview of Incipient Taxa and ICA Distribution

Incipient Target	Management Unit (MU)	Number of ICAs
Acacia mearnsii	Kahanahāiki	2
Achyranthes aspera	Kahanahāiki	3
Araucaria columnaris	‘Ōhikilolo	1
Casuarina glauca	Kahanahāiki	1
Cirsium vulgare	‘Ōhikilolo	1
	Kaluakauila	1
Desmodium intortum	MMR no MU	1
Ehrharta stipoides	‘Ōhikilolo	1
	Pahole	2
Pennisetum setaceum	Lower ‘Ōhikilolo	1

Rubus argutus	Kahanahāiki	2
	‘Ōhikilolo	2
	Upper Kapuna	1
	MMR no MU	1
	Mokuleia Forest Reserve	1
Syzigium jambos	Kaluakauila	1
Tecoma capensis	Upper Kapuna	1
Triumfetta semitriloba	Kahanahāiki	5
	MMR no MU	1

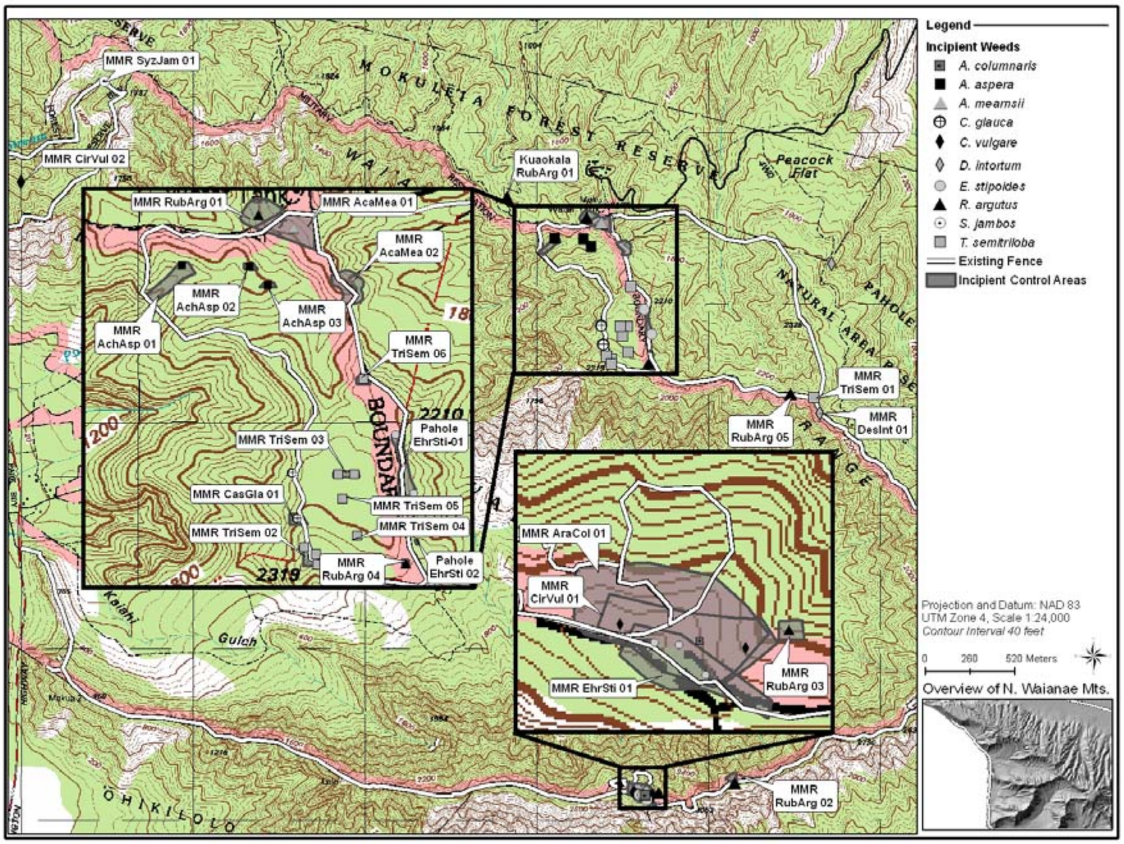


Figure 2.1.8: Locations of Incipient Weed Species in Makua Military Reservation

Incipient Species Control Discussion

Acacia mearnsii

The Pacific Islands Ecosystems at Risk (PIER) web site classifies this species as high risk due to the risk assessment score of 15. This high score was the result of a number of factors including a tendency for this species to form dense thickets, be fire tolerant, have prolific seed production, become naturalized in tropical or subtropical climates, etc. This species is already widespread in some areas of Oahu. However, NRS have targeted this species within MUs for the reasons listed above.

MMR-AcaMea-01; Kahanahaiki AcaMea

Acacia mearnsii is nearly non-existant in Kahanahāiki, and NRS feel that keeping it out of the MU is a high priority. This ICA is the core site for this incipient weed. NRS have been returning to this site for the past five years and pulling new seedlings found. In the coming year NRS will re-visit the site quarterly to survey for and eradicate all new seedlings and new trees found. It is possible that with constant pressure, *A. mearnsii* can be eradicated from the site, although it may be a while before the seedbank is completely exhausted.

MMR-AcaMea-02; Black Wattle by Schwepps trail/Pahole crossover

This ICA is made up of two outlier sites each with large mature trees. One site consisted of two trees and the other had only one tree, all of which were girdled with Garlon 4 at 20% dilution. NRS plan to revist the sites in the coming year and scope the areas for possible seedlings or other plants not seen on previous trips. It is highly possible that A. mearnsii can be completely eradicated from this ICA.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: AcaMea		**Acacia mearnsii**			
MMR-AcaMea-01	Kahanahaiki	1	1.00	2006-04-27	2005-05-03
MMR-AcaMea-02	Kahanahaiki	2	1.01	2006-04-27	2006-04-25

Achyranthes aspera

This species is of concern to NRS because it is incipient within the Kahanahāiki MU in MMR. It has a short lifecycle and is easily dispersed via a spine tipped bract on the seeds that can stick to clothing. For these reasons, NRS have a zero-tolerance for this species in Kahanahāiki. This taxon is found at several specific sites within the same small gulch. NRS visit the sites quarterly, and can manually pull all plants found within each location in a short time. Regular quarterly visits are important to prevent plants from maturing. It appears that eradication of this species from within the MU is a very attainable goal. With each visit, fewer and fewer immature plants and seedlings are found.

MMR-AchAsp-01; Kahanahāiki AchAsp Lowest

Since October 2005, two adult (the last being in April 2006), five immatures, and four seedlings plants have been found within approximately 1 acre. This is much improved compared to last year, when one adult, four immatures, and 120 seedlings were found. For 2006-2007, NRS will continue to visit the site at least quarterly and extend surveys out from the center of abundance in order to guarantee eradication.

MMR-AchAsp-02; Kahanahāiki AchAsp Middle

Since October 2005, only three seedlings were found. This is similar to the year before, when two immatures were found. This is a small area; approximately 0.1 acre. NRS will continue to monitor this site quarterly.

MMR-AchAsp-03; Kahanahāiki AchAsp Upper

No plants have been observed at this site since October 2005. The original site was only 0.08 acres so NRS are confident that this area has been thoroughly searched. NRS will continue to monitor this site quarterly over the next year. If no plants are seen, NRS may choose to monitor this site once a year or less because mature plants have not been seen at this site since May 2002.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: AchAsp		**Achyranthes aspera var. aspera**			
MMR-AchAsp-01	Kahanahaiki	4	3.50	2006-04-25	2006-05-23
MMR-AchAsp-02	Kahanahaiki	4	1.50	2002-05-13	2006-04-25
MMR-AchAsp-03	Kahanahaiki	4	1.50	2002-05-13	2003-06-24

Araucaria columnaris

NRS have targeted this species within MMR because it is incipient at ‘Ōhikilolo. *A. columnaris* often forms dense monocultures, and readily naturalizes. While common elsewhere on the island, it is not well-established on the ‘Ōhikilolo ridgeline. NRS are attempting to eradicate this taxon from this ICA and hope to eradicate all seedlings before they reach maturity.

MMR-AraCol-01; Norfolk Control at ‘Ōhikilolo Campsite

The only mature individual was killed several years ago. No weeding has been done in this ICA over the past year. However, in the course of sweeping overlapping WCAs, small numbers of *A. columnaris* have been killed. NRS plan to specifically sweep the area for *A. columnaris* once in the coming year. NRS also plan to research seed bed life of *A. columnaris*, to determine how long germination may be expected.

Casuarina glauca

Smith (1985) states: “this species is very similar to *C. equisetifolia*. However, it forms suckers prolifically, producing dense stands. It is the most aggressive ironwood in Hawaii.” This taxon also creates dense layers of duff and roots, which present a ready fuel source for fire. For these reasons this species is targeted by NRS in areas near relatively intact forest, such as the Kahanahāiki MU.

MMR-CasGla-01; Kahanahāiki Ironwood Removal

This ICA is located along the Mākua rim within Kahanahāiki MU and covers approximately ¼ acre. It stretches from the edge of the exclosure, down a ridge into MMR, and poses both an ecosystem and fire threat to populations of *Cenchrus agrimonioides* and *Achatinella mustelia* which abut it. NRS have been working to control this species in this ICA since 2002. This taxon spreads and matures slowly, and NRS have not weeded this ICA in the past year. NRS plan to sweep the area for resprouts and outliers once in the coming year.

Cirsium vulgare

This species received a score of 21 and a recommendation of ‘reject’ by the Hawaii Ecosystems At Risk (HEAR) project (www.hear.org). It is considered highly invasive because it produces copious amounts of seed which are widely dispersed by wind, seeds remain viable over a long period of time, and it grows in a number of climates and habitats.

MMR CirVul-01

The core population of this weed is located on ‘Ōhikilolo Ridge. This weed is not common in any of the MUs, and is a prime candidate for eradication. During the past year, NRS visited this

ICA two times, once in November 2005, when three immature plants were found, and again in January 2006, when no plants were found. Plants found were all hand pulled, no herbicide used. In the coming year NRS plan to re-visit the site, scope for any re-sprouts at least two times, and research seed bed life. It is believed that eradication of this weed is possible with continued vigilance.

MMR CirVul-02

This ICA is located in Kaluakauila Gulch on the far side of Mākua Valley. NRS found only one immature individual here. This is quite a distance from the ʻŌhikilolo population and it is not clear where this individual dispersed from. The individual plant was pulled out and the area around was searched. None were found. NRS plans to re-survey the area on the quarterly scheduled trips to Kaluakauila MU. It is highly probable that NRS will be able to eradicate *C. vulgare* from this ICA.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: CirVul	**Cirsium vulgare**				
MMR-CirVul-01	Ohikilolo	2	2.50	2005-06-15	2005-11-08
MMR-CirVul-02	Kaluakauila	1	0.10		2006-05-10

Desmodium intortum

This invasive species is widespread throughout the Pacific. It spreads via numerous hooked hairs on seed pods. Thus, it is easily carried and dispersed by hikers and hunters. In the past, NRS have targeted this species only in areas where it is not widespread or along trails where NRS, hikers, or hunters may disperse this species into native areas where it is not found. In the coming year, NRS will work with the State to define control goals for this taxon in the Upper Kapuna MU, which is directly adjacent to the current ICA.

MMR-DesInt-01; Makua East Rim DesInt

Due to decreased NRS presence in the East Rim portion of Mākua, NRS monitored this site only once this year. This site is relatively small and covers approximately 0.05 acres. NRS plan to visit this area quarterly in the coming year and renew control efforts.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: DesInt	**Desmodium intortum**				
MMR-DesInt-01	MMR No MU	1	2.00	2005-10-11	2005-10-11

Ehrharta stipoides

This species has the potential to drastically alter environments by creating a thick mat of vegetation in which it is difficult for native species to regenerate. *E. stipoides* seeds are also easily dispersed by awns that attach to clothing. NRS have chosen to target this species as an incipient in all MUs where it occurs except Palikea. The infestation along the Waiʻanae summit at Puʻu Palikea is too widespread for control, stretching approximately 3,000 meters along the summit and smaller ridges in the southern Waiʻanaes. This area is only treated along a small ridge that leads to the *Hesperomannia arbuscula* fence (see Chapter 3.1.14), and is discussed in the MU WCA Report.

Pahole-EhrSti-01; Pahole EhrSti along Kahanahāiki Fenceline
This ICA occurs along the Kahanahaiki/Pahole fenceline, and was likely introduced via hikers coming from the nearby State snail enclosure. There are three sites within this ICA, however all seem to have been eradicated. NRS will continue to monitor these sites quarterly. The area is relatively unaffected by *E. stipoides* compared to areas in the southern and central Waianae range. NRS feels that it can be controlled with continued monitoring.

Pahole-EhrSti-02; Pahole EhrSti in State Snail Exclosure
This ICA occurs in and around the State *Achatinella* enclosure along the Pahole rim. It is thought that *E. stipoides* was introduced during construction or monitoring for the snail site. While the infestation here is sparse, it has been persistent, and difficult to eliminate. NRS will monitor *E. stipoides* quarterly. At last treatment, plants were seeding within the snail enclosure and there was one large patch on the south end outside the exclosure. NRS feel this ICA can be controlled, but regular visits are vital to prevent recruiting individuals from maturing.

MMR-EhrSti-01; ‘Ōhikilolo EhrSti Areas
This is the first year *E. stipoides* has been found at ‘Ōhikilolo. This ICA covers 1.1 acres of the primary ‘Ōhikilolo campground, and areas along the fence both above and below camp. While it is unclear how *E. stipoides* reached ‘Ōhikilolo, it seems most likely that it hitchhiked via NRS gear. Unfortunately, this grass probably went undetected for a little while, since it can look very similar to another, less invasive species, *Vulpia bromoides*. Once identified, NRS aggressively treated the entire infestation with foliar spray. This appears to be very effective; on the most current visit, no plants were seen. NRS feel this infestation can be controlled and will continue to treat this site quarterly.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: EhrSti	**Ehrharta stipoides**				
MMR-EhrSti-01	Ohikilolo	4	4.25	2006-04-06	
Pahole-EhrSti-01	Pahole	1	1.00		
Pahole-EhrSti-02	Pahole	2	2.00	2006-08-02	2006-08-02

Fraxinus uhdei

This species is widely distributed in lower elevation mesic sites throughout the Waianae Mountains. However, NRS plan to target this species in select native areas where it is not yet established.

MMR-FraUhd-01; ‘Ōhikilolo Campsite FraUhd
This ICA contains one large mature and several small individuals within the ‘Ōhikilolo fence. NRS will begin removal of this species from this MU within the next year.

Rubus argutus

Rubus argutus (Blackberry) is a shrub that belongs to the Rosaceae family. It is native to the central and eastern United States and is a naturalized, highly invasive weed in Hawai’i. This brambling shrub produces edible fruit that is black when ripe, and it dispersed by birds. While *R.*

argutus is very well established at Mount Ka‘ala, and has spread down many of the side ridges of Ka‘ala, it is not well established past West Makaleha. NRS would like to keep it out of the northernmost Waianaes. *R. argutus* poses some interesting control problems; clip and drip treatment with Garlon 4 at 20% in FCO is not always effective. This taxon grows via runners underground, and readily re-sprouts from untreated runners. Stronger concentrations of Garlon 4 have been somewhat more effective, but NRS are considering using hand tools to dig runners out of the ground to achieve better control success.

Kuaokala-RubArg-01; RubArg Kuaokala Road
This ICA was visited twice last year. NRS killed nine *R. argutus* on the first trip and 13 on the second. All plants killed on the last trip were immature. This area will be visited quarterly in the next year.

MMR-RubArg-01; Kahanahāiki RubArg at Black Wattle
This ICA is located just outside of the Kahanahāiki exclosure. *R. argutus* was discovered during surveys at the *A. mearnsii* ICA in Kahanahāiki, and was first controlled in May 2003; NRS staff treated *R. argutus* basally with Garlon 4. Most of the plants were in steep areas, accessible by using webbing. NRS visited this ICA three times last year. 115 immature individuals were killed on a single weeding trip last year. This site will be visited quarterly in the coming year.

MMR-RubArg-02; ‘Ōhikilolo RubArg at Red Dirt Puu
This ICA is located just above the *Hedyotis parvula* MMR-C population. Weeding began in December 2001. NRS visited this ICA twice last year. On the first trip two immature plants were found. On the second trip, NRS didn’t find any plants. The absence of mature plants from this area for the past three years provides important information about *R. argutus* seed viability (refer to MMR-RubArg-04 section) NRS will visit this area two times next year.

MMR-RubArg-03; ‘Ōhikilolo RubArg in Lancam Gulch
Three trips were taken to this ICA last year. No plants were spotted on the last weeding trip to this area. No mature plants have ever been found in this area. This population was controlled before it could reproduce, which increases the chance of eradication from this area. This area will be visited two times next year to check for any regrowth.

MMR-RubArg-04; Kahanahāiki RubArg at SE Quad
NRS visited this ICA once last year and did not find any *R. argutus*. The last time a mature plant was found here was in 1999 and the last time any immature plants were found was in 2003. These results suggest it may take at least four years to exhaust the seed bank. Effective control was achieved by combining pesticide control with digging roots out. This ICA is fenced, making the re-establishment of this weed impossible via pigs. NRS will continue to monitor this area yearly for any re-growth.

MMR-RubArg-05; Makua East Rim RubArg
Three immature *R. argutus* were found and treated here in 2004. The same site was checked in 2005 and no plants were found. No surveying of the area was done over the past year to look for more plants, but this site will be visited during each half of the upcoming year to check for resprouts.

<u>UpperKapuna-RubArg-01; Kapuna RubArg Above PhyKaa Fences</u>
NRS weeded in this ICA on two trips last year for a total of 2.5 hours last year. The first trip targeted a patch of 70 plants and the second trip was done to treat scattered *R. argutus* by sweeping through the area. This area will continue to be visited twice a year.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: RubArg	**Rubus argutus**				
Kuaokala-RubArg-01	Mokuleia FR No MU	2	0.99	2005-06-01	2005-10-05
MMR-RubArg-01	MMR No MU	3	5.25	2006-02-22	2006-08-01
MMR-RubArg-02	Ohikilolo	2	3.50	2002-06-03	2005-11-09
MMR-RubArg-03	Ohikilolo	3	2.00		2005-11-08
MMR-RubArg-04	Kahanahaiki	1	0.10	1999-06-06	2003-08-19
UpperKapuna-RubArg-01	Upper Kapuna	2	2.50		2006-06-15

Syzygium jambos

Native to continental Southeast Asia, *S. jambos* is now a naturalized weed on many islands across the Pacific Ocean. Its fruit are dispersed readily by birds as well by humans and possibly feral pigs. This tree is detrimental to native ecosystems because it does not need disturbance to become established, and can germinate and thrive in shade, eventually overtopping and replacing most native canopy trees. Also, it is a carrier for the devastating *Puccinia*, or ohia rust, which affects all *Myrtaceae*, including *Metrosideros sp.* and *Eugenia sp.* While widespread in the Ko'olaus and southern parts of the Wai'anae Mountains, *S. jambos* is not well known from the Kaluakauila region, and thus is considered a priority weed in this area.

<u>MMR-SyzJam-01; Kaluakauila Upper Transect SyzJam</u>
This ICA was created when one immature *S. jambos* was found along a weed transect in 2005. It is likely that pig traffic is responsible for the spread of this incipient to the region. NRS controlled it, and will monitor the site in the future. Only one individual was found and it is hoped that NRS will be able to keep this weed out of Kaluakauila MU.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: SyzJam	**Syzygium jambos**				
MMR-SyzJam-01	Kaluakauila	1	0.08		2006-04-03

Triumfetta semitriloba

T. semitriloba is a perennial herb native to North America. It is common in dry disturbed sites on Oahu, however NRS would like to eradicate this species from sites where it is still sparse and keep it out of MUs. This plant produces copious amounts of seed burrs, which are easily transported by pigs and hikers. It reaches maturity quickly, and as a result, small populations can explode exponentially in a short time if not controlled. Frequent vistis, often twice a quarter, are necessary to achieve eradication.

MMR-TriSem-01; Makua East Rim TriSem

This site was found just inside the Pahole fence, on the east rim of Makua. It is possible that pigs spread this plant to this area before it was fenced. Ungulate control has reduced this influx. This site was not visited this year. NRS will monitor this site periodically but have not placed a high priority status for this site because *T. semitriloba* is found in many other areas along the east rim of MMR.

MMR-TriSem-02; C-Ridge corner

Including this site, there are a total of five sites of *T. semitriloba* in Kahanahāiki (all sites listed below) that NRS check with regularity. No new sites in Kahanahāiki were found this year. NRS aim to treat all sites at the same time so that the frequency of visitation can be monitored more easily. NRS take care when walking through the sites so as to not disperse *T. semitriloba* further. At the C-Ridge site, eleven mature plants were found in the beginning of the year and none have been seen since. NRS will continue treatment at all Kahanahāiki sites twice per quarter.

MMR-TriSem-03; Pisonia patch

Three immature plants were removed this year.

MMR-TriSem-04; SE Quad

Several mature plants and a handful of seedlings were removed this year.

MMR-TriSem-05; Orange Trail

No plants were found this year. The last mature plant seen was in January of 2005.

MMR-TriSem-06; Top of Switchback

Ten immature plants were found and eradicated at this site at the beginning of the year and none were seen since. No mature plants have ever been seen at this site.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: TriSem	**Triumfetta semitriloba**				
MMR-TriSem-02	Kahanahaiki	6	5.10	2006-04-25	2006-08-01
MMR-TriSem-03	Kahanahaiki	4	2.75	2006-08-01	2006-04-25
MMR-TriSem-04	Kahanahaiki	3	2.25	2006-04-25	2006-08-01
MMR-TriSem-05	Kahanahaiki	2	0.30	2005-01-09	2005-01-09
MMR-TriSem-06	Kahanahaiki	1	0.25		2005-09-06

Management Unit Weed Control Area Report

Ecosystem scale weed control effort is reported by IP MU. The MUs are arranged geographically, from the northern Wai‘anae Mountains, to the southern Wai‘anae Mountains, and across to the Ko‘olau Mountains. Each MU discussion begins with a brief introduction which covers MU-wide issues such as partner agencies, fire threat, large-scale fencing, and logistical considerations. Then, if relevant, transect survey results are discussed. Finally, there is a WCA discussion, in which strategy, this year’s control efforts, and future plans are described for each WCA. For reference, a map is included for all WCAs in the MU, and a table summarizes weed control efforts at all WCAs.

IP MU: Haili to Keālia

Weed control in this MU takes place on Army land at Dillingham Military Reservation (DMR). Much of DMR is made up of highly degraded habitat, but the rocky talus slopes on the south end of the reservation host patches of native dry forest. The long-term objective of weed management in DMR is to focus on these talus slopes and expand native forest cover. There is also a reintroduction of *Hibiscus brakenridgei* on the far west end of the MU. The weedy lower flats of DMR are dominated by *L. leucocephala* and *P. maximum* and are not a management concern but are a concern from a wildfire perspective. Two WCAs are defined for this MU, see Figure 2.1.9.

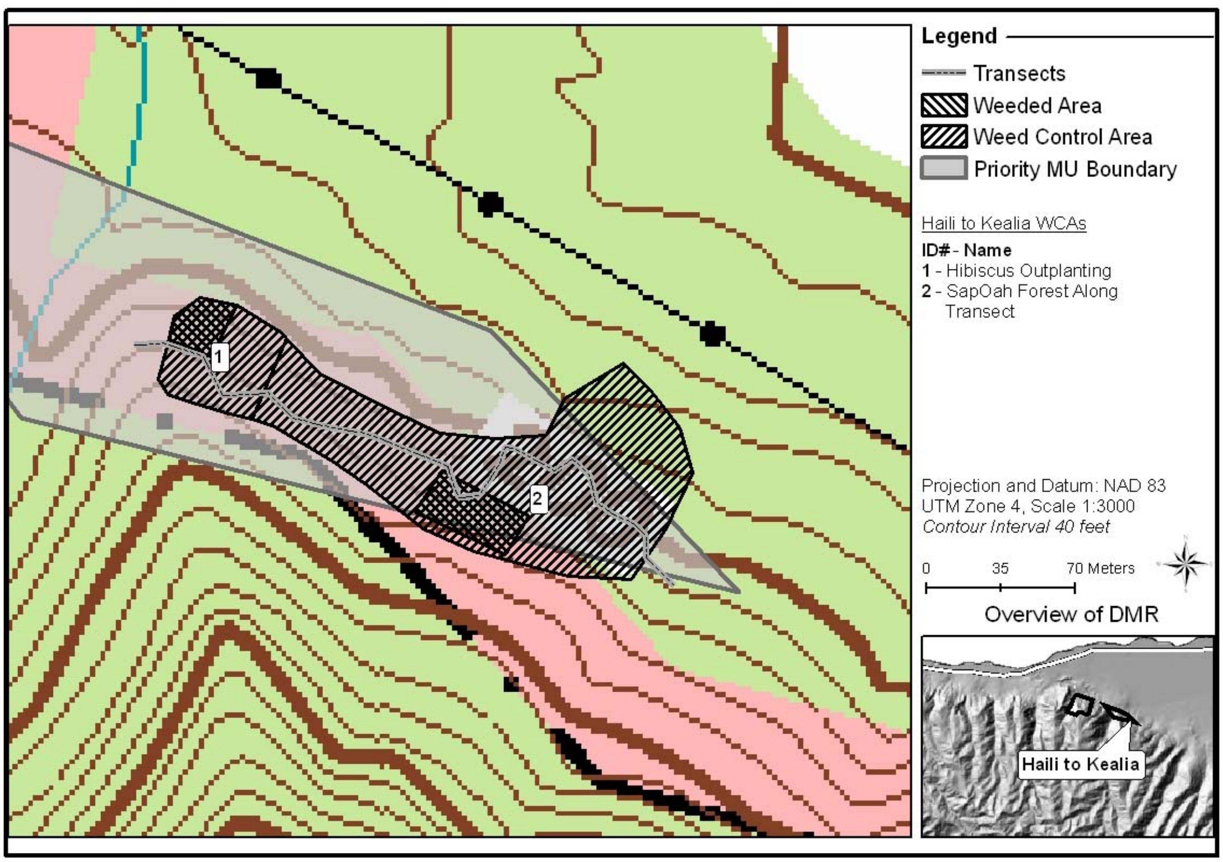


Figure 2.1.9 Weed Control Areas in Haili to Keālia, Dillingham Military Reservation

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
IP MU: Haili to Kealia					
HailitoKealia-01	Habitat	2351.9	553.3	23.53%	HibBraMok

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	4.00	
Ecosystem Weed Control	1	2.00	LeuLeu, PanMax
Total	2	6.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
HailitoKealia-02	Habitat	11573	1039.3	8.98%	HibKokKok

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	72.00	FicSp., PsiGua, SyzCum
Total	1	72.00	

WCA Discussion

Haili to Keālia-01; Hibiscus Outplanting

The area has an abundance of *P. maximum* and *L. leucocephala*. Weeding was conducted to prepare for more outplantings of *H. brackenridgei*. Given the preferred high light levels of this taxon, it is difficult to control the competitive sun-loving weeds which thrive in the area. If this continues to be a problem, NRS may consider some levels of habitat restoration via common outplantings to re-establish an appropriate native component that can help keep weed levels down.

Haili to Keālia-02; Sapoah forest along transect

This past year a group of Youth Conservation Corps (YCC) members worked with NRS in a 1000m^2 area removing alien species throughout a *Sapindus oahuensis* dominated forest. More area can be weeded to the east, west, and downslope of this site. NRS hopes that with continued weeding this area will eventually become mostly native and will only need occasional weeding.

IP MU: Ka‘ena

NRS coordinate with state NARS staff on management of the KAE-B *Chamaesyce celastroides* var. *kaenana* population located within the MU. This population is designated as MFS. Weed control efforts are centered around the *Chamaesyce* population, and there is one WCA defined in this MU, Ka‘ena-01. The population is surrounded by grassy slopes. In 2004, arson fires burned through parts of the region, and while they didn't affect the population, the potential fire threat to the site was made clear. In the past year, some NRS became certified as Wildland Firefighters. If fire threatens the site in the future, NRS will be able to assist State firefighting efforts. Between January and May 2006, NRS did not visit the NAR, while permits were under discussion with the State; this limited weed control for the year.

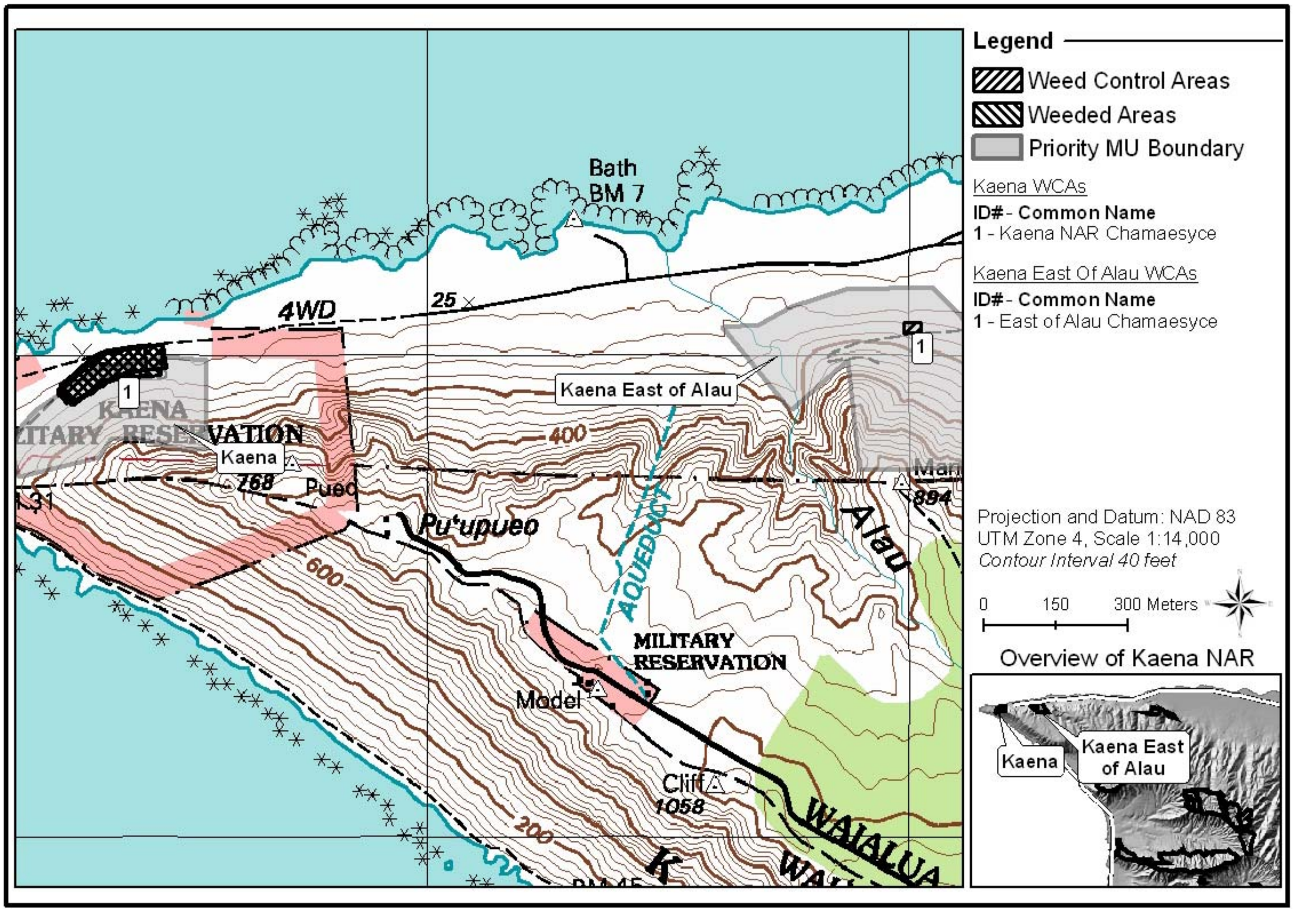


Figure 2.1.10 Weed Control Areas in Ka'ena and Ka'ena East of Alau

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
IP MU: Kaena					
Kaena-01	Habitat	12189.85	12063.83	98.97%	ChaCelKae

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	2	24.00	CenCil, ChlBar, PanMax
Ecosystem Weed Control	2	38.00	AcaFar, AchAsp, AtrSem, LanCam, LeuLeu, SchTer
Total	4	62.00	

WCA Discussion

Kaena-01- Ka'ena NAR Chamaesyce

NRS has made great weed control progress in this WCA over the years. Past efforts have resulted in large decreases in quantities of the woody shrubs *L. leucocephala* and *Acacia farnesiana* and the herbaceous *Atriplex semibaccata*. *L. leucocephala* requires hand-sawing and application of Garlon 4 at a concentration of 40%, *A. farnesiana* needs only 20% Garlon 4 after cutting, while *A. semibaccata* only requires hand pulling. NRS continue to sweep across the WCA to control these species, but the time needed to conduct these sweeps has decreased over time. This year, 18 hours were spent conducting sweeps, and much of this time was spent working on the newly expanded edges of the WCA. One new weed target is *Achyranthes aspera*. This species has just begun colonizing the open weeded areas of the WCA; due to its fecundity, sprawling nature, and fast growth, it's a significant threat. Control technique for this weed consists of handpulling and bagging of all plants found. Grass control continues to pose problems in this WCA. Twenty-two hours were spent on grass control this year. NRS try to time spraying so weedy grasses are beginning to flush, while native grasses have not yet emerged, but struggle with getting effective results. Certain species of grasses appear to be more susceptible to the grass-specific herbicide Fusilade; *Digitaria insularis* and *Panicum maximum* were observed to dieback more than *Chloris barbata*. NRS will experiment with handpulling, which may be more effective, take less total time, and have the greatest positive effect on native vegetation. More studies need to be done to determine optimal techniques in the coming year.

NRS believe that both the number of *Chamaesyce* plants, and the area in which the population occurs, has increased. NRS also think that native vegetation, such as *Sida fallax, Eragrostis variabilis, Panicum fauriei,* and *Myoporum sandwicense* have also increased due to weed control efforts over the years. Overall, it seems that enough weeding is being done to maintain a healthy population of *Chamaesyce*, but more weeding can be done to further promote the increase of common native vegetation. Hopefully, as native vegetation increases, weed control time should decrease. Therefore, to maximize efficiency, future outplantings will be done in previously weeded areas. NRS worked with DLNR staff this past year to outplant approximately 100 *Sesbania tomentosa* around this WCA. Other common native plants, which include *Eragrostis variabilis* and *Chenopodium oahuensis*, are currently being propagated for future outplantings with DLNR. NRS hope to use these outplantings in the weedy grass portion of the WCA, to help reduce regrowth. NRS will continue to balance grass spraying and other weed removal efforts this coming year and expect to see more native vegetation colonization of these weed free areas. This WCA will be visited quarterly, and each trip will involve targeting multiple weeds by applying different techniques.

IP MU: Lower ʻŌhikilolo

Maintenance weed control at Lower ʻŌhikilolo continued this year as in previous years. There are three WCAs in the MU, see Figure 2.1.11. Effort levels are directly tied to rainfall, as NRS must respond with spot spraying after rains. Grasses have evolved to resprout with rain after being stressed. It is notable that in the areas where the *C. celestroidies* WCAs were expanded to the road last year, grass cover was much more prevalent than in areas that have been maintained for multiple years. This indicates that the seed bank is being depleted in the retreated areas and enforces the goal of treating grass before it becomes reproductive. The additional use of a power sprayer from the road has helped speed control of grass in the lower part of the WCAs. The benefits of this technique are that no re-mixing is required as the spray reservoir is 200 gal, and spray force is greatly increase, increasing coverage. The limitation is that a hose must be pulled from the tank in the trunk into and around the WCA. As a result, NRS found this technique effective to retreat areas with extensive grass cover. However, in areas with sparse grass, a backpack sprayer is more efficient. Across all WCAs NRS prefers to use Fusilade directly around endangered species, and Round-up in less sensitive areas. *L. leucocephala* removal continues in the MU, however the effort is greatly diminished. Most of the WCAs have been completely swept at least one time and only require occasional re-treatment to remove individuals that have been missed or are new recruits.

An arson fire near Kaneana Cave threatened all three WCAs (see Appendix II). As a result of this and additional consultations with USFWS, the Army plans to expand the fire break areas around the endangered plants and expand buffers around the firebreak road. NRS strongly support this initiative.

In the next year NRS will look at developing a monitoring program to help direct control efforts. It would be ideal to maximize effect by analyzing effort expended compared to change over time. For example, it is less effective to go when grass is just starting to respond to the first rains of winter as most have not started to germinate and are not yet actively growing. However, effort required increases steeply if too much time lapses before treatment, as grass grows explosively, resulting in much more biomass to spray. Somewhere between these extremes there is an ideal where effort is minimized and effect maximized. Perhaps this question can be answered through monitoring.

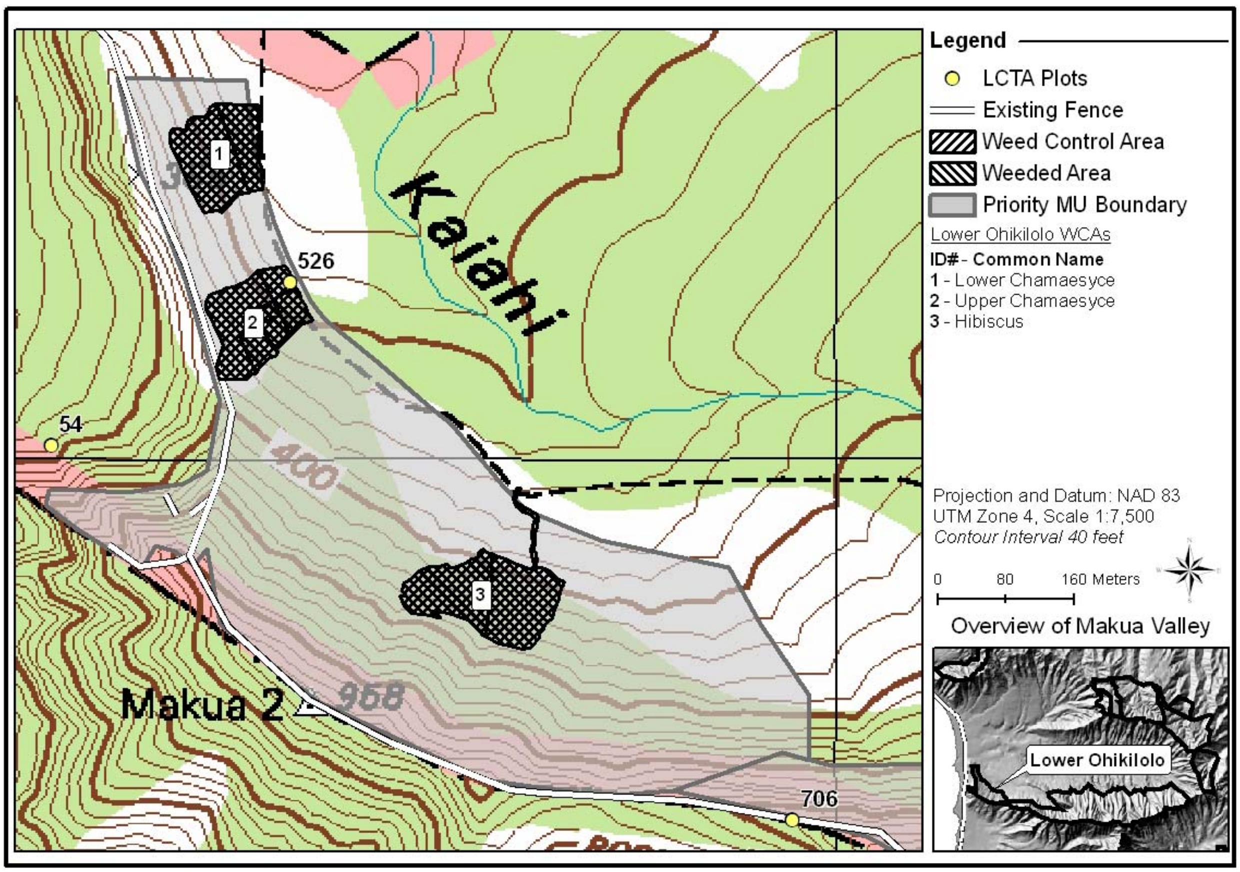


Figure 2.1.11 Weed Control Areas in Lower ʻŌhikilolo

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
IP MU: Lower Ohikilolo					
LowerOhikilolo-01	Habitat	10052.77	10051.84	99.99%	ChaCelKae

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	7	53.20	ChlBar, ChlSp., PanMax, RhyRep
Total	7	53.20	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
LowerOhikilolo-02	Habitat	10199.9	10199.9	100.00%	ChaCelKae

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	5	6.70	ChlBar, PanMax, RhyRep
Ecosystem Weed Control	1	12.00	AcaFar, LeuLeu
Total	6	18.70	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
LowerOhikilolo-03	Habitat	13708.48	13708.48	100.00%	HibBraMok

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	8	99.50	AndVir, ChlBar, DesInt, MelMin, PanMax, PasFim, RhyRep
Ecosystem Weed Control	1	33.00	Leuleu
Total	9	132.50	

WCA Discussion

LowerOhikilolo-01 Lower *C. celestroides* patch

Grass was controlled throughout the WCA on six trips this year. NRS plan to weedwhack *Leonotis nepetifolia* in the fall to facilitate finding the higher fuel content grass species seedlings when they are sprayed in the winter. NRS did not conduct *L. leucocephala* and *A. farnesiana* weed control in this past year, but rather prioritized work on untreated areas in the other WCAs in this MU first.

LowerOhikilolo-02 Upper *C. celestroides* patch

Grass was controlled throughout the WCA on five trips this year. The majority of the effort was between November and June. *L. leucocephala* and *A. farnesiana* control was conducted this year. Still more control of these species needs to be done in the next year in the upper-west corner of the WCA. NRS installed an informal plot to investigate the effectiveness of a basal Garlon 4 treatment of grass during the summer. NRS was motivated to perform this trial as the typical 1% Round-up treatment is ineffective on grass when it is dried and not actively growing in the early summer. Results are still pending. An effective control technique would be useful as these grass clumps are the first to respond to rains and because of their size they rapidly become mature. If they could be removed in the summer, then come the winter all new plants would have to grow from seedling size before becoming reproductive.

LowerOhikilolo-03 *H. brackenridgii*

NRS made eight trips to the WCA to control invasive grass. The majority of the trips were between October and March. *L. leucocephala* was controlled with the help of the Wildland Fire Crew and hula halau volunteers in the lower section of this WCA. More *L. leucocephala* needs to be controlled on the lower east side of the patch. *Dodonea viscosa* seeds were spread in a pilot project to determine the feasibility of using this technique to establish this species. Results show that few survived and are detailed in Appendix VI. Perhaps they need to be spread in large rocky areas where grass will not out-compete them. *Myoporum sandwicense* and *Santalum ellipticum* are now growing in this WCA despite the fact that no adult plants were seen at the start of weed control. This may mean that the seed bank still has viable seeds and continued weed control will allow more natives to reestablish. The alien *Bidens pilosa* population has increased in the WCA. NRS plan to weedwhack this population in the fall to facilitate finding the higher fuel content grass species seedlings when they are sprayed in the winter.

IP MU: Kaluakauila

Kaluakauila MU is one of the most highly fire-threatened units in all of Mākua, surpassed only by Lower ʻŌhikilolo. The area is vulnerable to fires from nearly all directions, with steep fuel-laden slopes which make fire suppression a difficult task.

A fire burned into the bottom of Kaluakauila MU earlier this year, affecting an outplanting site of *Hibiscus brackenridgei* subsp. *mokuleianus*, as well as a wild population of *Chamaesyce celastroides var. kaenana* (Appendix IV).

The newly created Wildland Fire Crew outlined in their recent report a plan for fire prevention and management to protect Kaluakauila MU from future burns. The plan consists mainly of three components, including the creation and maintenance of new fire/fuelbreaks in strategic locations around the MU, the reduction of arson along Farrington Highway, and fuel reduction directly around protected species within the MU. In addition, NRS members have been trained to assist Wildfire Team members and are available to help on-site for future fires.

There are three WCAs drawn in Kaluakauila (Figure 2.1.12). Two are centered around concentrations of rare taxa and native dry forest remnants. The third, Kaluakauila-03, encompasses a grassy ridgeline separating Kaluakauila from the greater part of MMR. This WCA is a fuel reduction area; no work has been done here for the past year. The Army Wildfire Crew will assist with work in this WCA over the next year. Kaluakauila-03 is not discussed below.

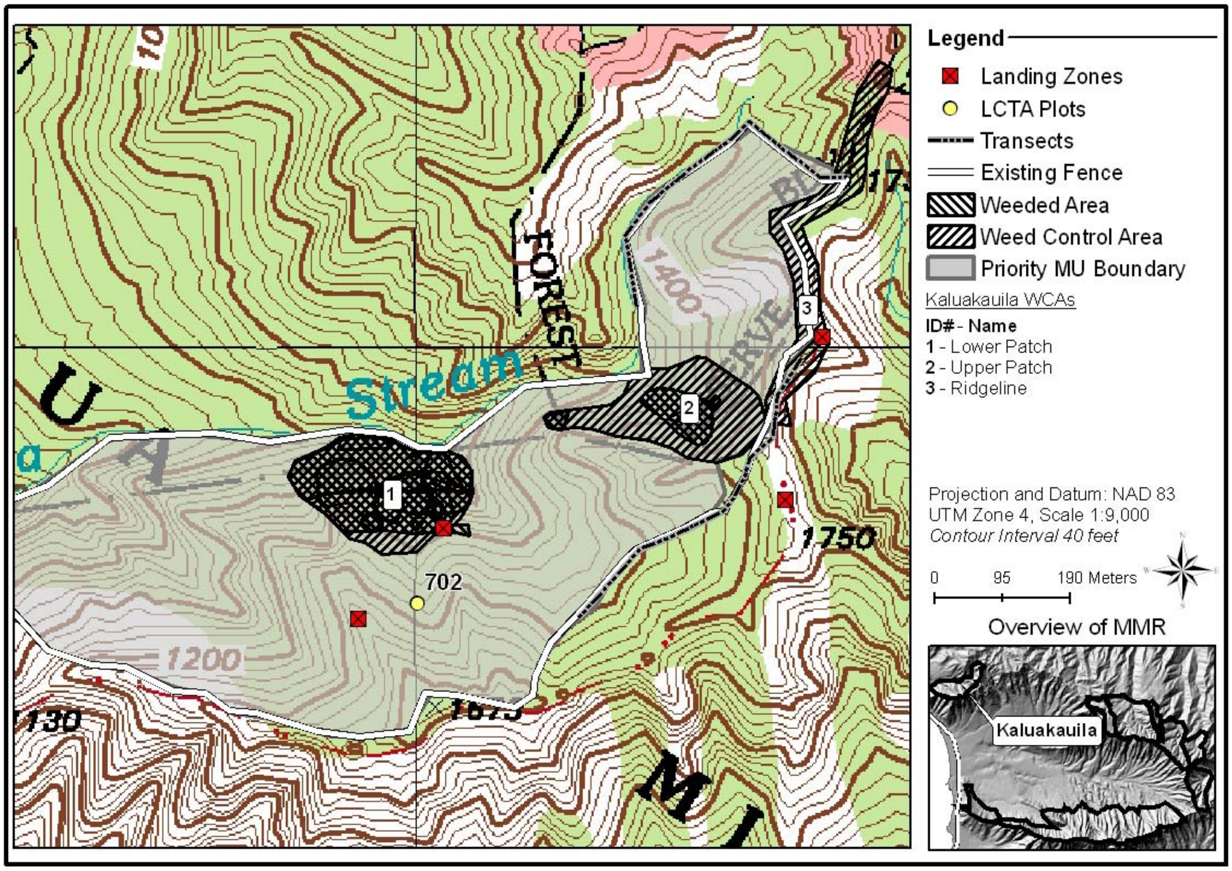


Figure 2.1.12: Kaluakauila Weed Control Areas

Transect discussion

There are two transects in this MU. One significant weed was found this year, *Syzigium jambos*. This species, while common elsewhere, is not known from Kaluakauila. As a carrier for the destructive ohia rust (identified as *Puccinia psidii)*, it is doubly significant. The rust would potentially be detrimental to *Eugenia reinwardtiana* and *M. polymorpha*—native trees in the same family as *S. jambos*. Only one tree was seen and it was killed.

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
IP MU: Kaluakauila					
Kaluakauila-01	Habitat	29441.38	26075.43	88.57%	AbuSan, BobSan, BonMen, EupHae, HibBraMok, NerAng, NotHum

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	3	38.50	DigIns, GreRob, LanCam, LeuLeu, MelMin, PanMax, RhyRep, SetGra
Ecosystem Weed Control	5	47.50	GreRob, LanCam, LeuLeu, PsiCat, PsiGua, SchTer, SyzCum
Total	8	86.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Kaluakauila-02	Habitat	24712.62	5514.767	22.32%	AbuSan, BobSan, ChaCelKae, EupHae, HibBraMok, MelTen, NerAng, NotHum

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	5.50	AgeRip, MelMin, OplHir, PanMax
Ecosystem Weed Control	2	5.00	AgeRip, CorFru, LanCam, LeuLeu, PasSub, PsiCat
Total	3	10.50	

WCA Discussion

Kaluakauila-01 (Lower Patch)

For a number of years NRS have been working in the lower patch to restore native habitat for protected species by focusing mainly on *P. maximum* and *L. leucocephala* removal. The Lower Patch WCA contains seven populations of rare plants, four wild and three reintroductions. To encourage the survival and enhancement of these rare and protected species, it is imperative to keep *P. maximum* and *L. leucocephala* under control.

2006 saw a marked reduction of *P. maximum* throughout the lower patch. Spraying was highly successful and effort from the previous year has resulted in the opening up of much of the understory within the patch. Spraying efforts this year were focused on treating resprouting grass, which has become sparse and patchy throughout the area. Native seedlings of *Diospyros sandwichensis, D. hillebrandii,* and *Rauvolfia sandwicensis* have been seen emerging in dense aggregations, which may be a result of the removal of grasses. It is interesting to note that spraying effort actually decreased from last year from 53 to 38.5 total hours spraying in the Lower Patch.

This year an informal trial using different concentrations of Roundup herbicide was performed on *P. maximum*. It was found that a concentration of 0.5% is enough to sufficiently kill the grass. In the coming year NRS plan to switch spraying operations to using 0.5% instead of 1% to further reduce the risk of negatively affecting non-target plants.

Other weeding efforts within the Lower Patch WCA have focused on *L. leucocephala*, involving large sweeps though areas to allow native canopy trees to thrive and dominate (Figure 2.1.12).

L. leucocephala is also detrimental to native species because it is thought to use a high amount of water compared to other plants, which puts stress on competing native species in this water-limited WCA. Garlon 4 at a 40% dilution rate was applied to the cut stems of *L. leucocephala* in weeded areas. Areas within the WCA have been prioritized based on their percentage of native plant cover. High priority areas have approximately 75% or more native cover, and are treated first. Other areas are visited after high priority areas have been weeded. It is hoped that the intensive effort required to remove *L. leucocephala* will pay off by not having to treat the area again in the same way. Successive sweeps through treated areas will be necessary to remove emergent seedlings, but will require much less effort than the initial sweep.

To ensure that *P. maximum* is sufficiently suppressed to allow native plant regeneration, NRS will continue monitoring and grass spraying if necessary throughout the Lower Patch WCA every quarter for the 2006-2007 year. If done at this frequency, grass levels should be kept low enough so that sweeps do not require much time or herbicide on any given trip.

During the coming year NRS will continue *L. leucocephala* removal throughout the patch, once a quarter as well. Monitoring of formerly weeded areas will show if re- weeding will be necessary. NRS will also begin to evaluate the possibility of removing other canopy weeds, including *P. cattleianum, S. terebinthifolius,* and *G. robusta* in higher priority areas.

Reduction of grass in the Lower Patch WCA is seen as a positive effect of weeding effort in Kaluakauila. However, the area is surrounded by dense *P. maximum*, and therefore is still threatened by wildfire as mentioned above. It may be feasible to expand the native forest boundary by coordinating grass removal and common native canopy species outplanting at the WCA boundaries. This would increase potential habitat for protected species as well as decrease the effects of wildfires on core protected species populations such as *Euphorbia haeleeleana* and outplanted populations. Also, by filling in gaps created by weeding, NRS could potentially reduce the amount of future grass control effort by reducing the amount of habitat favorable for grass growth.

The positive response of the native tree seedlings to the grass removal observed in the Lower Patch WCA provides us with a unique opportunity to experiment with restoration strategies to expand native habitat cover. This year NRS will experiment with translocation of seedlings from overcrowded areas to places recently cleared of weeds. It is important to combine weeding with native outplanting to discourage alien plant regrowth into the weeded area. Also, by transplanting seedlings from dense patches to open areas, we may be utilizing many plants that may have died as a result of competition with cohorts. Using wild germinated seedlings is also much more cost-effective than using greenhouse grown plants, and may increase survival rates by using plants adapted to that specific microclimate.

Monitoring

Plot 702

Please see the discussion and data analysis in Chapter 1: Feral Ungulate Management.

Kaluakauila-02 (Upper Patch)

The Upper Patch is more uniform than the Lower Patch, and has a larger area of 75% or more native canopy. Weeding effort in the Upper Patch has focused mainly on grass and broadleaf canopy control around the three reintroduced and four wild populations of rare plant species in the Upper Patch WCA (Figure 2.6). Grass control throughout the area concentrated on new re-growth, with the observation that previously sprayed grass had actually died, and treatment was effective. NRS did expand the area controlled for grass this year, to encompass new reintroductions and better protect the forest patch. NRS will continue to control grass in the WCA and remove weeds from outplanting sites therein, and will visit the site at least three times in the following year to ensure the improvement of the outplantings and the native forest. Habitat restoration techniques discussed above will be implemented in the Upper Patch if found to be successful and feasible in the Lower Patch.

An informal trial was performed on *Ageratina riparia*, a widespread herbaceous weed. NRS found that it is possible to treat the weed with a 1% roundup foliar spray, a finding that may be helpful for future attempts at controlling this aggressive weed.

IP MU: Kahanahāiki

Numerous WCAs were established in this MU over the past year because there are multiple MFS taxa and many areas of 75% native forest. WCAs were also mapped out to include existing weeding areas. All WCAs fall within the fence, minimizing the disturbances caused by ungulates—primary agents of weed dispersal. Weed control is not conducted throughout the entire fenced area as much of the south-facing fenceline is very weedy both in the understory and overstory and not worth weeding. Over the years, NRS spent much time documenting vegetation types and prioritizing MU level weed areas based on high levels of native components and proximity to endangered species.

Four LCTA plots occur within the MU, plot 56 located in WCA Kahanahāiki-03, plot 55707 located in WCA Kahanahāiki-09, plot 703 located in WCA Kahanahāiki-04 and plot 716 located outside any WCA but in the MU (Figure 2.1.13). Only plot 703 was not read by NRS Monitoring this year; it could not be relocated. NRS continue to look for this plot and it will be read as soon as it is located. The discussion of plot 716 appears in the Kahanahāiki MU section of Chapter 1: Feral Ungulate Management. Detailed discussions of each plot and the data analysis appear in the WCA sections below.

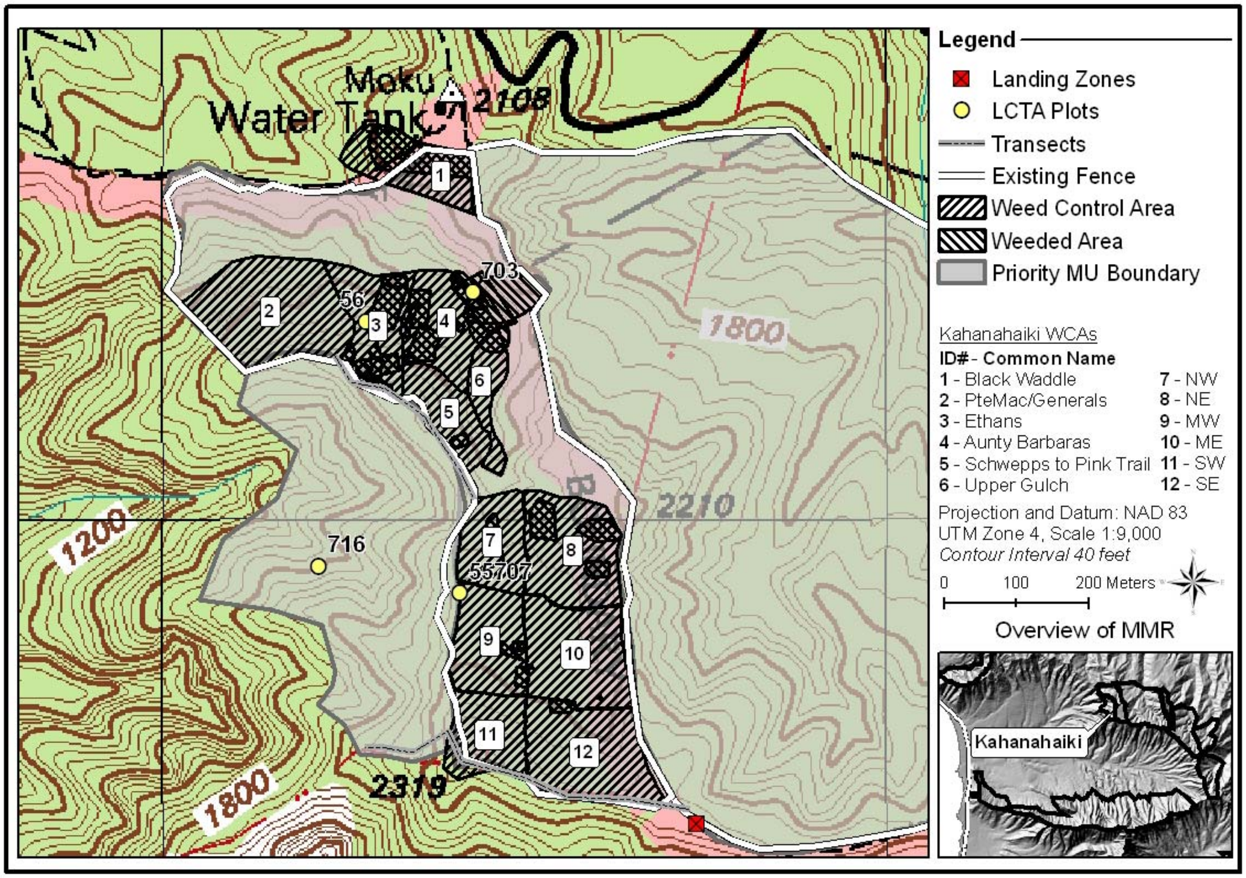


Figure 2.1.13 Weed Control Areas in Kahanahaiki, Makua Military Reservation

<u>Transect Discussion</u>

There are two weed transects read in Kahanahāiki. Both run alongside the fence. No new significant weeds were found along either this year.

Monitoring

Plot 716

Please see the discussion and data analysis in Chapter 1: Feral Ungulate Manaement.

IP MU: Kahanahaiki

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present	Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Kahanahaiki-01	Habitat	6807.84	2785.349	40.91%		Grass Control	1	2.00	MelMin
						Total	1	2.00	
Kahanahaiki-03	Habitat	13980.01	5071.018	36.27%	AlpPon, CyaSupSup, DelSub, FluNeo, SchObo	Ecosystem Weed Control	4	49.50	AleMol, Clihir, CraCre, GreRob, LanCam, PsiCat, PsiGua, RubRos, SchTer
						Total	4	49.50	
Kahanahaiki-04	Habitat	13998.24	5749.253	41.07%	CenAgrAgr, CyrDen, DieFal, FluNeo, SchNut	Grass Control	2	7.00	MelMin, PasCon
						Ecosystem Weed Control	6	58.00	AleMol, BudAsi, ChrPar, CliHir, GreRob, PasEdu, PsiCat, PsiGua, RubRos, SchTer, SyzCum
						Total	8	65.00	
Kahanahaiki-05	Habitat	9122.041	364.3728	3.99%	CenAgrAgr, CyaSupSup, DelSub, SchNut, SchObo	Grass Control	1	0.50	MelMin
						Total	1	0.50	
Kahanahaiki-07	Habitat	11241.32	1639.618	14.59%	CenAgrAgr, CyaSupSup	Ecosystem Weed Control	1	7.50	GreRob, LanCam, PsiCat, SchTer
						Total	1	7.50	
Kahanahaiki-08	Habitat	18384.99	6527.801	35.51%	CenAgrAgr, SchNut, SchObo	Ecosystem Weed Control	1	3.00	GreRob, PsiCat, SchTer, SpaCam
						Total	1	3.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Kahanahaiki-09	Habitat	14073.09	10278.96	73.04%	CenAgrAgr

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	18.00	PsiCat
Ecosystem Weed Control	2	76.00	PsiCat
Total	3	94.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Kahanahaiki-10	Habitat	18889.65	11665.27	61.75%	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	3	10.00	MonHib, PsiCat
Total	3	10.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Kahanahaiki-11	Habitat	11441.89	8825.093	77.13%	CenAgrAgr

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Unknown	1	0.00	
Total	1	0.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Kahanahaiki-12	Habitat	21145.24	18264.63	86.38%	CenAgrAgr

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	3	114.00	CliHir, PsiCat
Total	3	114.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
MMRNoMU-01	Habitat	5719.412	3197.025	55.90%	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	0.00	MelMin
Total	1	0.00	

WCA Discussion

Kahanahāiki-01; Black Wattle area weed control

This WCA is easily accessible to NRS because it is near the trail head. Weeding tasks that have taken place here include backpack spraying *Melinis minutiflora*. NRS will visit this area twice a year to spray grasses. *Microlepia strigosa* (palapalai) has been used for outplantings in this area and is doing well. This area is good for volunteer groups to work on because it is easily accessible and includes both weeding and outplanting tasks.

Kahanahāiki-02; Ptemac/Generals

No weeding was done in this WCA this past year, however both grass control and ecosystem level weed control are planned for the coming year. *Blechnum appendiculatum* trials done in July 2005 were analyzed twice this report year and show promising results. Only a few plots had any resprouts and some plots had native plant revival. NRS is encouraged by these results and will continue to experiment with a lower pesticide percentage. In 2002 trials at ʻŌhikilolo using a hand-saw and 2% and 3% Round-up proved ineffective. The 2005 trial used a pick and 10% Round-up. NRS will experiment with a pick and 5% Round-up for Report Year 2007.

Kahanahāiki-03; Ethans Gulch

Three weeding trips were conducted in the upper regions of this WCA (south side). Weeding was done at one site for outplanting *Schiedea obovata* and another nearby where an outplanting of common natives also occurred. In the previous reporting year, NRS had aggressively removed *P. cattleianum* from this area and this year NRS continued that project. At another site, closer to the gulch bottom, NRS again weeded in effort to remove *P. cattleianum* and replace it with common native gulch species to be outplanted this winter. In all sites where *P. cattleinaum* has been removed in this WCA, NRS have been surprised to find very little recruitment of this or other habitat altering weeds. To prevent future colonization, NRS are establishing common outplantings to increase native cover

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Monitoring

Plot 56

This plot shows significant changes in the mean number of interceptions (χ) of non-native species over time (p=0.059). Interceptions of non-native species declined from their initial value in 1996 χ=2.88±2.03 to a lower χ=2.14±2.08 in 2006. Interceptions of native vegetation were unchanged in this time (p=0.9067). There is no need to adjust these data for values that seem to be erroneous, as all data conform nicely to the patterns described above and have similar standard deviations. This area was fenced in 1996 and no ungulates are known to have been in the vicinity since 1998. Only non-native species show a significant response corresponding to ungulate removal; however this plot has been the site of intense weed control efforts focused on non-native canopy species and the decline in non-native species χ may be due to those efforts. In fact, non-native tree species χ appears to be declining though not significantly (p=0.137).

Several understory species were first detected at this plot this year including the non-natives *B. appendiculatum* and *Crassocephalum crepidoides* however; at least one non-native tree has been eliminated from this plot, *G. robusta*. The only species that showed significant change over time was *S. terebinthifolius* which decreased (p=0.0902, 1996 χ=2.4±1.14 2006 χ=1.0±0.0, n=5 for all years). *P. cattleianum* showed no change in mean interception in this plot despite a significant effort to remove the species from this area which was undertaken in 2004. Most individuals killed at that time were fairly tall and may have escaped detection by this method in early visits due to their height or new individuals growing into the light gaps created by the weeding have replaced those removed. It is important to note that when conducting this type of weed control NRS purposefully leave several individuals at a site to maintain some sort of canopy while the native forest recovers. Data collected in the future may help resolve some of these questions as the community continues to respond to the recent alterations.

Kahanahāiki-04; Aunty Barbs

This is a very large WCA. Work is focused on the region directly around several rare species outplantings. This site was visited eight times last year for girdling trees and grass spraying. Chainsaws were useful in weeding this area to girdle the bigger trees and to clear monotypic stands of *P. cattlianum*. The canopy in this area mainly consists of non-native trees such as *G. robusta*, *A. moluccana* and *P. guajava*. Weeding in this area is focused on clearing weedy grasses and shrubs to allow native understory to expand. Larger canopy weeds have been killed to allow more sunlight to reach these established native plants. Although most of the canopy is weedy, areas directly around the reintroductions are mostly native. This area will continue to be visited once each quarter to weed outplanted areas. Future monitoring efforts will continue to focus on hot spots of weedy grasses and shrubs such as *Oplismenus hirtellus* and *R. rosifolius*.

Monitoring

Plot 703

This plot shows a significant change in the mean number of native species interceptions over time for the years it was read, 1996, 1999 and 2003 (p=0.005). The mean number of interceptions **(**χ) has steadily decreased throughout this time period beginning with χ=2.37±1.22 in 1996, χ=1.87±0.88 in 1999 and χ=1.25±0.46 in 2003. The plot could not be located this year by NRS staff but attempts continue. This area was fenced in 1996 and has been ungulate free since 1998. Subsequent to ungulate removal from the area there was a period of significant mortality for *Pisonia umbellifera*. In fact when individual species mean intereption is analyzed the reduction in *Pisonia* species' χ is evident though not significant (*P. brunoniana* p= 0.1504 and *P. umbellifera* p=0.1130). The mean interception of the two species of *Pisonia* present declined from 2.26±1.19 to 1.83±0.72 for *P. brunoniana* and from 3.00±1.36 to 2.29±1.05 for *P. umbellifera*. NRS noted that *P. umbellifera* suffered greater population declines during this unexplained dieback than did *P. brunoniana*.

The mean number of non-native species interception showed no significant changes within the lifetime of the plot (p=0.827), however individual non-native species did show significant changes in response to ungulate removal. *Clidemia hirta* increased following ungulate removal (p=0.0845; prior to fence χ=1.25±0.5, post fence χ=2.43±1.3) while *Deparia petersenii* decreased (p=0.0769; prior to fence χ=1.6±0.52, post fence χ=1.0±0.0). The only native species to show a significant change was *Morinda trimera* which also decreased (p=0.0312, prior to fence χ=2.25±0.71 post fence χ=1.25±0.5).

This plot had not been weeded prior to 2003, the most recent data collection visit, but has been the site of fairly intense weed control efforts since that time. NRS expects more current data will show a decrease in the mean non-native species interception as a result of these efforts. Weed control in the vicinity has been focused on canopy species such as *Aleurites moluccana*.

<u>Kahanahāiki-05; Schwepps/Pink Trail</u>

NRS staff went to this site once last year to spray *M. minutiflora*. A handsprayer was sufficient to treat grass near the native plants *S. nuttalii* and *C. agrimonioides*. NRS will visit this site each quarter next year to monitor and control the weedy grasses and expand weeding to some of the steeper native forest patches.

<u>Kahanahāiki-06; Upper Gulch</u>

This area was not weeded last year but NRS worked with volunteers to increase the native vegetation found here by outplanting *M. strigosa,* a native fern. NRS plant to visit this WCA twice next year.

Kahanahāiki-07; North Western Quadrant

Last year one weeding trip was made in a small gulch containing large amounts of *Melicope lanaiensis*. This trip targeted *G. robusta*, *Lantana camara*, *P. cattleianum*, and *S. terebinthifolius*. The weeding in the main gulch looked effective, and not many weeds have come back, so more work will be done to target surrounding areas. This WCA has very patchy forest distribution and weeding efforts were focused on the most native part of it, the gulch. Other parts of it were weeded in previous years, and are scheduled to be re-swept next year. Future trips will be made two times in the next year to continue to expand weeded areas and target hot spots in previously weeded areas.

Kahanahāiki-08; North Eastern Quadrant

This WCA has sections with high levels of weed cover and therefore weed control is focused in small areas with higher levels of native cover or around rare plant populations. This year NRS weeded carefully through a wild population of *C. agrimonioides* as well as targeted *G. robusta* over a portion of the WCA. No large-scale sweeps were conducted this year, but are planned for in the coming year.

Kahanahāiki-09; Middle Western Quadrant

This WCA had a high level of *P. cattleianum* seedling recruitment. Seedlings grew in thick 1-2m high stands in areas where incomplete control of larger trees was conducted in previous years. NRS has developed a technique where weedwhackers with blades are used to clear these stands, and then the remaining small stumps are sprayed with Garlon 4 in water. This technique has been particularly good project for volunteers who can clear and pile slash after NRS weedwack an area. *M. strigosa* was later outplanted in these areas to aid in the reestablishment of native groundcover. To date, all of the ferns outplanted are still alive and slowly beginning to spread. NRS will visit this site quarterly next year to continue to clear thick areas of *P. cattleianum* and retreat any resprouts from previously weedwhacked areas. *Melinis minutiflora* and *R. rosifolius* will be monitored and efforts will be made to keep these weeds out of native patches.

Monitoring

Plot 55707

When comparing the number native species intercepted in the plot over time for all the years the plot was read (1996, 2003, 2006) there was a significant change over time ($p=<0.0001$). ***The mean number of native species interceptions (χ) increased over time (1996 $\chi=1.89\pm1.39$, 2003 $\chi=2.58\pm1.66$ and 2006 $\chi=3.71\pm2.33$).***

The mean non-native species interception in this plot has decreased from 1996 ($\chi=2.15\pm1.5$) to present ($\chi=1.75\pm1.02$) but not significantly. The data from 2003 and 2006 are fairly similar and despite not being significant the trend in the change among all years is clear ($p=0.27$).

This area has been pig free since the fence was completed in 1996; however some pigs still remained in the area through 1998. When the data are examined looking for effects of ungulate removal there was a significant increase in native species' χ after fencing from 1.89 ± 1.39 to 3.35 ± 2.23 ($p<0.0001$). Native sedges, ferns, shrubs, trees and vines all showed a significant positive response to ungulate removal ($p<0.043$ in all cases). There was a non-significant trend for non-native grasses to increase slightly but they were generally rare in the plot both before and after ungulate removal (p=0.1114). Several species increased in this plot including *Acacia koa* which increased over 2 fold (p=0.0011), *A. oliviformis* also increased over 2 fold (p=0.002), *Metrosideros polymorpha* (p=0.0003), and *Sphenomeris chinensis* (p=0.09). This plot has received frequent weed control and augmentation with *A. koa* which help to explain some of the changes in species' interception. Despite this, non-native species showed no significant change either as a group or individually. Several species were observed only in 1996 such as *P. cattleianum* (n=51) and *R. rosifolius* which was rare even in 1996 (n=1). Weed control efforts here should focus on non-native tree species like *S. terebinthifolius* and grass species like *Paspalum conjugatum*.

Kahanahāiki-10; Middle Eastern Quadrant

This area was weeded on three different trips last year. Most of the effort in this area was to reduce the thick stands of *P. cattleianum* saplings described above. *Montanoa hibiscifolia* was also targeted in this WCA as it is not yet well established in Kahanahāiki MU. This WCA has not been thoroughly swept for other common weed species for several years, however it will likely be targeted for this type of treatment as well as continued *P. cattleianum* removal this year.

Kahanahāiki-11; South Western Quadrant

This area was not weeded last year but it is still the most native WCA in the Maile Flats region. It was swept for weeds in 2004 and next year NRS will visit this site two times.

Kahanahāiki-12; South Eastern Quadrant

While this WCA has some very nice forest patches as well as surprisingly high levels of hapu'u ferns (*Cibotium chamisoi*), there are weedy patches throughout. Many of these weedy areas are monotypic *P. cattleianum* stands; however there are also several light gaps in the WCA, such as one resulting from the dieback of *Pisonia umbellifera,* that foster the invasion of sun-loving weeds. This WCA was weeded three times last year, again mainly focusing on weedwhack clearing of large areas of *P. cattleianum* as described in the Kahanahāiki-09 WCA discussion. Next year, work will continue to focus on *P. cattleianum* control as well as focus on other isolated weed patches, and fence and trail corridors to facilitate ease of large-scale sweep weeding in the future. The entire WCA was swept for all weeds in March 2005, and is scheduled for retreatment again in the coming reporting year.

IP MU: Pahole Gulch

This is the second year that NRS has conducted weed control in Pahole Gulch within NAR. Unfortunately the permit application process delayed the continuation of work in the gulch until May 2006. Since May, NRS has been making trips to the gulch to conduct weed control and evaluate strategies. NRS is still in the process of developing the over-all weed control strategy approach for the gulch. Weed actions conducted in the gulch are based on objectives established through discussion between NRS and the NARS Specialist. Within the next year NRS plan to completely refine the WCA boundaries and outline others in the MU. Within the Pahole gulch WCAs and subunits have been established based on populations of existing and reintroduced rare plant taxa and areas with intact native habitat.

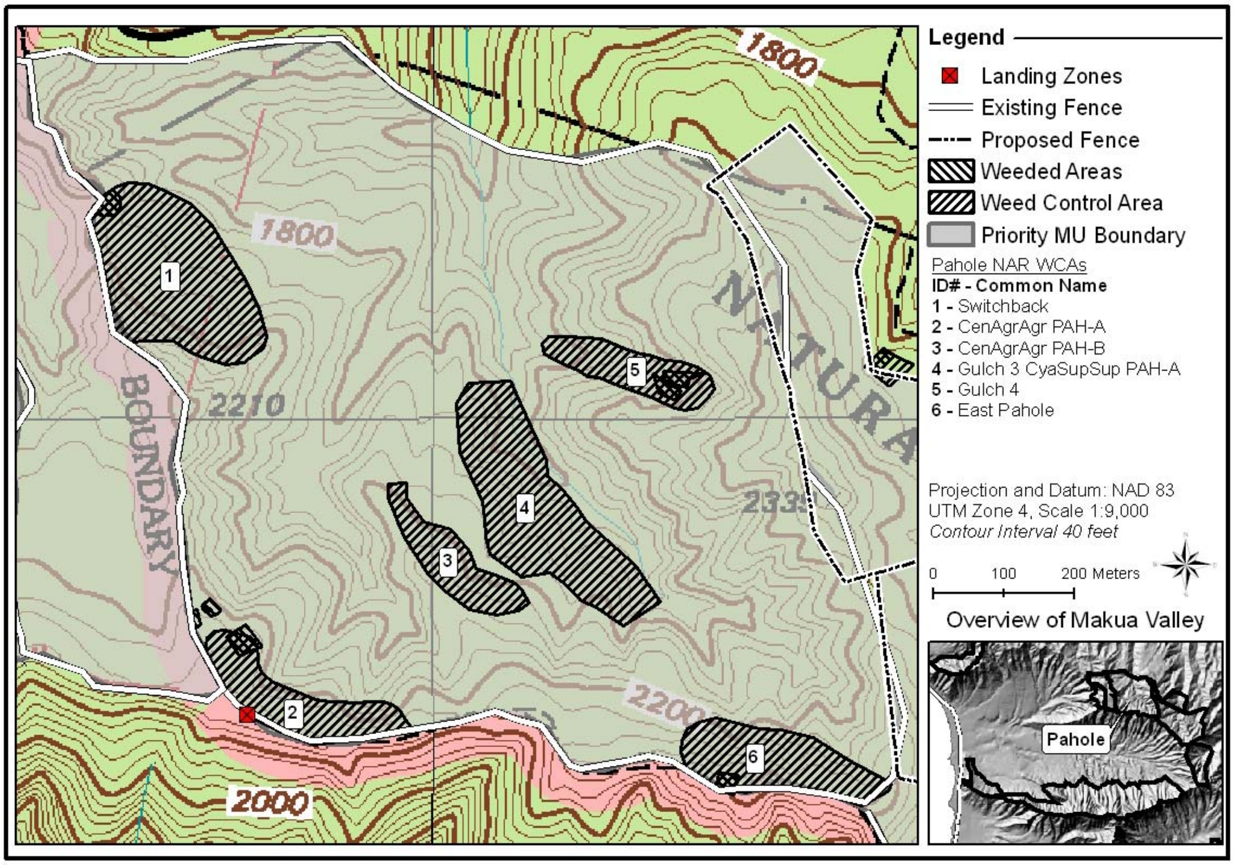


Figure 2.1.14 Weed Control Areas in Pahole NAR

<u>WCA Discussion</u>

<u>Pahole-01; Switchbacks, SchNut Reintro</u>

Pahole -01 is located on the North East facing slopes of Pahole about a third of the way out to the overlook. It includes the reintroduction site for *S. nutallii* at the switchback site and reintroduction sites that where established this year for *C. agrimonidies* and *S. obovatum*. Weeding was conducted prior to outplanting *S. obovata* and *C. agrimonioides*. Weeds are not re-establishing and the reintroductions are doing well. Many of the reintroduced plants are producing seeds and NRS hope that intermittent weeding will be sufficient. The WCA contains a mix of native dominated and alien dominated areas. There is much more area to cover within this WCA and NRS look forward to expanding weed control. The eastern side of the WCA (down slope away from the ridge crest) is an area of high quality native forest. NRS feel that this area is especially important to target. The NARS specialist indicated that there was plot reading to be completed in the area before weed control operations should proceed. Perhaps the plots can be read by the Monitoring Program Manager and weeding can resume. Grass control also needs to be conducted in this WCA during winter months when *M. minutiflora* begins to invade.

<u>Pahole-02; Cenagr PAH-A</u>

WCA Pahole -02 spans the flat area above the Pahole snail enclosure between the Pahole and Makua rim. There are nice patches of native forest separated by dense stands of *P. cattleianum*. *Dicranopteris linearis* dominates the area near the Pahole rim. NRS made three weeding trips to the area this year. On one trip, NRS used volunteers to work near the trail in the flat, *P. cattleianum* dominated, accessible areas. NRS has also focused on areas where there is native understory such as *M. strigosa* and *N. exaltata* that is fringing the boundaries of native and alien canopies. This way, when the *P. cattleianum* is removed, these species can fill in the gaps between native canopies. NRS has seen this strategy work in this and adjacent areas.

Pahole-03; Cenagr PAH-B

WCA Pahole-03 is centered around a wild *C. agrimoniodies* population. NRS did not conduct weed control in the WCA this year; however, plan to resume operations in the area soon. The highest priority action is to control *M. minituflora* that grows in along the open ridge crest and in the past directly smothered *C. agrimoniodies*. These patches must be manually cleared away from the *C. agrimoniodies*. Then once at a safe distance of at least more than three meters they can be sprayed. Down slope from the *C. agrimoniodies* the native forest is being invaded by *P. cattleianum*. NRS will begin to slowly work in this area in the next year.

Pahole-04; Gulch 3 Cyasup Reintro/Chaher

WCA Pahole-04 is centered around reintroductions of *C. superba* and *C. herbsti*. NRS did not conduct weed control in the WCA this year; however, plan to begin weed operations in conjunction with site preparations for *C. herbsti* reintroduction in the coming winter. The area that surrounds the *C. superba* reintroduction is more problematic. This species was reintroduced along the gulch bottom in a site that is excellent for *C superba* but unfortunately dominated by introduced species including *R. rosifolius, Christella parasitica, Paspalum conjugatum*. The presence of these species in the under story does not seem to impact the *C. superba* as these plants are robust, however, the dense cover possibly inhibits any possible germination. Unfortunately, even in a native dominated habitat, germination is unlikely because of slug predation on newly germinated seedlings. NRS will not prioritize larger scale under story weed control in this area until slug control techniques are developed.

Pahole-05; Gulch 4

WCA Pahole-05 encompasses an area where *Pritchardia kaalaensis* was outplanted by NRS. Unfortunately, the outplantings are not doing well. NRS has done extensive weed control in the area in the past and went to the area twice this year to do maintenance and prepare new areas for reintroduction in the coming year. The weed control has changed the regime of weeds in the area. *Buddleia asiatica* has replaced *Ageratum adenophora* that was removed. *B.asiatica* has since been removed. NRS will continue to maintain and expand efforts in this area as is needed to support continued reintroduction efforts.

Pahole-06; East Pahole Rim Schnut/Cyalon

WCA Pahole-06 is in the South eastern corner of the fence. This area is one of the most intact areas remaining in Pahole. This WCA contains wild populations of *C. longiflora* and *S. nutallii*. NARS staff has suggested that NRS pair weeding trips with collection trips to minimize impacts. NRS strongly agree with this strategy. One trip was made this year. NRS has attacked *P. cattleianum* to prevent fruits from rolling downhill into native dominated areas. NRS focused on removing stands that did not have too many seedlings growing underneath. In past years NRS has swept through native areas removing sparse canopy weeds. This site will be visited, at most, two times year and care will always be taken to minimize impacts.

Pahole-07

WCA Pahole-07 is located outside the Pahole fence near the Nike site. Weeding was conducted prior to outplanting *S. obovata*. The area is relatively native and NRS feel that that not much weeding will need to be done in this area. NRS will monitor the results of the weed control and conduct more control if necessary.

Pahole-No MU; Pahole Road

WCA Pahole-No MU covers roadside weed spray along the access road from the Dillingham Ranch gate to the Pahole Mid-elevation Nursery. This effort is shared with NARS staff. NRS sprayed the road four times this year and will monitor vegetation over the next year and respond accordingly.

IP MU: Pahole

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Pahole-01	Habitat	42691.98	2264.998	5.28%	CenAgrAgr, CyaSupSup, SchNut, SchObo
Pahole-02	Habitat	18225.8	2058.337	11.29%	CenAgrAgr, CyaLon, HedDegDeg, PlaPriPri
Pahole-05	Habitat	12584.59	3088.569	24.54%	CyrDen, PhyKaa
Pahole-06	Habitat	21361.96	3460.317	16.20%	CyaLon, CyrDen, SchNut, SchObo
PaholeNoMU-01	Trail	0	0		

WCACode	Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Pahole-01	Ecosystem Weed Control	1	12.00	CliHir, LanCam, PsiCat, SchTer
	Total	1	12.00	
Pahole-02	Ecosystem Weed Control	3	18.50	CliHir, LanCam, PsiCat, SchTer, StaDic
	Total	3	18.50	
Pahole-05	Ecosystem Weed Control	2	14.00	AgeRip, BudAsi, RubRos
	Total	2	14.00	
Pahole-06	Ecosystem Weed Control	1	12.00	BudMad, CliHir, LanCam, PsiCat
	Total	1	12.00	
PaholeNoMU-01	Ecosystem Weed Control	3	27.00	MelMin, PanMax
	Total	3	27.00	

IP MU: Upper Kapuna

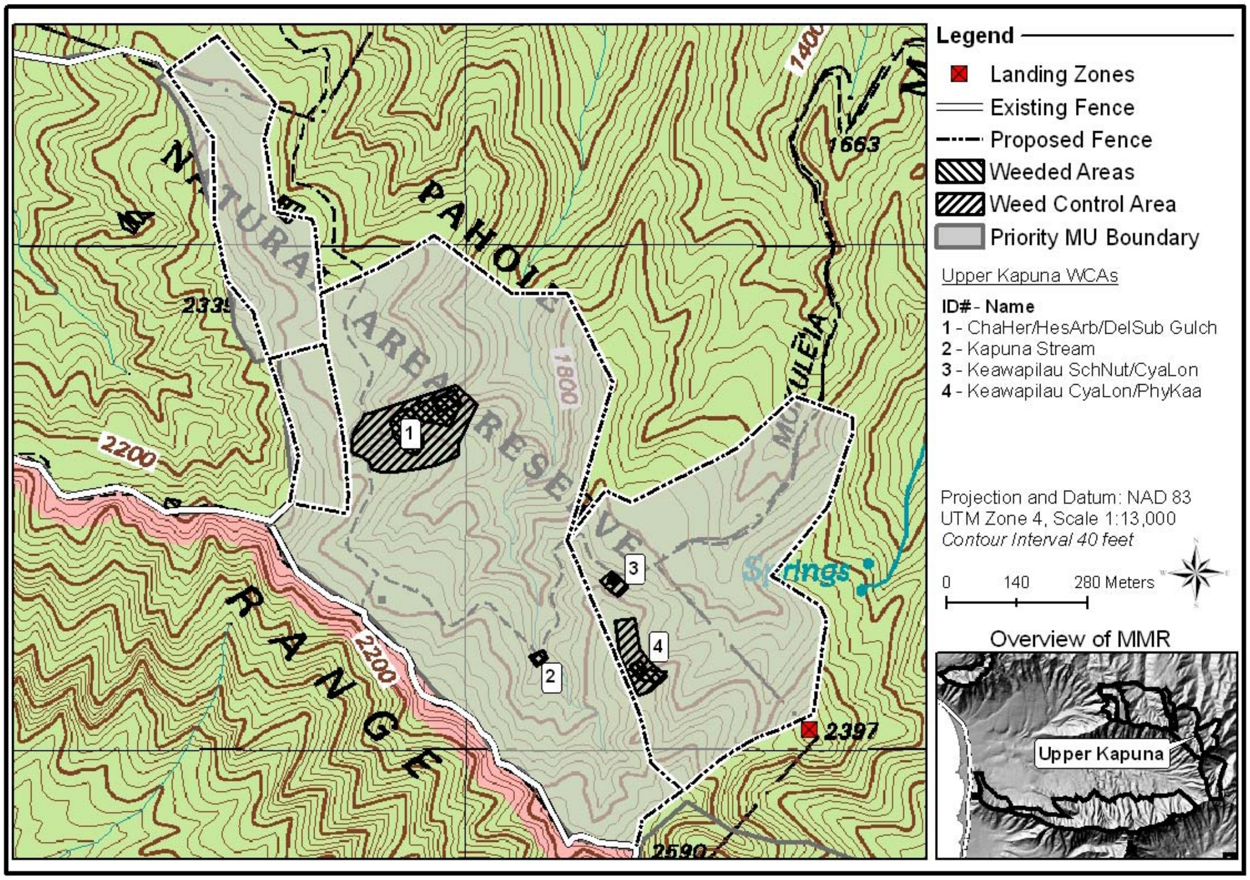


Figure 2.1.15: Weed Control Areas in Upper Kapuna, Pahole NAR

Upper Kapuna MU includes five WCAs. A sixth WCA lies just outside the MU boundary. One is a fenceline, the rest are situated around populations of protected plant species, wild and reintroduced. All WCAs were established with the assistance of NARS staff. Two of the WCAs are currently within small fences, while the remaining three are not protected at this time. However, a system of four staggered fences is proposed for the area, the third of which will include Upper Kapuna-03 and 04, and the fourth of which will include Upper Kapuna-01. NRS have committed to helping the state complete the units, and construction is pending initiation by the state's fencing contractor.

At the present time weeding is concentrated in the direct vicinities of the rare plant populations. Once the areas are fenced, NRS will intensify efforts in the MU, weed priorities will be re-evaluated and perhaps more effort will be spent improving the habitat between rare plant populations and in areas with high native composition. It is possible that future weeding could expand current WCA boundaries, leading to the merging of nearby WCA's.

NRS did not access this MU between January and May 2006, as permitting issues with the State were settled. Upon the commencement of weeding activites in the MU, NRS noted regrowth of weeds during the interim. It is hoped that NRS will continue to be allowed to weed in the

WCA's with regularity in the future so as to insure that progress made by previous weeding effort is not lost to re-infestation by non-native species.

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
IP MU: Upper Kapuna					
UpperKapuna-01	Habitat	28340.27	10101.75	35.64%	ChaHer, DelSub, HesArbu

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	52.50	BleApp, ChrPar, CliHir, LanCam, PsiCat, RubRos, Schter
Total	2	52.50	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
UpperKapuna-02	Habitat	566.2155	523.0246	92.37%	ChaHer, CyaSupSup

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	4.00	CliHir, PsiCat, RubRos
Total	1	4.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
UpperKapuna-03	Habitat	1345.736	426.3477	31.68%	CyaLon, SchNut

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	19.50	BudAsi, CliHir, PsiCat, RubRos
Total	2	19.50	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
UpperKapuna-04	Habitat	6995.6	4892.227	69.93%	CyaLon, PhyKaa

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	42.50	BudAsi, CliHir, GreRob, PsiCat, RubRos, SchTer
Total	2	42.50	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
UpperKapuna-05	Fenceline Clearing	0	0		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	121.00	CliHir, EucRob, GreRob, PsiCat, SchTer
Total	2	121.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
UpperKapunaNoMU-01	Habitat	1843.315	1648.023	89.41%	CyaSupSup

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	6.00	ChrPar, FraUhd, RubRos, SchTer
Total	1	6.00	

WCA Discussion

Upper Kapuna-01; Chaher/Hesarb/Delsub Gulch

There are a number of rare plant species present in this WCA, several of which are designated MFS. There is also some very nice native habitat in the WCA, the maintenance and expansion of which being critical to the survival of the rare plant taxa found therein. Weeding effort over the past year has been focused on areas around the rare plants, and in areas of healthier native forest. The weeding effort in this WCA is focused mainly on understory weeds, as the state managers feel it necessary to keep overstory control to a minimum (6% per trip) to reduce light gaps which stimulate rapid growth of lower weeds.

It will be necessary to continue weeding effort in this WCA on a regular basis, as there are aggressive weeds which do not take much time to return to the weeded areas like *R. rosifolius* and *B. asiatica*. NRS plan to return to this site at least four times in the next year to improve the habitat for the rare plants present. Priority areas for weeding will continue to be around rare plants, as well as increasing the buffer of native dominated habitat around them.

Upper Kapuna-02; Kapuna Stream

This WCA is contained by a small fence, in which are planted *C. superba* and *C. herbstii*. Weeding is focused on maintaining the health of the microclimate around the outplantings. The area is small and so not much effort is needed to keep up with weed regeneration. The main weed in the area is *R. rosifolius*, an understory plant which can quicky colonize an area. In the coming year, NRS will visit the site at least once to monitor the re-growth of R. rosifolius and other weeds and treat them if necessary. This site is managed for fruit production, and so not much effort is invested in weeding the surrounding habitat. The understory is primarily native, with the exception of a thick carpet of *B. appendiculatum;* the overstory is mixed native and non-native. Weeding is focused only on understory species at this time so as not to alter the light regime for the outplanted species.

Upper Kapuna-03; Keawapilau SchNut/CyaLon.

There are two protected species in this WCA, *Cyanea longiflora* and *Schidea nuttalii*, both of which are designated ‘Manage for Stability’. The area contains a fair amount of overstory weeds separating some small diverse native patches. In the past year the weeding conducted at this spot has focused on understory weeds. Weeding is concentrated mainly in the immediate vicinity of the rare taxa. It was noted that the areas look good and that weeding from the previous year was effective but that *Clidemia hirta*, a common understory weed in the area, had re-colonized the weeded areas. This year much of the *C. hirta* around the lower *C. longiflora* was weeded. In the following year NRS will visit the site quarterly to assess the re-growth of weeds, and continue to keep the areas around the protected plants free of weeds to eliminate competition and to encourage recruitment.

On September 25th of this year NRS visited this WCA with Patti Welton to assist in a reading of a “releve” plot which was first installed and read in 1933 by Mrs. Welton for her PhD thesis at the University of Hawai‘i. The plots give a measure of community structure based on height and cover of all species present. There are releves scattered throughout Upper Kapuna and Pahole MUs, and in the future it will be important to read the plots before weeding occurs. It is important to read them prior to weeding to get baseline data for the area, so that the effects of future weeding can be measured.

Upper Kapuna-04; Keawapilau CyaLon/PhyKaa

Upper Kapuna-03 and 04 are close enough together that weeding at the two sites is often tasked as one action. The areas immediately around the rare plants are particularly sensitive due to the presence of the rare taxa and the steep terrain of the site. NRS only weed directly around the taxa to maintain their existing microclimates. In the rest of the WCA, there are patches of mostly native forest where more intense, understory weed control is conducted. NRS believe that species such as *C. longiflora* would benefit from creating more continual habitat through the population. The only canopy weeding that occurs in this WCA is the removal of *G. robusta,* which occurs sparsely and does not affect the shade/light dynamics very much due to its height and foliar structure. NRS plan to revisit this site quarterly in the coming year.

Upper Kapuna-05; Kapuna fenceline

This year a new fenceline was cleared in the Kapuna area in preparation for fence construction. The cut vegetation was treated with Garlon 4 herbicide at 20% dilution rate. In the coming year NRS will monitor the fenceline for re-growth and treat as necessary, but will not maintain this WCA into the future.

Upper Kapuna No MU-01; 1-Acre Site

This WCA is defined by an old outplanting site within a fence, containing a number of protected species which are doing very well and are some of the largest outplanted specimens of their species anywhere. The area is known as the “1-Acre Site”, and is on state land. Weeding is focused within the fenced area on understory weeds as there remains a high number of understory weeds, the fern *C. parasitica* in particular, and the overstory is largely native-dominant. One trip was spent weeding in this WCA, and it was observed that the site is looking good, with healthy outplantings and large native canopy trees. In the coming year NRS plan to re-visit the site at least once to treat understory weeds around the outplantings. The WCA is managed mainly for fruit production, so ecosystem scale weeding here is limited.

IP MU: West Makaleha

The West Makaleha MU is within Mokulēʻia Forest Reserve and borders MMR and Pahole NAR. At this time, there are two WCAs within the West Makaleha MU, West Makaleha-01 and West Makaleha-02 (Figure 2.1.16). The management actions for West Makaleha-01 revolve around maintaining the habitat for a population of *S. obovata*. The management actions for West Makaleha-02 are focused first around a population of *C. grimesiana* subsp. *obatae*. Secondarily, the site will be utilized to continue habitat restoration efforts and expand outplanting sites of, *C. longiflora, S. obovata,* and *Pritchardia kaalae*.

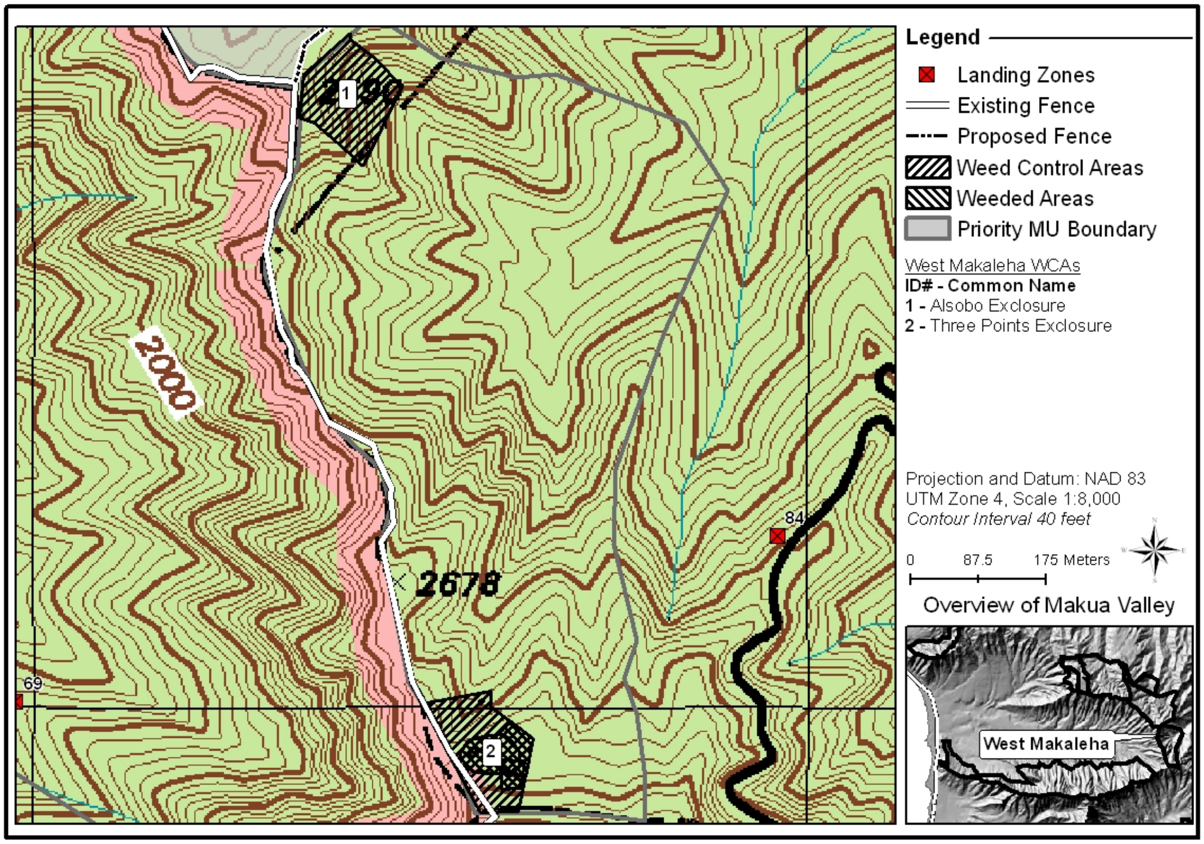


Figure 2.1.16 Weed Control Areas in West Makaleha

WCA Discussion

West Makaleha-01; Alsobo Exclosure

NRS have intentionally minimized their presence and impact in the area. Management actions are scheduled with routine monitoring and collection visits because the plants grow on a steep slope, and the immediate habitat is not highly threatened by weeds. No weeding was done in 2005-2006. Follow-up weeding for past canopy removal above the slope is scheduled for next year.

West Makaleha-02; Three Points Exclosure

NRS try to initiate control efforts quarterly in order to keep weed populations manageable. The long term objective for this WCA is to restore the area to a predominantly native forest. Complete eradication of all alien invasive species in the near future is unrealistic but attainable goals have been established for;

- 100% native canopy cover
- 95% native understory

These restoration goals will take many years to accomplish for a large percentage of the WCA but short term objectives directed at guiding management efforts will help to attain the desired end product.

- Prevent incipient invasive aliens from becoming established.
- Create a Zero Tolerance weed list to guide effort.

- Develop/locate protocols to treat species which NRS don't currently have a means of controlling.
- Use volunteer labor for select projects.

The highest priority weed control in this area is concentrated around a population of *C. grimesiana* subsp. *obatae*. The forest within this area is relatively intact and does not require a large amount of management to keep it so. As it stands now, *R. argutus* and a few other understory species are the biggest challenges for this area. All of the canopy *P. cattleianum* within this area have been eradicated. NRS was able to visit the area two times this year and focused all efforts on the understory weeds. NRS will continue this as it appears that the strategy has been working. Quarterly trips are planned and shall include overnight camping stays in order to maximize time spent.

Work in the upper open portion of West Makaleha-02 has been focused on habit restoration efforts and expanding outplanting sites of *D. subcordata*, *C. longiflora, S. obovata,* and *P. kaalae*). NRS has successfully controlled grass species dominating the upper portion of the exclosure in the past with undesirable consequences (NRS Report, 2005). NRS has moved away from the total elimination of grass from this area for the time being and focusing more energy on spot treatment associated with outplanting of common native species. NRS will also continue quarterly management actions of *R. argutus* and other understory invasive species through spraying and clip and drip methods.

NRS have taken an aggressive approach to killing the monotypic *P. cattleianum* stands with impressive results (NRS Report 2005). This aggressive approach in combination with hand weeding has facilitated the recruitment of more natives. NRS will continue with this management action and combine common native outplanting with it.

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present			
IP MU: West Makaleha								
WestMakaleha-02	Habitat	13375.15	4940.791	36.94%	CyaGriOba, DelSub, PriKaa, SchObo			
				Treatment Type		**# of Visits**	**Effort (Person Hrs)**	**Species Controlled**
				Grass Control		1	1.50	MelMin, PasCon
				Ecosystem Weed Control		4	23.50	BudAsi, CliHir, PasCon, PasEdu, PsiCat, RubArg, RubRos
					Total	5	25.00	

IP MU: ʻŌhikilolo

The ʻŌhikilolo MU lies between Mākua and Mākaha valleys. There are a total of 19 WCAs within this MU, most of which are established around wild and outplanted populations of *Pritchardia kaalae*, wild populations of a number of other rare and protected plant species, and also a large number of *A. mustelina*. There is much variation among WCA's in the level of weeding effort they receive. Some WCA's, like Ohikilolo-10, are largely native and require only occasional understory weeding, while others are alien dominated, and will require long-term plans if native-dominance is to be achieved. The MU is threatened by fire originating from

MMR as well as from roadside fires started on Farrington Highway. As of 2005 the entire MU has been cleared of feral goats, the effects of which are quantified by data from four LCTA plots three of which are reported below and the other appears in Chapter 1: Feral Ungulate Management.

Within the MU, LCTA plot 713 is located in WCA Ohikilolo-03 (see Chapter 1 for discussion and data analysis), plot 705 is located in WCA Ohikilolo-05, plot 714 is located in WCA Ohikilolo-10 and plot 715 is located in WCA Ohikilolo-13 (Figure 2.1.19). Only plot 714 was not read by NRS Monitoring this year because it is mostly native with a thick fern understory, had been read in 2003 and we did not wish to damage the forest in order to collect the data this year. This plot will be read next year. Detailed discussions and the data analysis appear in the WCA sections below.

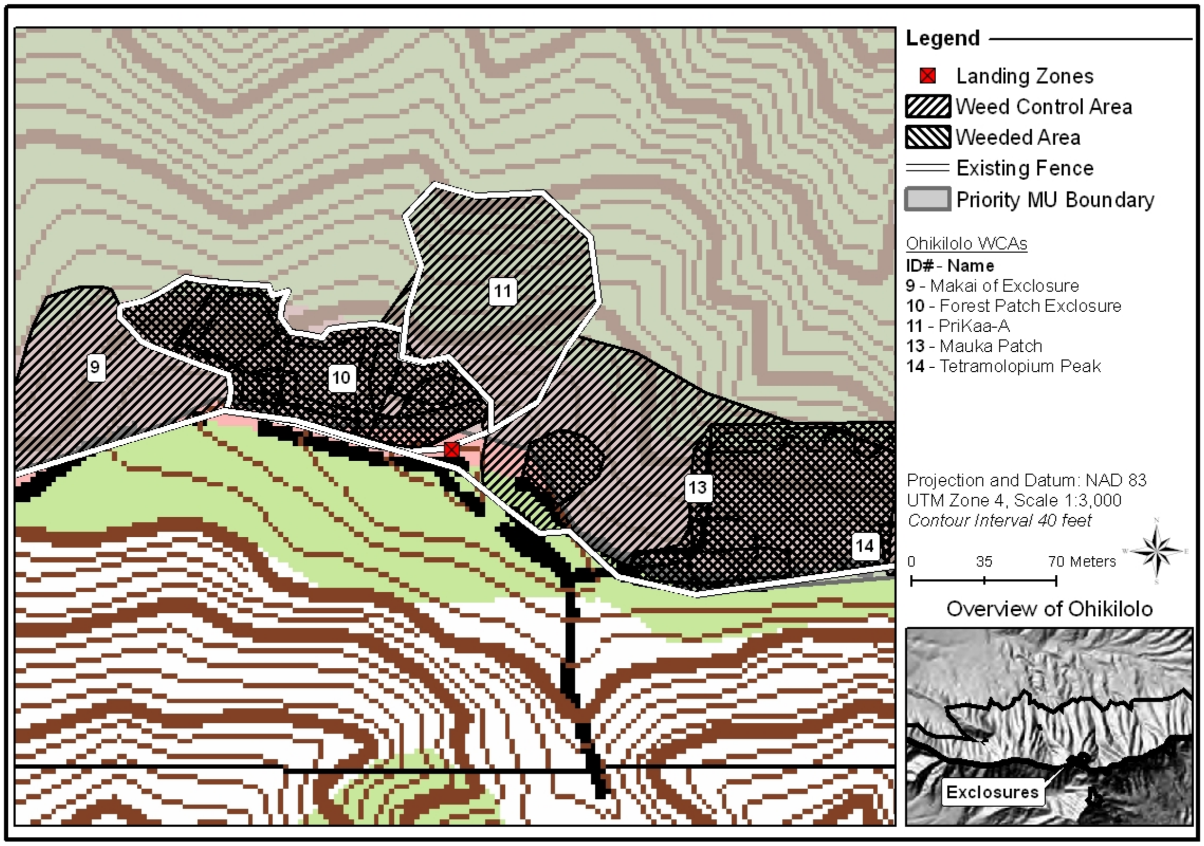


Figure 2.1.17 Weed Control Areas in ʻŌhikilolo – Fence Exclosures Section, Makua Military Reservation

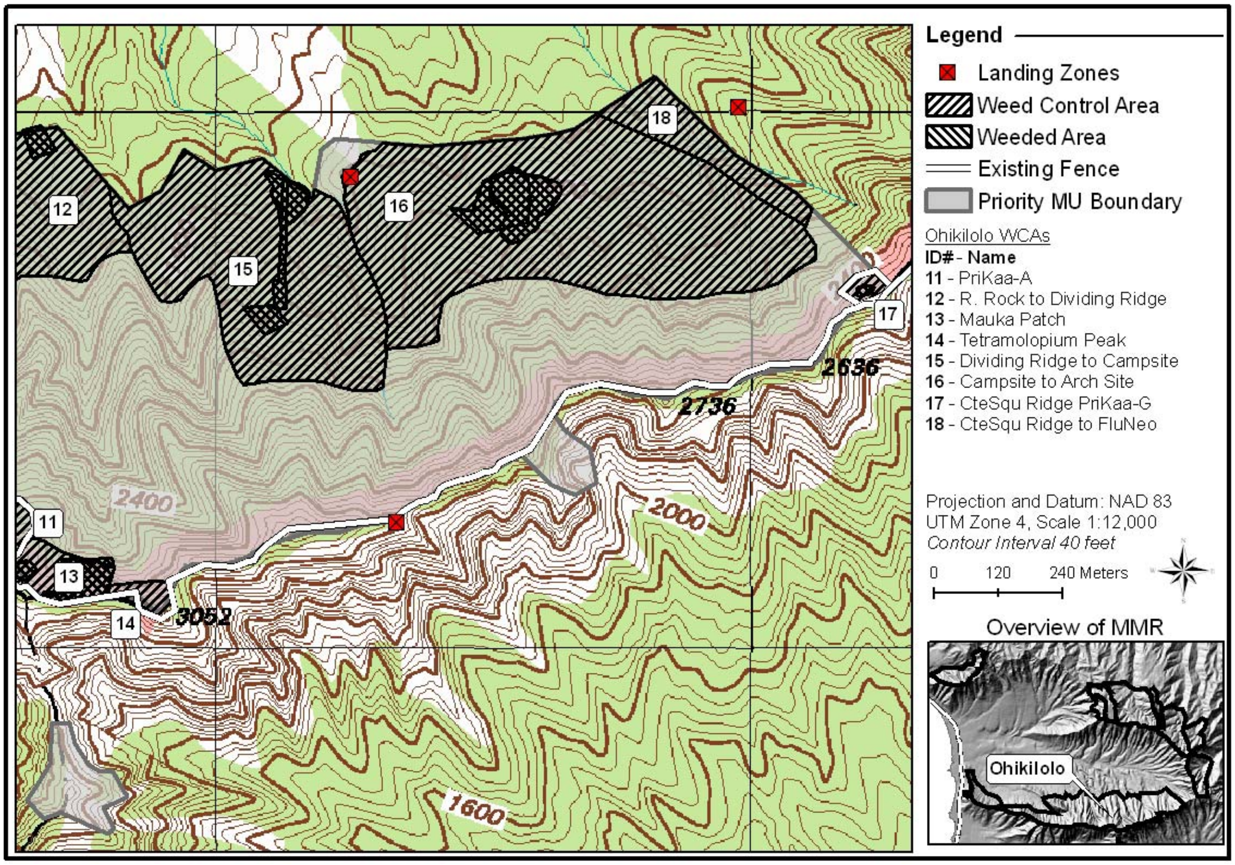


Figure 2.1.18 Weed Control Areas in Ohikilolo – Mauka Section, Makua Military Reservation

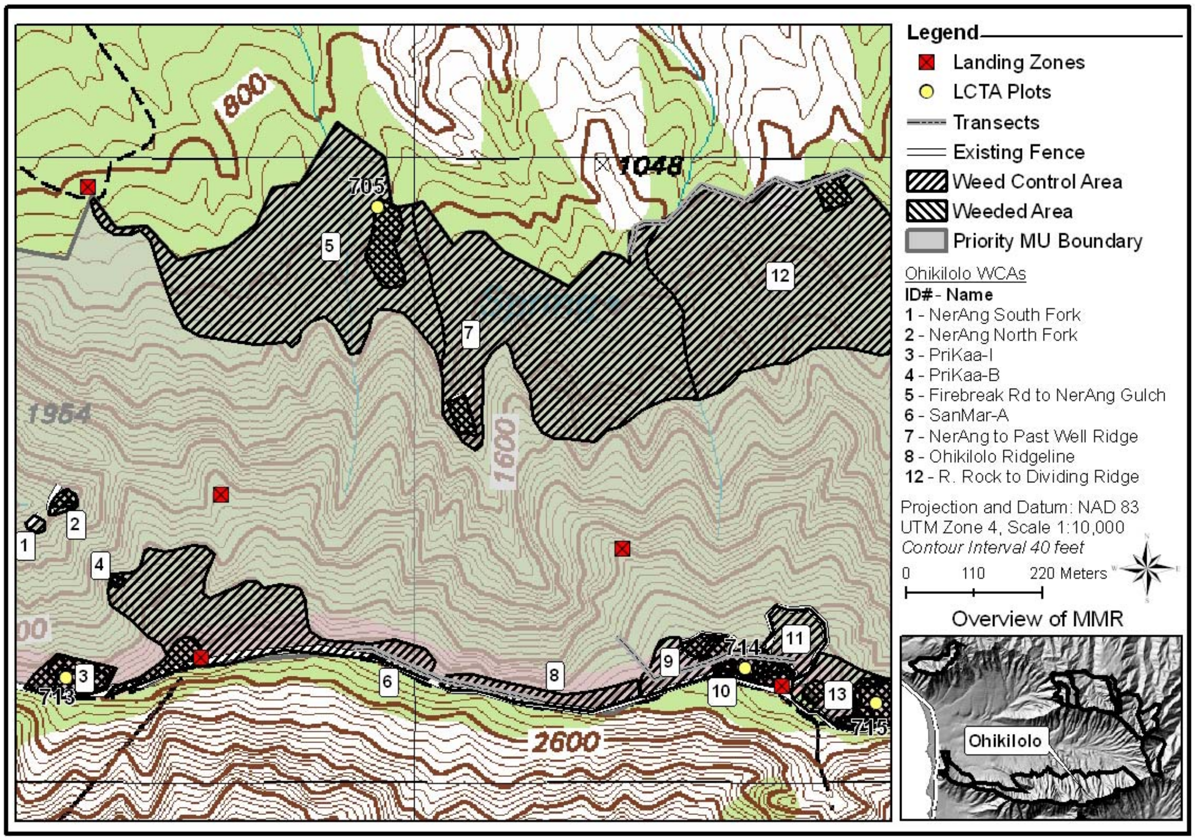


Figure 2.1.19 Weed Control Areas in Ohikilolo – Makai Section, Makua Military Reservation

Transect Discussion

There are two transects in this MU. No new significant weeds were identified.

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present

IP MU: Ohikilolo

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Ohikilolo-02	Habitat	1244.415	871.1389	70.00%	NerAng, NotHum

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	4.00	AgeAde, BleApp, MelMin
Ecosystem Weed Control	1	1.00	AgeAde
Total	2	5.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Ohikilolo-03	Habitat	6570.25	6470.33	98.48%	MelTen, PriKaa, PteMac, VioChaCha

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	3	8.50	AgeAde, AgeRip, EriKar, GreRob, LanCam, SchTer, StaDic
Total	3	8.50	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Ohikilolo-04	3M	372.912	210.5436	56.46%	PriKaa

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	2	0.75	AndVir, MelMin, RhyRep, SetGra
Total	2	0.75	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Ohikilolo-05	Habitat	92851.78	18087.61	19.48%	BobSan

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	15.50	AgeAde, AgeRip, AleMol, CorFru, GreRob, MelAze, PasEdu, PluCar, PsiCat, PsiGua, RivHum, RubRos, SchTer, SenSur, SpaCam, SyzJam
Total	2	15.50	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Ohikilolo-06	Habitat	3862.677	100.9095	2.61%	DubHer, SanMar

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	1.00	MelMin, RhyRep
Total	1	1.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Ohikilolo-10	Habitat	7514.252	7241.446	96.37%	PriKaa, SanMar

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	2	6.50	MelMin, RhyRep, SetGra

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present		
				Ecosystem Weed Control	3	31.50	AgeAde, AgeRip, EriKar, LanCam, RubRos, SchTer, SetGra, StaDic, TriSem
				Total	5	38.00	
Ohikilolo-12	Habitat	107927.7	8652.23	8.02%	BobSan, LobNii, Nespol		
				Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
				Ecosystem Weed Control	1	4.00	PsiCat, SchTer, SyzCum
				Total	1	4.00	
Ohikilolo-13	Habitat	16507.03	9035.364	54.74%	MelMak, NotLon, PriKaa, PteMac		
				Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
				Grass Control	2	3.50	MelMin, SetGra
				Ecosystem Weed Control	4	126.00	AgeAde, AgeCon, AgeRip, BleApp, BudAsi, ChrDen, ChrPar, CupCar, EriKar, KalPin, LanCam, PsiCat, PsiGua, RubRos, SchTer, SetGra, StaDic, SyzCum, TooCil, TriSem
				Total	6	129.50	
Ohikilolo-15	Habitat	141076.5	28410.85	20.14%	AleMacMac, BobSan, DieFal, FluNeo, PteMac		
				Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
				Ecosystem Weed Control	3	32.00	BudAsi, GreRob, KalPin, LanCam, PsiCat, PsiGua, RubRos, SchTer, SyzCum
				Total	3	32.00	
Ohikilolo-16	Habitat	226524.3	38880.4	17.16%	AleMacMac, BobSan, MelTen, PteMac		
				Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
				Ecosystem Weed Control	3	57.50	CliHir, GreRob, PsiCat, SchTer, SpaCam, TooCil
				Total	3	57.50	
Ohikilolo-17	Habitat	3599.952	512.3422	14.23%	PriKaa		
				Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
				Ecosystem Weed Control	1	4.50	AgeAde, GreRob, PsiCat, SchTer, StaDic
				Total	1	4.50	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Ohikilolo-19	Habitat	43742.19	3920.042	8.96%	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	3.00	GreRob
Total	1	3.00	

WCA Discussion

Ohikilolo-01; NerAng South Fork

No weeding was conducted this year. NRS will weed here next year.

Ohikilolo-02; NerAng North Fork

NRS weeded around a wild *Neraudia angulata* population while collecting from plants there this year. The area is dominated by weeds and NRS will weed once a year to encourage *N. angulata* recruitment.

Ohikilolo-03; Ohikilolo Koiahi Prikaa-I

This WCA is home to an outplanted population of *P. kaalae* and a handful of other rare species. The habitat it contains is patchy, with some very nice native stands of understory species, but it is completely dominated by *S. terebinthifolius* in the overstory. Weeding effort this year has concentrated on removing *G. robusta* from the patch, as well as some cutting and spot spraying of understory weeds. This spot would be a good plot to plant common native overstory trees, which would provide a canopy for the outplantings and native understory species, and allow for the future removal of the *S. terebinthifolius* overstory. At present, it is felt that removal of the overstory would be detrimental to shade-loving understory plants, and that the transition has to be made slowly. NRS plan to visit this site at least once in the coming year to weed the understory and to assess the feasibility of planting common canopy species in the future.

Monitoring

Plot 713

Please see discussion and data analysis in Chapter 1: Feral Ungulate Management.

Ohikilolo-04; Ohikilolo Prikaa-B

This small WCA contains a small population of wild *P. kaalae*. The population is made up of 3 mature trees and six seedlings at the edge of a steep cliff. The area around the trees is weeded, small herbaceous plants and grass being the main targets. In the past year the site was visited twice to weed. Only a small amount of herbicide and effort were expended. It is unclear how NRS will manage this population in the future, as the *P. kaalae* are only being managed for fruit production. The habitat surrounding the trees is not forested and is not ideal for restoration. It would require a huge investment in time and resources to try to rehabilitate this site.

Ohikilolo-05; Road to Nerang Gulch

This year NRS weeded on a forested ridge in this WCA that was last weeded just less than two years prior to this effort. Due to the fact that the area is mostly native, only a few weeds such as

P. cattleianum had established since last weeded, and were not yet mature. NRS believe that this two year revisitation frequency may be appropriate for similar types of habitats throughout Lower Mākua. NRS would also like to follow up this weed control with grass control where it is encroaching from the edges of the forest patch.

Monitoring

Plot 705

This plot shows significant changes in the mean number of native and non-native species interceptions over time (native p=0.02, non-native p=0.04). Both native and non-native mean number of interceptions (χ) increased over time from 1996 (native χ=2.56±1.54 and non-native χ=1.68±1.02) to 2006 (native χ=3.38±2.02 and non-native χ=2.25±1.29) though the total number of hits of invasive species decreased, χ, the mean, increased (Figure 2.1.5). This plot has been weeded for overstory invaders such as *P. cattleianum, G. robusta* and *A. moluccana* in 2002, 2003 and 2004. Additionally goat removal has been carried out by NRS at this location; therefore these changes represent those that could be expected following intensive management activity and upon removal of goats (pigs may still be impacting this area) but without reintroductions.

Specifically, in response to management native trees (1996 χ=2.56±1.54 2006 χ=3.38±2.02) and non-native grasses (1996 χ=1.12±0.33 2006 χ=2.5±2.12) have significantly increased in mean number of interceptions in the plot (p=0.0221 and 0.0073 respectively). However, non-native grass was only encountered twice in 2006, which is a dramatic decrease in the total number of points at which it was encountered from 1996 (n=17). Therefore the increase in mean interceptions of non-native grass may be an artifact of sampling and not represent a real increase in cover. Non-native herbs and vines were detected only in 2006 and this could be due to relief from browse pressure. Understory weed control activity has been low in this area and these data suggest that in the absence of browsers, grass and herbaceous species' control may have to be intensified in order to reduce non-native plant cover. No ferns were detected in this plot at either date sampled. This could be due to significant and continued disturbance by feral pigs which continue to be present in the area.

<u>Ohikilolo-06; Ohikilolo Sanmar-A</u>

This WCA surrounds a population of *Sanicula mariversa*. The primary threats to this site are weedy grasses. Weeding effort this year has been minimal, and it was observed that past years weeding efforts succeeded in killing many of the grasses in the area. In the coming year NRS will re-visit the site to monitor the *S. mariversa* and assess if more grass control is necessary. NRS will also monitor the possible influx of *Stachytarpheta dichotoma* to the site, and treat it and other common fenceline weeds as necessary.

<u>Ohikilolo-07; Nerang to Past Well Ridge</u>

This year NRS focused weeding in this WCA around a site of wild and reintroduced populations of *N. angulata* and *Nototrichium humile*. The weed control conducted around the rare plants is difficult because the gulch has steep walls and therefore weeds are mostly controlled in the gulch bottom and up as high as staff can get on the gulch walls. NRS have anecdotally noticed an increase in native fern cover in the gulch bottom likely due to the continual removal of feral ungulates and weeds such as *Ageratina riperia, A. adenophora* and *R. rosifolius*.

Ohikilolo-08; Ohikilolo Transect 9 Ridgeline

NRS expended no weeding effort in this WCA during the 2005-06 reporting year. In the future, NRS will seek to expand on efforts from 2004-05 and sweep any previously untouched areas in this WCA for *G. robusta* and *S. terebinthifolius*.

Ohikilolo-09; Ohikilolo Makai of Exclosure

The effort spent weeding in this WCA was spent on grass control. Five hours of grass control were spent in this WCA this year. This area has some nice native habitat, and since not much weeding has ever been done in this WCA, it would be a good opportunity to set up a monitoring plot inside to document and measure the effects of weeding on habitat structure and composition.

Ohikilolo-10; Ohikilolo Forest Patch Exclosure

This year NRS went to this WCA to weed once. The forest within this WCA is native dominant, and is home to a high number of *A. mustelina*. Weeding was split between ecosystem and grass weeding. The most prosperous weed in the area is *Rubus rosifolius*, which quickly occupies open areas if left un-weeded for long periods. Weeding effort in this patch has decreased over time, as natives fill in weeded areas. NRS have noted that native ferns seem to be responding well, and are filling in understory areas. On the last trip to weed in this WCA, NRS commented on the health of the habitat, finding it hard to move because of the thickness of the native vegetation. In the coming year, NRS plans to re-visit the WCA twice to ensure that grass and other weeds are suppressed. *A. mustelina* will most likely benefit from the weeding effort done in this WCA as the native canopy species regenerate and become more common.

Monitoring

Plot 714

This plot shows almost no change in the mean number of interceptions of native and non-native species over time for all years it was read (1996, 1999, 2003). Again, the data from 1999 don't match the patterns seen in the data collect in both other years. The means from 1999 are higher for both native and non-native species than those for both 1996 and 2003, and have higher standard deviations. A small 10 acre fence was erected around this area in 1999 and these data could be a response to removal of browsing pressure from goats. Additionally, these data were collected slightly later in the year (June compared to May in 1996 and March in 2003) and this could have contributed to the differences in the values. From these data NRS concludes that there have been no marked changes in the vegetation in this plot (native $p=0.186$, non-native $p=0.7196$). NRS believe however, that the volume of the understory vegetation has increased and suggest that this method is not adequate to detect such changes.

Upon examination of these data, it becomes clear that the number of non-native plant interceptions has always been very low in this plot (1996=6, 1999=26, 2003=14) while native species interceptions have always been high (1996=148, 1999=233, 2003=62). Native sedges', the only group of species that showed any significant change with goat removal in this plot, ($p=0.0338$) mean interception (χ) dropped from 1.83 ± 0.408 to 1.0 ± 0.0 with goat removal. This group was rare overall (prior to goat removal n=6, post goat removal n=2), and this decrease may be due to limits of the sampling design which is not ideal for detecting species with low cover. Weeding intensity has been fairly constant at this site but without current data it is difficult to determine if weeding efforts are significantly altering the vegetation community. These data suggest that weeding activity in this plot could be reduced due to the low occurrence of non-native species found here. The location and weed control history of the area may provide NRS an opportunity to evaluate the importance of weeding frequency on successful removal of species from the ecosystem. The plot will be read in 2007 and these questions will be evaluated.

Ohikilolo-11; Ohikilolo Prikaa-A Fence

NRS expended no weeding effort in this WCA during the 2005-2006 reporting year. NRS plan to weed 0 times in the next year.

Ohikilolo-12; Rons Rock to Dividing Ridge

NRS weeded one forest patch in this area on one trip this year. The area is relatively flat, and has several large *Syzigium jambos* that NRS would like to girdle with chainsaws next time.

‘Ōhikilolo 13; ‘Ōhikilolo Mauka Patch

Weeding effort was spent in the this WCA on nearly every trip taken to ‘Ōhikilolo this year. Currently the weeding strategy for this WCA consists of large sweeps through the area to cover as much ground as possible. Because of intensive weeding efforts here in previous years, and because of continuing weeding trips, the area is made up primarily of native plants, and not as much effort is needed now to keep it in a native-dominant state.

Effort is also invested in grass control within the WCA, with the major target being *M. minutiflora*. This grass forms dense mats which may inhibit seedling germination and growth, and so it is important to spend time to control it.

The area that is primarily swept on weeding trips consists of a large piece of habitat from the ridge fenceline, around the *Melicope makahae* down to the *Pteralyxia macrocarpa*. Within that section *Freycinetia arborea* and a variety of ferns are thriving and make up the majority of the goundcover. An alien fern, *B. appendiculatum*, is covering a lot of ground on the ridge tops where taller ferns have not become established. This weed, however, is very low in stature and does not affect higher vegetation tiers, besides possibly affecting seed germination rates. No control is planned for this weed at the present time.

The *R. rosifolius* epidemic noted in last years report is under control, although *R. rosifolius* does persist in sporadic numbers and has to be continually attacked during weeding sweeps.

This WCA contains a large number of outplanted *P. kaalae* which are scattered all around the area. A large weeding effort was undertaken to clear the area for planting. Weeding in the next year will partly focus around the outplantings to ensure that they are not overrun by aggressive fast-growing weeds filling in the gaps created by clearing.

In the coming year weeding effort will be similar to this year, with large area sweeps through native dominated areas and outplanting sites. Sweeping the site three times a year should be adequate to control weeds as well as allow time for expansion efforts at the boundaries of the native dominated areas.

Monitoring

Plot 715

This plot shows both native species counts and non-native species counts differed significantly among years for all years the plot was read (p=0.0033 and 0.006 respectively). Again, the mean counts (χ) for non-native species intercepted in 1999 were much higher than the counts for all other years. In this plot however the native counts seem more reasonable compared to the other years' values. The standard deviation of the non-native counts from 1999 is also exceptionally high (2.006) compared to other years. It is not known why the mean was higher in 1999, there were different investigators each year, and this could be a function of biases in the way the plot was read, or could represent a real increase in the intercepted vegetation on the line. Goats remained in the area until 2005 despite the fence completion in 2000 however the rate of detection and presumed associated impacts have declined sharply beginning in 2001-2002. Weed control activity in the vicinity of the plot has been fairly intensive beginning in 2001 and has been focused on understory weeds.

Upon goat removal NRS expects that understory species cover will increase and therefore the mean number of species interceptions (χ) will also increase. When comparisons were made between growth form groups' χ before and after goat removal, only native vines showed a significant increase in χ (p=0.0302). This group includes species like *Freycinetia arborea* whose χ rose significantly through time (p=0.0620 1996 χ=1.25±0.5 to 2006 χ=3.9±1.91) confirming that understory species will respond favorably to goat removal. Overall the trend is for both native and non-native species interception to increase over time (native species:1996 χ = 1.95±1.05, 2006 χ = 2.75±1.6, non-native species:1996 χ = 1.78±0.44, 2006 χ = 2.43±1.08). This indicates that overall, vegetative cover is increasing in this plot. Interception of the non-native fern *B. appendiculatum* has shown an increasing trend since it was first detected in 2003 in this plot (p=0.1563) and the non-native tree *S. terebinthifolius* may be increasing as well (p=0.0113 but largely due to spike in 1999). This suggests that weed control activity in this area may need to be increased in order to reduce non-native species' cover.

<u>Ohikilolo-14; Ohikilolo Tetramolopium Peak</u>

NRS expended no weeding effort in this WCA during the 2005-2006 reporting year. Grass is the primary threat in this WCA, which consists of a steep ridgeline and peak home to *Tetralopium filiforme*. Last year the grass in this WCA was well sprayed, and after subsequent monitoring this year it was deemed that no retreatment was necessary.

<u>Ohikilolo-15; Dividing Ridge to Campsite</u>

Several days of weed control were spent in this WCA, prioritized around rare plant populations. NRS weeded a large area of habitat around a *Bobea sandwicensis* population, as well as around an area encompassing a *Flueggea neowawraea* and several *Alectryon macrococcus*. Next year NRS plans to weed in this area two times.

<u>Ohikilolo-16; Campsite to Arch Site</u>

This WCA has several areas of large, continuous patches of native forest. Of note, NRS discovered a really large, over 80% native, broad slope that had been overlooked in the past. NRS conducted about 55 people hours' worth of weeding during two trips to this area, created one continuous weeded area, and noted that there remains more appropriate habitat to sweep through. The most dominant weed in the area are large *P. cattleianum* trees, but individuals are few and far between likely because the native canopy and understory are healthy and little room is left for invasion of weeds. While no MIP taxa are in this area, NRS are considering this forest patch for future outplantings of MIP taxa. NRS need to look at planning additional fencing to protect this intact WCA.

Ohikilolo-17; Ohikilolo Ctesqu Ridge Prikaa-G

This WCA is defined by a small fence erected this year to protect a reintroduction of *P. kaalae*. The overstory in this steeply graded habitat is largely native-dominated with some aliens, predominantly *S. terebinthifolius*. The understory largely open and is dominated by herbaceous alien species such as *B. appendiculatum* and *A. adenophora*. Since the outplanting in the beginning of the year, the WCA has been weeded twice. In February it appeared that *A. adenophora*, a non-native perennial herb, had expanded in number and size amongst the outplantings possibly due to increased light availability. Weeding was focused on basally treating large clumps of this weed. It has been observed that cut pieces of *A. adenophora* have the ability to re-root in suitable conditions, making the "clip and drip" technique less appropriate for this weed. NRS applied G4 at 20% onto the uncut bases of the clumps. However, the day was overcast, and soon after the site was weeded a larger rainshower engulfed the area. On a later sweep, in August of this year, it was observed that nearly all the large clumps of *A. adenophora* had died. Treatment appeared to have been successful. In the coming year, NRS plan to monitor the regrowth of *A. adenophora* and other understory weeds by doing bi-annual sweeps through the outplanting site, and possibly removing some of the non-native canopy trees to ensure optimal habitat for the outplanted *P. kaalae*.

Ohikilolo-18; CteSqu Ridge to FluNeo

NRS expended no weeding effort in this WCA during the 2005-2006 reporting year.

Ohikilolo-19; ‘Ōhikilolo Fence between Prikaa I and Sanmar A

This WCA complements ‘Ōhikilolo-08; both are defined along the fenceline, both include areas of approximately 100% alien vegetation and areas of around 75% native shrub, and the primary targets at both are *G. robusta* and *S. terebinthifolius*. This WCA was created this year, and NRS targeted all *G. robusta* reachable without ropes. In the future, NRS plan to sweep the rest of the WCA. Once an initial sweep is done, retreatment may not be necessary for several years.

IP MU: Mākaha

Just a few of the areas within Mākaha are in exceptional condition. A majority of the MU that is to be fenced is heavily impacted by a variety of weeds. In order to delineate WCAs within the fence, NRS created fairly large sections. Initially, NRS have focused more attention to weeding around rare or endangered plant populations and habitat with high conservation value within the different sections. With more visits, NRS have realized that more effort needs to be focused on other sections of lesser quality as well in order to abate the invasion. NRS are also focusing on eliminating zero tolerance weeds from the fenced area. As Mākaha Valley is surveyed in greater detail and more fences are constructed, more WCAs will likely be established. Only WCAs in which control has been conducted this year are discussed below.

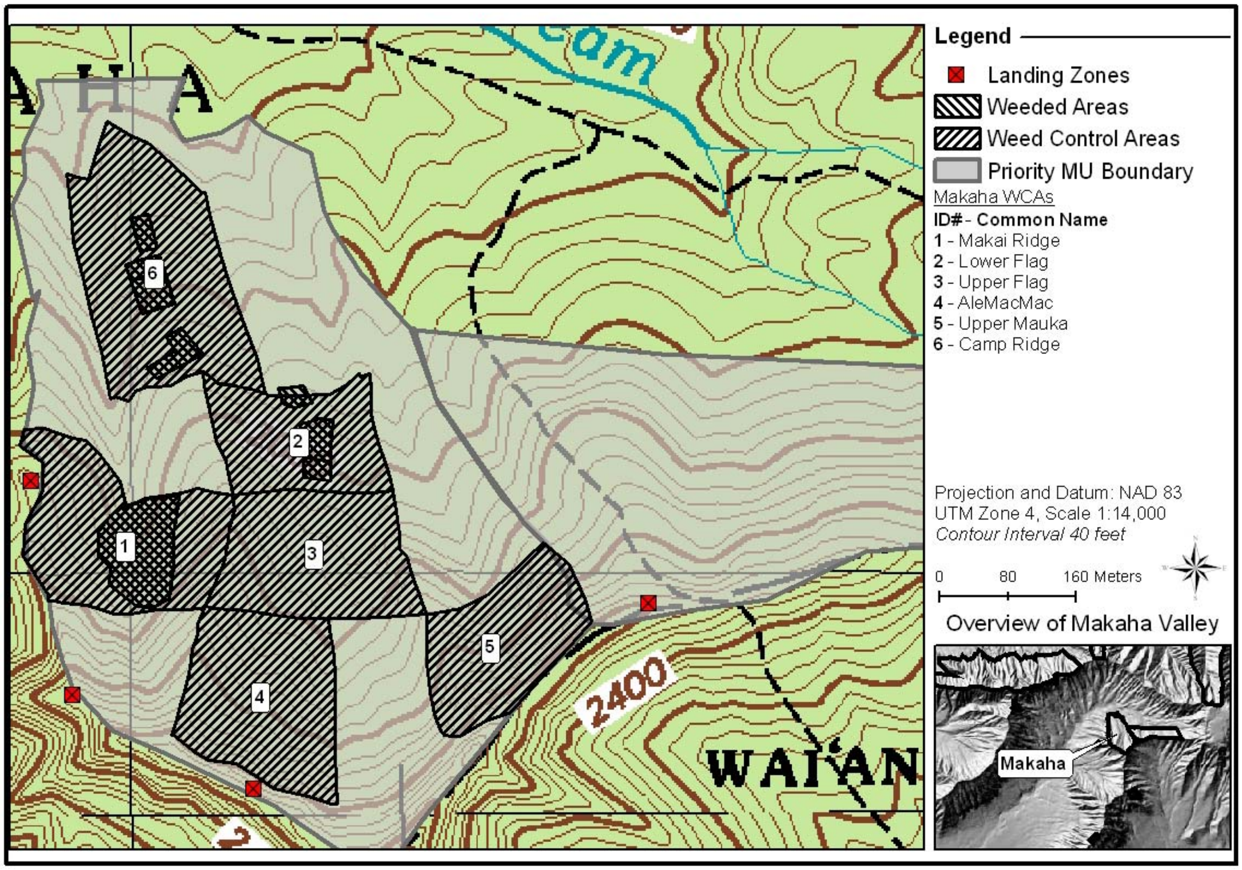


Figure 2.1.20 Mākaha Weed Control Areas

WCA Discussion

Mākaha -01; Makai Ridge

In the past, NRS have focused management efforts in Makaha-01 around an individual of *F. neowawraea*. In order to allow the habitat time to recover from the removal of the canopy NRS decided to focus its efforts on one habitat altering species of tree, *Toona ciliata*. This is the one site within the fence with a sizable population of *T. ciliata* and the most likely source of seed for dispersal within the fence. In 2005-2006, NRS spent 23.5 hours clearing 2.3 acres of all mature trees. This is the first time NRS has attempted a large scale control of this species. The process will probably take at least 3 years to eliminate the seed source.

Mākaha -02; Lower Flag

NRS conducted three work excursions with the Waianae High School Hawaiian Studies group in order to remove *P. cattleianum*, *Coffee arabica* and other weeds. This area was selected due to its proximity to the access trail and the bottom of the fence. There are also irregular patches of native canopy throughout this WCA and NRS hope that this native habitat will eventually spread with the removal of these weeds. NRS spent a total of 35 hours conducting weed control over a 2500 m² area.

Mākaha -06; Camp Ridge

NRS, in association with Associate Professor Tamara Ticktin of the University of Hawai‘i, created test plots in order to measure the response of native habitat with the removal of *P. cattleianum* and other weeds. Twelve 20 x 20 meter plots were set up to evaluate three different methods of weed removal. Three of the plots were Total Cut, whereby all alien species were completely removed. Three more plots were Total Girdle, so all the alien trees were killed by means of girdling and were left standing. Three other plots were Selectively weeded by size so that some large alien trees were left alive and only small alien species were removed. The last three plots were set up as controls. Within each 20 x 20 m plot a 10 x 10 m subplot was arranged so that all the trees that were > 1 cm dbh were measured and tagged within each of the 10 x10 m plots, ten 1 x1 m plots were done so that all of the seedlings were measured and tagged.

The 1 x 1 plots are to be remonitored every 1-2 months tagging and recording all of the new native seedlings and removing, drying, and weighing all of the new alien weeds. Light measurements were taken before and after weeding, then every three months there after in each of the 1 x 1 m plots using hemispheric photographs and LICOR light meters. There was also one HOBO set up in a total cut plot and a second in a total girdle plot prior to the weeding documenting any changes in light, soil moisture, humidity, and temperature.

To date, all of the results are incomplete. All trees in the plots will be re-measured one year after the experiment which is October 2006 and results reported in next years report.

Mākaha -07; Fenceline

This WCA consists of weeding along fenceline. A total of 68 people hours were spent clearing all of the vegetation along the fence corridor. Once the fence is complete, any weeding actions that take place within the areas of the WCA that are a part of other WCA’s will be reported likewise.

Mākaha-No MU; Trail Trisem

In an effort to stop the progress of *Triumphetta semitriloba* into the fenced MU, NRS has spent nine people hours clearing this weed from along the trail corridor. It appears that this method has been working with less plants being observed each time. NRS shall continue with this action.

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
IP MU: Makaha					
Makaha-01	Habitat	35385.17	18248.78	51.57%	FluNeo

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	23.50	TooCil
Total	1	23.50	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Makaha-02	Habitat	22754.41	2689.832	11.82%	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	3	35.00	CofAra, PsiCat, SchTer, TooCil, TriSem
Total	3	35.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Makaha-06	Habitat	45433.15	4818.784	10.61%	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	5	186.90	AgeAde, AleMol, BudAsi, CliHir, CofAra, CorFru, FraUhd, GreRob, KalPin, LanCam, MelAze, PasEdu, PluCar, PsiCat, SchTer, TooCil, TriSem
Total	5	186.90	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Makaha-07	Fenceline Clearing	0	0		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	3	68.50	GreRob, LanCam, PsiCat, SchTer
Total	3	68.50	

IP MU: Puʻukūmakaliʻi

This is the first year any weed control work has been conducted in the Puʻukūmakaliʻi MU. The MU encompasses an important population of *T. filiforme*, which has been designated as MFS. The MU is very steep, encompassing the tops of very sheer cliffs north of Kolekole Pass. Currently, only one WCA has been drawn in the MU, and weed control has been limited to those areas accessible without rappelling gear.

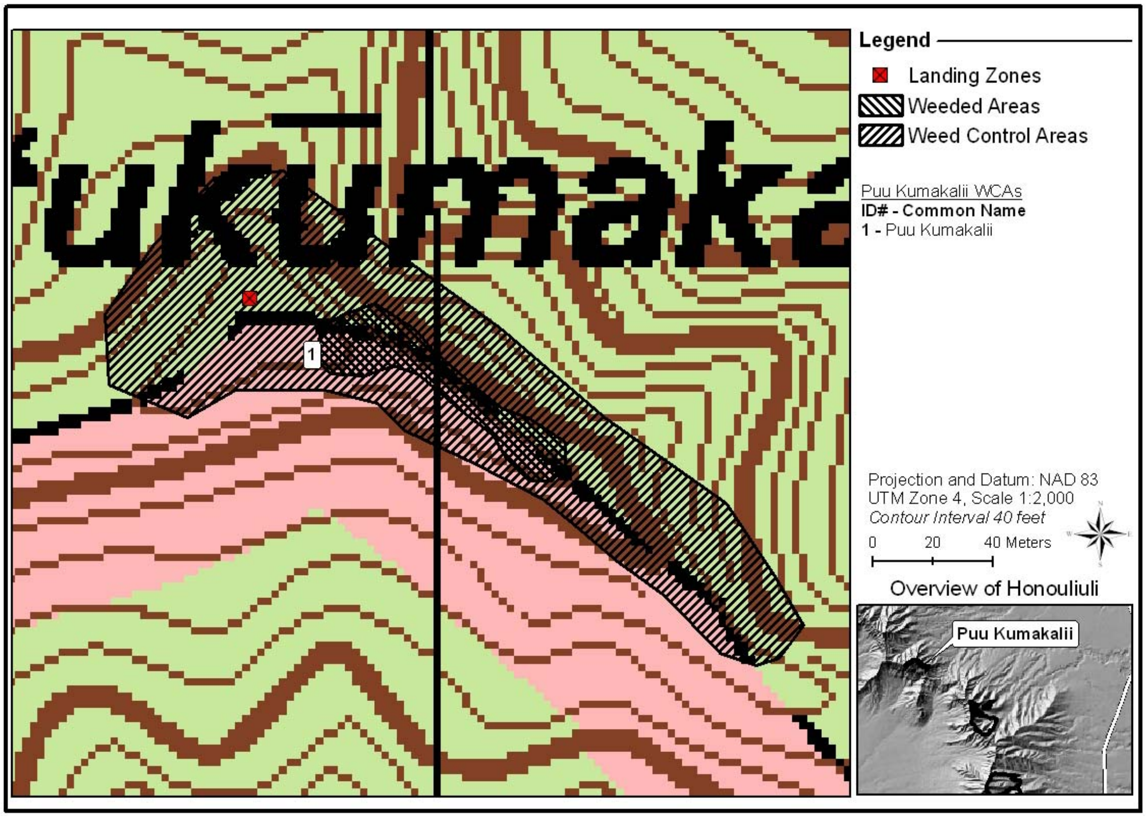


Figure 2.1.22 Weed Control Areas in Pu‘u Kūmakali‘i

WCA Discussion

Kumakalii-01

This WCA is drawn around an outplanting of *T. filiforme* and the surrounding area. It was weeded once last year. On that weeding trip, a LZ was cleared at the ridge top. The weeds that were targeted were *S. actinophylla* and *P. cattleianum*, both of which are uncommon in this area. In particular, *S. actinophylla* poses a large threat to this MU, and NRS hope to prevent it from dominating the MU. Both the WCA and the MU need to be surveyed to better prioritize weed control, scope populations of uncommon weedy trees, and identify native vegetation communities. No weed control was done directly around the reintroduction site, as it is a native species dominated cliff. Next year NRS will visit the site at least once to better scope the area and check for any *S. actinophylla* resprouts.

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
IP MU: Puu Kumakalii					
Kumakalii-01	Habitat	12001.64	1306.239	10.88%	TetFil

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	3.00	PsiCat, SchAct
Total	1	3.00	

IP MU: Wai‘anae Kai

This is the first year NRS have performed any weed control in the Wai‘anae Kai MU. Both WCAs are centered around rare plant populations. Effort in Wai‘anae Kai will intensify as management goals are defined and logistical considerations resolved. NRS work collaboratively with State Forest Reserve staff and PEP staff in this MU. The lower portion of the MU is predominantly vegetated with *P. maximum* and *L. leucocephala*, and is threatened by fire. The state constructed a fire break to mitigate this fire threat in 2003. In the past year, many NRS became certified as Wildland Firefighters. If future fires threaten the MU, NRS will be able to assist in fire fighting efforts.

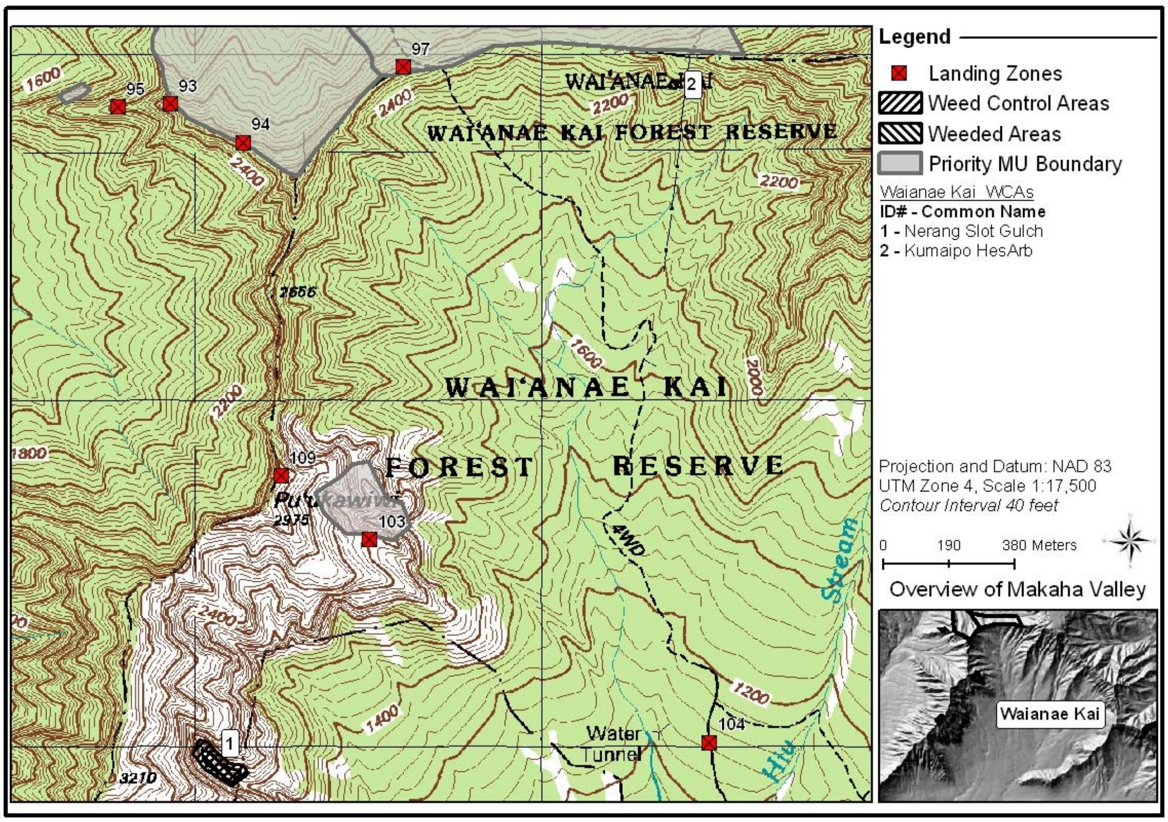


Figure 2.1.23 Weed Control Areas at Wai‘anae Kai

WCA Discussion

WaianaeKai-01; Nerang Slot Gulch

This WCA is located in a slot gulch with very high cliff walls. The gulch houses important populations of *N. angulata* and *N. humile*. The vegetation in the gulch is mixed, with some native elements, and large amounts of *L. leucocephala*. While the gulch is surrounded by grass, there is very little *P. maximum* in the WCA itself. Little work has been done in this WCA because it is not yet fenced. Preliminary weeding has focused on large, scattered tree weeds, particularly *Casuarina equistifolia*, *G. robusta*, and *Melia azedarach*. NRS hope to eradicate such low-density overstory weeds. In the future, NRS will target *L. leucocephala*, continue to treat weedy trees, and kill grass as necessary to reduce fire threat. This topographically isolated

WCA is expected to respond well to weed control; once woody weeds have been removed, the site may only require maintenance once a year.

WaianaeKai-02; Kumaipo HesArb

PEP staff built a fence protecting *Hesperomannia arbuscula* in May 2006, defining this WCA. This *H. arbuscula* site is not designated as MFS, therefore, NRS will focus on assisting on-going efforts rather than beginning large scale weeding. The vegetation at the site is mixed, with a variety of native mesic canopy and understory species. NRS assisted PEP in clearing fenceline and performing weed control. Work centered on clearing understory weeds. To prevent the creation of light gaps favorable for *R. argutus* and *C. hirta*, few canopy species were killed. NRS will maintain a low level of effort at this site, and will continue to assist PEP management efforts at this site.

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
IP MU: Waianae Kai					
Waianae Kai-01	Fuelbreak	9288.504	3603.674	38.80%	NerAng, NotHum
Waianae Kai-02	Habitat	441.5404	439.164	99.46%	HesArbu

Waianae Kai-01:

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	7.50	AcaCon, CasGla, GreRob, LeuLeu, MelAze, PsiGua, SchTer
Total	1	7.50	

Waianae Kai-02:

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	14.00	CliHir, GreRob, LanCam, PsiCat, RubArg
Total	1	14.00	

IP MU: ʻĒkahanui

The ʻĒkahanui MU is comprised of a number of WCAs around wild and reintroduced populations of rare plants. The area is currently managed by TNC, but during the coming year NRS will assume the majority of the management responsibilities for the MU. The area is threatened by fire. A 170 acre fire occurred in 2005, which fortunately burned only five acres of forest within the TNCH preserve boundary. In 2004, another large fire in the adjacent Puʻu Maiʻalau Gulch to the south, burned with 300 m of the fence.

Most of the WCA's are protected in a 40 acre fence, completed in 1999. NRS are in the process of constructing a new 170 acre fence to greatly increase the area protected from feral ungulates, and to encompass all the presently managed WCA's and their corresponding rare plant populations. Completion of this fence is expected in the summer of 2007.

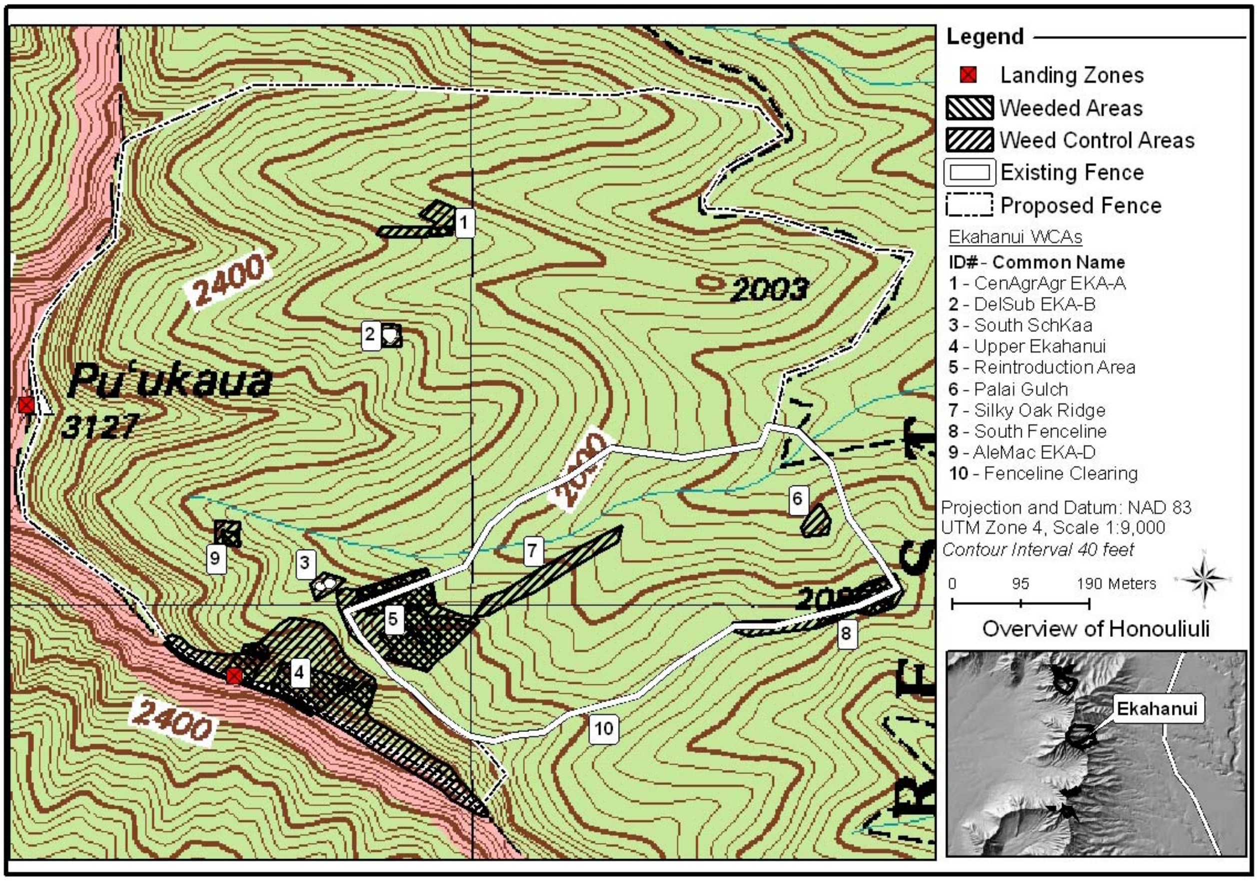


Figure 2.1.24: Weed Control Areas in ʻĒkahanui

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present

IP MU: Ekahanui

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Ekahanui-01	Habitat	2459.3	297.1	12.08%	CenAgrAgr

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	2.00	CliHir, GreRob, PsiGua, SchTer
Total	1	2.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Ekahanui-04	Habitat	26366.45	1808	6.86%	PlaPriPri, SchKaa, UreKaa

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	4	15.50	AndVir, MelMin, PasCon, RhyRep
Total	4	15.50	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Ekahanui-05	Habitat	15352	12301	80.13%	AleMacMac, CenAgrAgr, CyaGriOba, DelSub, SchKaa

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	2.50	MelMin, PasCon
Ecosystem Weed Control	5	71.50	AgeRip, BudAsi, ChrPar, CliHir, GreRob, LanCam, PasSub, PsiCat, RubRos, SchTer
Total	6	74.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Ekahanui-08	Habitat	4012.297	888.1375	22.14%	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	3	8.50	MelMin, PanMax
Total	3	8.50	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Ekahanui-09	Habitat	1022.6	4034	394.48%	AleMacMac

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	3.00	LanCam, PsiCat, SchTer
Total	1	3.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Ekahanui-10	Fenceline Clearing	5649	4034	71.41%	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	5.00	PsiCat
Total	1	5.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
HuliwaiNoMU-01	3M	620.6545	95.27272	15.35%	CenAgrAgr

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	3.00	AgeRip, CliHir, LanCam, PasSub, SchTer
Total	1	3.00	

WCA Discussion

Ekahanui-01; Cenagragr EKA-A

Only one trip was made to weed this WCA during this year. The weed control objective at this WCA is to suppress weeds around the *C. agrimonioides* var. *agrimonioides* plants. This population is a wild site, but the habitat around it is patchy, with a mixture of weeds and natives. Although there are some nice patches, not much is done currently due to the dense weed cover. Once the fence is completed and this WCA is protected, NRS plan to visit the site to weed around the *C. agrimonioides* var. *agrimonioides* and improve the habitat one or two times per year. In the following year NRS will monitor weed re-growth and treat if needed.

Ekahanui-02; Delsub EKA-B

This WCA is very small, surrounded by poor quality habitat. NRS work to keep understory weeds down to facilitate rare taxa fruit production. In the '04-'05 reporting year the area was heavily weeded, and this year it was deemed that no weeding was needed. NRS will continue to monitor the WCA and hand weed two meters around the plant during fruit collection trips.

Ekahanui-03; ʻĒkahanui South Schkaa

No weeding effort was conducted in this WCA for the '05-'06 reporting year. When the entire ʻĒkahanui MU fence is completed, this largely native site will be used for reintroductions. Weed control efforts will begin then. TNC has already begun weed control across a 4 acre area to control Christmas berry and guava.

Ekahanui-04; Upper ʻĒkahanui

This WCA is comprised of some very steep terrain housing a couple populations of rare plants, and some *Achatinella mustelina*. This year a total of 14 hours of weeding effort were spent controlling the grass here. The grass spraying has proven to be hazardous on the steep areas, and NRS needs to develop a safer technique for spraying grass in this WCA.

After three trips to spray grass in this WCA over the past year, NRS observed that much of the grass died, and that only two trips are needed in the next year for follow-up spot spraying. Future trips should require less time and herbicide than previous trips, demonstrating that intensive initial investment in weeding can lead to reduced efforts in later years to maintain healthy native habitat. NRS plan to survey the WCA for the most intact forest patches and begin weeding selectively in them if there is extra time on weeding trips.

Ekahanui-05; Reintroduction Area

This WCA is the most intensely weeded area in the entire MU. It spans a four acre area of mixed native and alien forest, and has been an important reintroduction site for many rare taxa over the years (Figure 2.1.23). Initially, a large amount of effort was spent removing *Passiflora suberosa* to establish the site as a reintroduction area, with little re-treatment of that weed needed since then. However, much effort has been spent at this site improving habitat by reducing potential competition from other weeds. Over the year, a total of 71.5 hours were spent weeding in this WCA (see Table above).

Around the *C. agrimonioides* var. *agrimonioides* outplantings, trips focused on opening up the canopy. Fruiting of the *C. agrimonioides* var. *agrimonioides* has been noted since then and it is thought that the plants are doing well with a little more light. Non-native grass control was also done in this area on one trip this year.

For other outplanting areas within the WCA, weeding focused mostly on understory and vine clearing around outplantings to discourage competition and to allow the outplantings room to grow. All areas should be re-visited at least every other quarter to ensure that understory weeds and vines do not take over in the outplanted areas.

Ekahanui-06; ‘Ēkahanui Palai Patch

This site is managed to promote fruit production of the *C. grimesiana* reintroduction. While there are some native canopy and fern components, NRS limit weeding effort at the site. No weed control was conducted at the site this year by NRS. TNC staff conducted limited follow up weeding of understory weeds.

Ekahanui-08; ‘Ēkahanui South Fenceline

Two trips were taken to this WCA this year. With the exception of ‘Elepaio, there are no rare and few common native taxa in this WCA. It was created to help reduce fuel loads close to the exclosure. This is one of the few places where *P. maximum*, the fuel-loading grass, is found on the fenceline. The time between visits was too long, and NRS will strive to visit the site quarterly in the future.

Ekahanui-09; AleMac EKA-D site north outside fence

This WCA was created this year. This area is an outlier-it is not within a current fenced area, although the second larger sub-unit fence will include this area. The area was found rather by chance, while checking on an *Alectryon macrocarpus* nearby. The area has a very native canopy with a few *A. mustelina*. These resources encouraged NRS to weed in the area, taking out small non-native canopy trees and understory weeds. Hopefully this will allow the native species to increase at this site. NRS will return to the WCA at least two times in the next year to monitor and continue to improve the habitat.

Ekahanui-10; ‘Ēkahanui Fenceline Clearing

This WCA is made up of the fenceline cleared in preparation for the construction of the second subunit of the ‘Ēkahanui fenceline. Fenceline clearing is not yet complete. A small amount of herbicide was used and NRS will monitor for regrowth of weeds and will assess whether or not additional treatment is necessary.

HuliwaiNoMU-01

This WCA does not lie in any IP MU, but is close to the ʻĒkahanui MU. Only one trip was made to weed in this MU during the past year for rare plant protection.

IP MU: Kaluaʻā and Waiʻeli

NRS and TNCH collaborate on management for these areas. Several more WCAs were created this year to reflect areas that TNCH has weeded. NRS hope to expand weed control efforts in these areas in the future. NRS are only beginning to understand the scope of, and participate in, these TNCH projects. Weed control this year focused mostly on creating and maintaining reintroduction of both common and rare plant sites, which are some of the most appropriate habitats for weeding. Some of the areas are very weedy and NRS and TNCH have managed to significantly reduce the amount of the aggressive *Passiflora suberosa* that reduces light and strangles established native and reintroduced plants. Weeding is particularly tedious in this MU given the numbers of native snail populations which must be avoided. In some areas NRS have to exclude weeding certain sites where snails are known to occur because of the potential negative impact on these tree and ground snails.

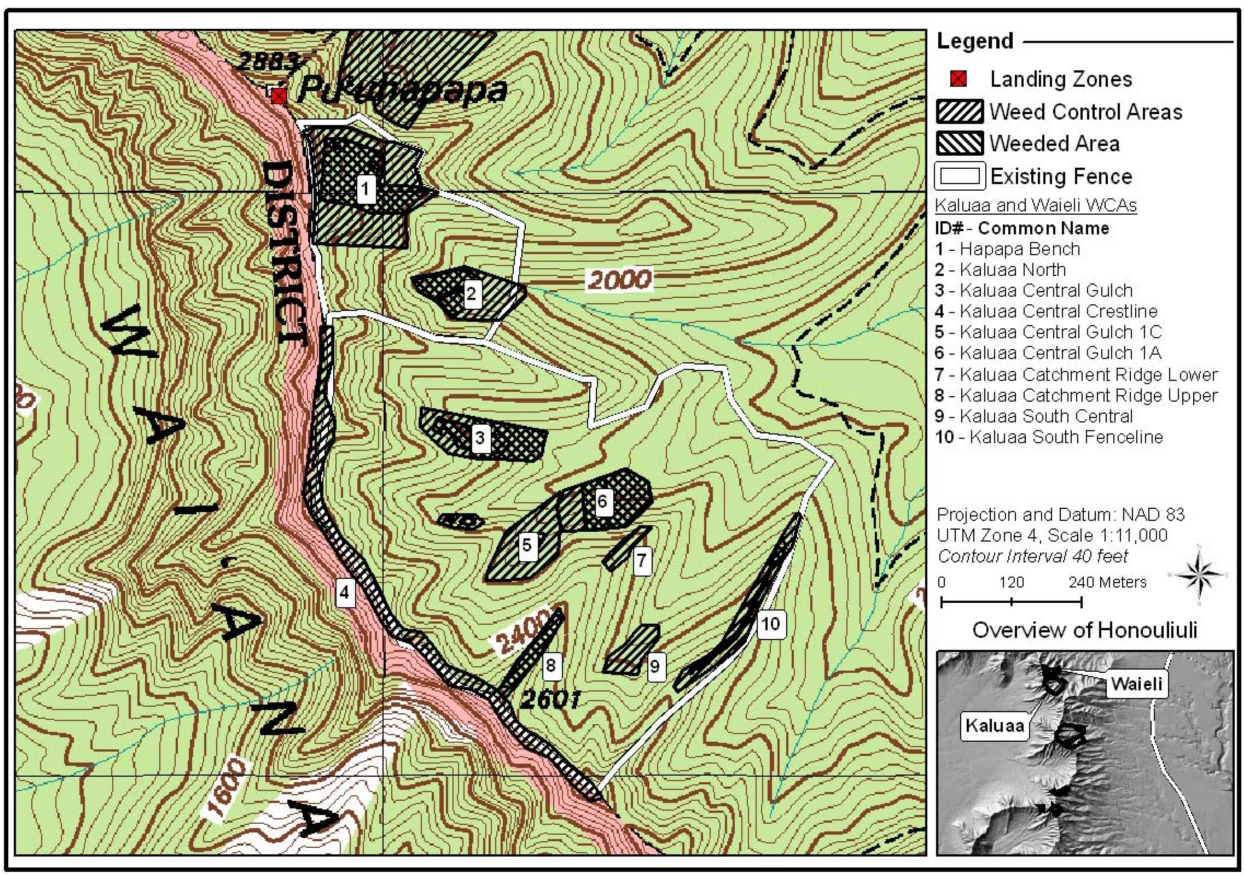


Figure 2.1.24 Weed Control Areas in Kalua'ā & Waiʻeli

WCA Discussion

Kalua‘ā and Wai‘eli-01; Hapapa bench

This three acre site was weeded by TNCH staff early in the calendar year. The goal is to gradually reduce *Schinus terebinthifolius* canopy cover. Continued understory reduction of *C. hirta, P. edulis, B. asiatica,* and *E. karvinskianus* is still needed. The area will continue to be weeded two times per year.

Kalua‘ā and Wai‘eli-02; Kalua´ā North

This two acre site was weeded by TNCH staff as a potential NRS outplanting site. The upper third of this WCA was weeded this year. Canopy control is complete. Understory reduction of *C. hirta* and *P. suberosa* is still needed. The area will continue to be weeded two times per year.

Kalua‘ā and Wai‘eli-03; Kalua´ā Central Gulch

Weeding is done in this WCA to maintain and expand outplanting sites. Lots of *P. suberosa* was removed, and without this invasive component, the area is left with high levels of native canopy. As mentioned above, NRS are also careful to limit their weeding in areas where known populations of two species of ground snails (*Amastra micans* and *A. spirizona)* occur. NRS also weeded in a new area this year that was proposed as an outplanting site. Although no plants were in fact reintroduced, NRS should continue weed control up-gulch from this site. Two of the three acres of this WCA were weeded this year.

Kalua‘ā and Wai‘eli-04; Kalua´ā Central Crestline

Grass control was conducted and will continue once every six months by TNC staff. Weed control for woody alien plants is still needed for the fenceline.

Kalua‘ā and Wai‘eli-05; Kalua´ā Central Gulch 1C

Weeding was conducted around the following rare plants in this area by TNC staff: *S. kaalae, D. subcordata,* and *U. kaalae* populations. Understory weeding will continue every six months by TNC staff.

Kalua‘ā and Wai‘eli-06; Kalua´ā Central Gulch 1A

This 2 acre WCA encompasses many reintroductions, and 76% of the entire WCA is considered a TNC Project Stewardship site, and NRS leave that part alone for that purpose. NRS conducted no other weed control in this WCA this year. Understory weeding will continue every six months by TNC staff.

Kalua‘ā and Wai‘eli-08; Kalua´ā Catchment Ridge Upper

Weeding was conducted around *C. agrimonioides* and *S. kanehoana* in this area. Understory weeding will continue every six months by TNC staff.

Kalua‘ā and Wai‘eli-09; Kalua´ā South Central

This one acre site was weeded in preparation for TNC outplantings. Understory weeding will continue every six months by NRS and TNC staff. This site may be used for NRS reintroductions this coming year.

Kaluaʻā and Waiʻeli-10; South Fenceline

This site was weeded for the *S. kanehoana* outplanting. The area is abundant with *D. linearis* and NRS hopes that *S. kanehoana* grows well in this environment. The *D. linearis* will help to keep weed regrowth at bay. NRS will monitor the outplantings and will plant more in the future if the current outplantings continue to thrive.

Kaluaʻā and Waiʻeli-11; Kalua´ā Central Gulch 2

This site was weeded in preparation for outplanting, however no plants were reintroduced here. The habitat looked similar to other areas of *P. mollis*. There is a decent native plant population here as well. This could still be used as a future outplanting site.

Kaluaʻā and Waiʻeli-12; Waieli Dryfalls Alemacmac

Almost 20% of this two acre WCA was weeded this year. Managed species include *A. macrococcus*. *Toona ciliata* and *S. terebinthifolius* canopy was reduced by TNC staff. Understory weeding will continue every six months by TNC staff and NRS as feasible.

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present

IP MU: Kaluaa and Waieli

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
KaluaaandWaieli-01	Habitat	33518.84	13829.55	41.26%	MelChr

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	4	38.00	CliHir, EriKar, LanCam, MelMin, PasSub, RubRos, SchTer, TooCil
Total	4	38.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
KaluaaandWaieli-02	Habitat	11797.58	4266.515	36.16%	AleMacMac, DieFal, SchKaa, UreKaa

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	21.00	CliHir, PasSub, RubRos, SchTer, TooCil
Total	2	21.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
KaluaaandWaieli-03	Habitat	12586.88	9100.383	72.30%	AleMacMac

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	4	52.00	BudAsi, CliHir, IpoCai, LanCam, PasEdu, PasSub, PsiGua, RubRos, SchTer, TooCil
Total	4	52.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
KaluaaandWaieli-05	Habitat	10876.72	985.8016	9.06%	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	6.00	CliHir, LanCam, RubRos, SchTer, TooCil
Total	1	6.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
KaluaaandWaieli-06	Habitat	12225.94	9111.412	74.53%	AleMacMac, CyaGriOba, DelSub, PhyMol, SchKaa, UreKaa

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	46.00	CliHir, PasSub, RubRos
Total	2	46.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
KaluaaandWaieli-08	Habitat	3800.976	2978.834	78.37%	CenAgrAgr

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	14.00	BudAsi, CliHir, LanCam, MelMin, PanMax, PasSub, SchTer
Total	1	14.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
KaluaaandWaieli-09	Habitat	4327.179	1570.608	36.30%	
KaluaaandWaieli-10	Habitat	8611.691	1860.842	21.61%	CenAgrAgr, SteKan
KaluaaandWaieli-11	Habitat	1438.288	301.6661	20.97%	
kaluaaandWaieli-12	Habitat	33574.3	6109.168	18.20%	AleMacMac, CyaMem, DieFal, PhyMol, SchHoo, UreKaa

WCACode	Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
KaluaaandWaieli-09	Ecosystem Weed Control	2	10.50	CliHir, LanCam, PasSub, PsiCat, PsiGua, RubRos, SchTer
	Total	2	10.50	
KaluaaandWaieli-10	Ecosystem Weed Control	3	21.00	CliHir, GreRob, LanCam, PasSub, StaDic
	Total	3	21.00	
KaluaaandWaieli-11	Ecosystem Weed Control	1	4.00	LanCam, PasCon, RubRos, SpaCam, TooCil
	Total	1	4.00	
kaluaaandWaieli-12	Ecosystem Weed Control	1	12.00	SchTer, TooCil
	Total	1	12.00	

IP MU: Puali‘i portion of Palikea MU

The Puali‘i portion of the Palikea MU is comprised of three recently designated WCAs around wild and reintroduced populations of rare plants. The area is currently managed by TNCH but during the coming year NRS will assume management responsibilities for the MU. The area is threatened by fire due to large amounts of light and heavy fuel types east of the area, however, no fires in recent years have threatened the MU. TNCH staff is in the process of constructing a fence to encompass all the presently managed WCA’s and their corresponding rare plant populations. Completion of this fence is expected by November 2006.

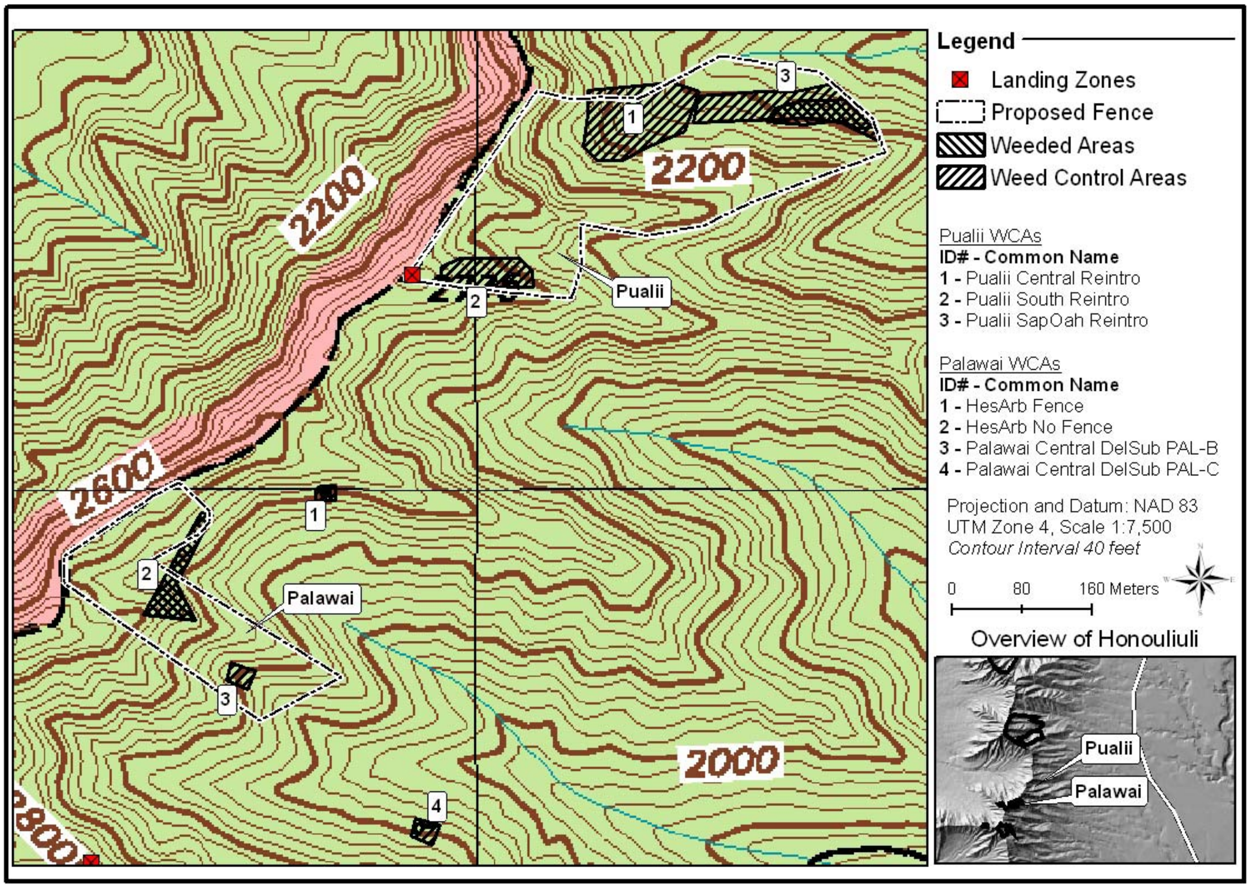


Figure 2.1.25 Weed Control in Puali‘i & Pālāwai Gulches

WCA Discussion

Puali‘i-01 Central Reintroduction Site

Puali‘i-01 contains a native dominant forest patch consisting of a *Pouteria sandwicensis* stand. The stand is near rare plant populations *Diellia falcata*, *Urera kaalae* and *Sicyos lanceoloidea*, and serves as a new reintroduction site for TNCH staff, where *Delissea subcordata*, *Urera kaalae,* and *S. lanceoloidea* were planted this year. There was no weeding effort in this WCA by the NRS staff for the ’05-’06 reporting year, however, TNCH staff had weeded the area in the previous reporting year to prepare the site for plant reintroductions. When the fence is completed, weed control efforts will begin for the ’06-’07 reintroductions.

Puali‘i-02 South Reintroduction Site

Puali‘i-02 is a native dominant area consisting of a *Metrosideros polymorpha* canopy. This area also serves a reintroduction site by TNCH for *Delissea subcordata*, *Gardenia brighamii*, and *P. mollis*. No weeding by TNCH or NRS staff occurred during the ’05-’06 reporting year.

Puali‘i-03 *Sapindus oahuensis* Reintroduction Site

Puali‘i-03 contains a native dominant forest of *Sapindus oahuensis*. The forest is also a new reintroduction site for TNCH staff, where *Abutilon sandwicensis* and *Gardenia brighamii* were planted this year. There was one weeding effort this year consisting of 15 hours of work controlling *S. terebinthifolius*. Once the fence is completed weed control efforts will resume.

IP MU: Palikea

The Palikea MU is on the Southern end of the Waianae Mountains. In the last year NRS has collaborated with TNC staff on weed control in this area. The area contains some relatively intact areas as well as others that are completely alien dominated. *S. terebinthifolius* is particularly dominant in the areas below the MU. *Ehrharta stipioides* and *Morella faya* are also prevalent on an access route to this area. As far as NRS knows, this is the only area where these species are widespread on O'ahu. NRS are careful to prevent spread. A 25 acre fence is planned in the Palikea peak area and will encompass the existing two acre fence. Completion of this larger unit is expected by fall 2007.

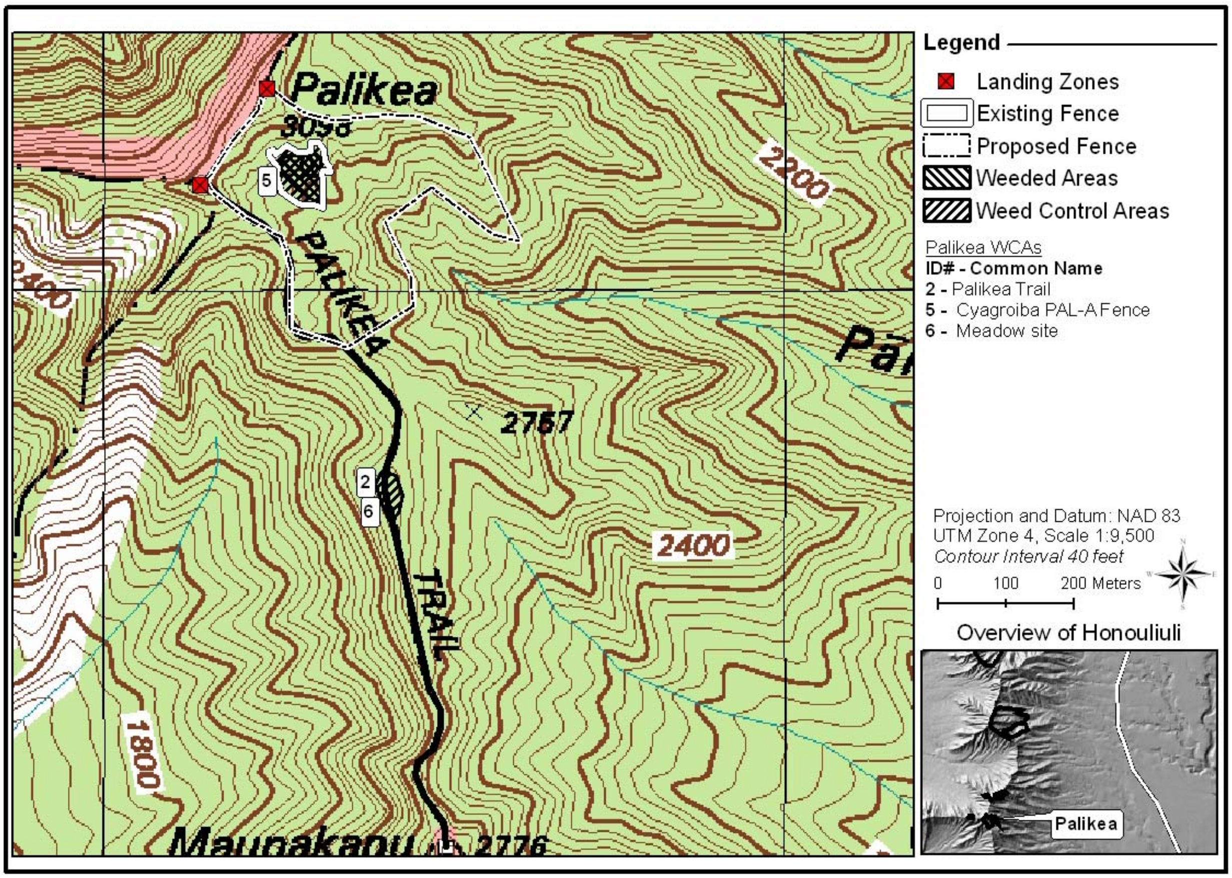


Figure 2.1.26 Weed Control Areas in Palikea

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present

IP MU: Palikea

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Palikea-01	Habitat	378.8505	60.64963	16.01%	HesArbu

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	0.50	EhrSti, MelMin, PasCon
Ecosystem Weed Control	1	4.50	PasSub, PsiCat, SchTer
Total	2	5.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Palikea-02	Trail	2803.129	2803.129	100.00%	HesArbu

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	3	3.50	EhrSti
Total	3	3.50	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Palikea-03	Habitat	7507.921	2368.256	31.54%	HedPar

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	2.00	AxoFis, MelMin, PasCon
Ecosystem Weed Control	1	0.50	AgeAde, AgeRip
Total	2	2.50	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Palikea-04	Habitat	8617.785	2514.285	29.18%	HedPar

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	4.00	EriKar, GreRob, MelQui, PsiCat, SphCoo
Total	1	4.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Palikea-05	Habitat	5382.713	3100.04	57.59%	CyaGriOba

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	2.50	EhrSti
Ecosystem Weed Control	3	21.00	CliHir, PasSub, PsiCat, RubRos, SchTer
Total	4	23.50	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Palikea-06	Habitat	1854.305	351.9855	18.98%	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	2	6.00	EhrSti
Total	2	6.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present			
PalikeaNoMU-02	3M	621.3672	123.3277	19.85%	DelSub			
				Treatment Type		# of Visits	Effort (Person Hrs)	Species Controlled
				Ecosystem Weed Control		1	2.25	AgeAde, SchTer
					Total	1	2.25	

WCA Discussion

Palikea-01; Hesarb fence

This WCA is centered around a wild *H. arbuscula* population (Figure 2.1.26). Weeding in this WCA will hopefully encourage *H. arbuscula* regeneration. The 100 m^2 exclosure is relatively free from alien species from past years of weeding. NRS made one maintenance weeding trip to the exclosure and pulled alien seedlings as well as sprayed invasive grasses. NRS is reluctant to kill the large *S. terebinthifolius* trees that may be providing shade to the *H. arbuscula*. Because of this, *S. terebinthifolius* seedlings and offshoots will have to be killed each year. NRS will plan to visit this site two times in the next year.

Palikea-02; Palawai Hesarb unfenced

Last year NRS discovered *E. stipioides* along the trail to the *H. arbuscula* exclosure (Figure 2.1.26). In an effort to prevent spread to the exclosure and possible to areas outside of Palikea NRS spray regularly. This year NRS sprayed the area four times and has found this approach effective in reducing *E. stipioides* occurrence. Most of the treated area has remained dead with just a few tiny re-sprouts. Unfortunately the ridge crest above the exclosure is more infested and it is likely that this area is connected to the large scale infestation known from the Pu´u Palikea vicinity.

Palikea NoMu-02; Palawai Delsub Pal-C

WCA 02 is located in the lower elevations of Palawai gulch (Figure 2.1.26). This area is almost completely dominated by *S. terebinthifolius*. However, there is one small pocket with many native species. In this area TNC found a wild *D. subcordata* population. This WCA includes this area. NRS hopes that because of weeding the *D. subcordata* will be able to regenerate. NRS made one trip to this area to perform maintenance weeding. NRS will plan to visit the site twice in the next year. The downslope corners of the 400 m^2 exclosure are dominated by *S. terebinthifolius* however, *A. mustelina* has been observed in this area so no weeding has been done there. The upslope corners have a large population of *A. adenophora.* It would be labor intensive to basal treat this area. NRS should consider spraying with Round-up as long as no native plant or invertebrate species are impacted.

PalikeaNoMu-03; Palikea trail Ehrsti

On the trail out to the Palikea MU (Figure 2.1.26), *E. stipoides* was prevalent and NRS began weeding to prevent spread via NRS to not only others area at Palikea but also to other areas that NRS works. This is the only location on O‘ahu where NRS knows this species to be prevalent. This species is extremely good at adhering to the cloths and shoes of workers. NRS has removed it on more than one occasion from project vehicles. It is also suspected that it has spread from this location to the Pahole snail exclosure as well as possibly to ‘Ōhikilolo. NRS made two trips to treat the trail this year. Most of the treated area has remained dead with perhaps 10 one-foot areas of re-growth. With a major spray and at least two follow up sprays to kill re-growth per year, this invasive will be greatly impaired in its ability to spread. Unfortunately it is prevalent in the surrounding unmanaged areas and re-treatment will be ongoing.

Palikea-03; Hedpar Halona

This WCA surrounds a wild population of *Hedyotis parvula*, located mostly on the Navy owned cliff face (Figure 2.1.27). Weeding effort in this area is focused on reducing competition from surrounding weeds. One trip was made this year, and effort was spent spraying grass with fusilade and also controlling broadleaf weeds with 20% Garlon 4 herbicide. The area is steep and difficult to navigate with a backpack sprayer. NRS plans to return to this site in the coming reporting year to assess the need for further weeding around the protected plants. There are many areas that are unreachable without a rope. Areas previously treated by NRS without ropes are dangerous. NRS will use ropes in the future.

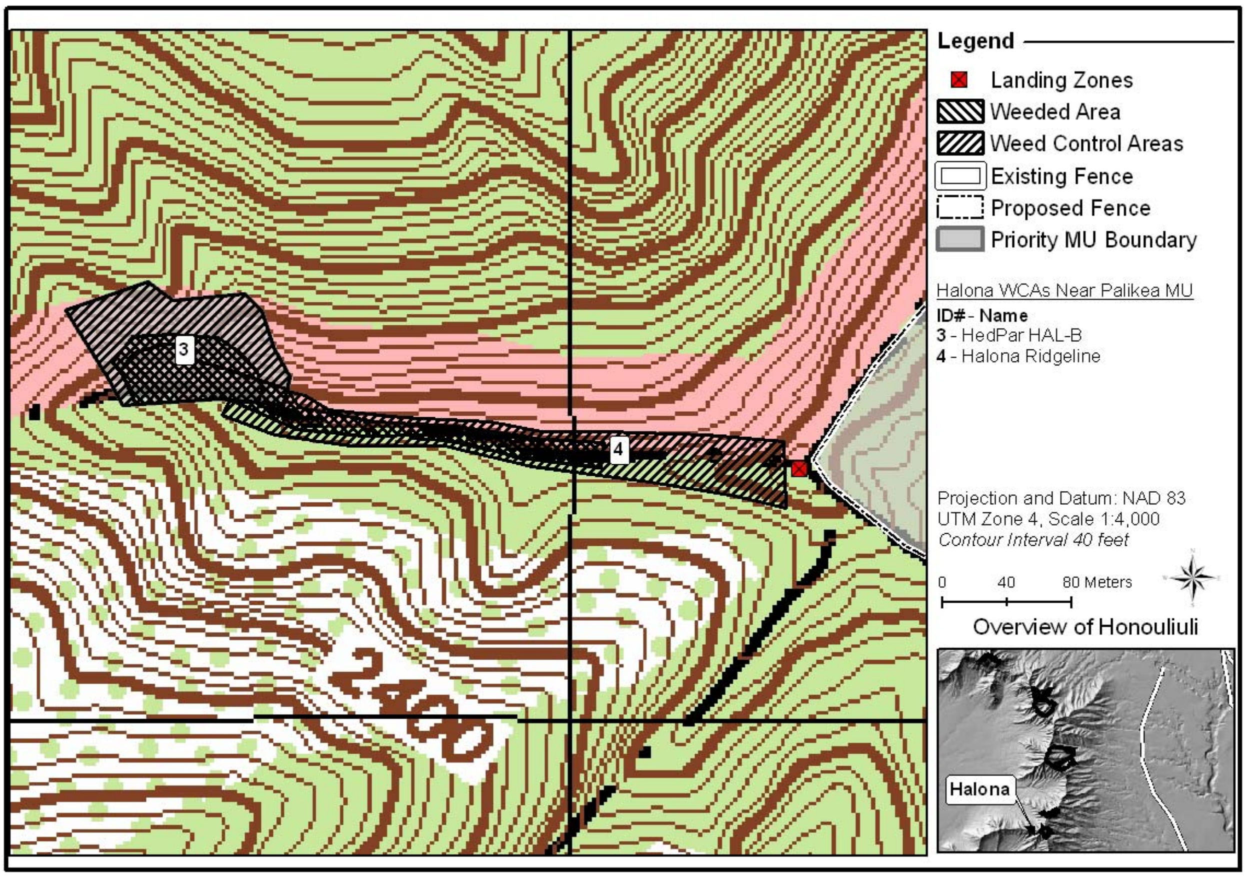


Figure 2.1.27 Weed Control Areas in Hālona

Palikea-04; Halona Ridgeline

The ridgeline WCA spans from the LZ to Palikea-03 WCA (Figure 2.1.27) and is a newly created WCA devoted to the control of *E. karvinskianus* and a handful of other uncommon weeds that NRS feels are worth keeping to a minimum. The area is alien-dominated, so ecosystem scale control is not done at this WCA. There are a few non-native species that NRS believes would significantly threaten the rare plant populations in the surrounding area if allowed to infest the area. These species include *Grevillea robusta, Psidium cattleianum, Sphaeropteris cooperi,* and *Melaleuca quinquenervi*. A few plants of all these species were found on the ridgeline, and NRS feels it is important to ensure they remain at manageable levels. NRS plans to return to the area once in the coming year to control these species.

<u>Palikea-05; Palikea CyaGri Fence</u>

This WCA is comprised of a two acre fence unit constructed around an outplanting of *C. grimesiana* (Figure 2.1.26). This population has been augmented by NRS and TNC and presently contains the largest reintroduction population of *C. grimesiana*. NRS and TNC conducted three weed control trips to this area in the last year. Many of the canopy weeds were removed in previous years and the present weed focus is on understory species including *E. stipoides* that has not yet become established in the area. Within the fence, the understory is lush with native species that have multiplied since the fencing weed control began. This area needs to be maintained with semi-regular weeding. NRS believe that two to three weeding trips per year is adequate. The priorities are to weed in outplanted areas and monitor *C. grimesiana* seedling growth as the weeds stop persisting. *Spaeropteris cooperi* continue to pop up in and around the fence area and NRS will consistently kill it.

<u>Palikea-06; Palikea Meadowsite</u>

This WCA has been used as a volunteer outplanting site (Figure 2.1.26). The area is flat and *E. stipiodes* can be controlled easily with persistent spray. NRS will spray this site at least two times per year.

IP MU: Lower ‘Ōpae‘ula

No weed control has been done in this MU for over two years. The area is home to diverse forest and several rare taxa, and historically has seen significant levels of weed control. NRS stopped weeding in this area due to high pig presence; open weeded areas were targeted by pigs. Once ungulates are removed NRS believe that this MU has a high potential for restoration. A large fence is proposed to be built at Lower ‘Ōpae‘ula. Once the fence is completed NRS will resume weed control.

OIP REPORT

All formatting and reporting follows the same format as Chapter 2 of the MIP Report, Weed Management. The MIP and OIP have similar general weed control requirements; please refer to the Mākua Section 7 Weed Management overview in the introduction of Chapter 2 for a complete discussion of IP weed management requirements. Table 2.2.1 below summarizes weeding effort across OIP MUs.

Table 2.2.1 OIP Management Units: Weed Control from 9/1/05 to 8/31/06

		WCA Total acres	Total Acres Covered	# of Visits	Effort (Person Hrs)
IP MU:	East of Oio	0.30	0.30	1	3.00
IP MU:	Ekahanui	17.5	8.83	17	111.00
IP MU:	Kaala	60.1	29.8	10	181.25
IP MU:	Kaleleiki	1.97	0.11	1	20.00
IP MU:	Kaluaa and Waieli	32.8	12.4	21	224.50
IP MU:	Kaunala	9.86	1.63	6	80.00
IP MU:	Makaha	25.6	6.36	12	313.90
IP MU:	Oio	6.59	1.82	5	51.00
IP MU:	Opaeula/Helemano	192	63.8	13	332.00
IP MU:	Pahipahialua	2.96	0.89	4	41.00
IP MU:	Poamoho	11.5	3.30	1	23.50
IP MU:	Pualii	1.67	0.58	1	15.00
IP MU:	West Makaleha	6.61	2.44	5	25.00
	Totals	370	132	97	1421.15

Survey Report

Surveys are conducted both on Army land and partner agency land (see Figures 2.2.1 and 2.2.2). Three types of surveys are conducted by NRS: road, landing zone, and transect. Transect survey results are discussed in the relevant discussion in the Management Unit Weed Control Area Report. Road and landing zone survey results are summarized in Tables 2.2.1 and 2.2.2, respectively, and discussed below.

Road Survey Report

Road surveys are conducted once a year, usually in the first quarter of the year. Some of the surveys are conducted along roads used for military training, and some are conducted along roads used often by NRS. Two road surveys were not conducted this year. RS-KTA-03 was not surveyed because the road was in disrepair and was not drivable; NRS will survey it when road repairs are made. RS-KLOA-3 also is in disrepair, and it appears that the Army has discontinued use of this road. If Army use changes, NRS will resume survey efforts.

Table 2.2.2: Road Survey Summary

SurveySiteCode	SurveySiteName	SiteLength (km)	Army/NRS Use	Significant New Pest Species
Property Name: Dillingham Military Reservation				
RS-DMR-01	Dillingham Roads	2.692	Army and NRS	
Property Name: Kahuku Training Area				
RS-KTA-01	Charlie 1 Gate to Foxtrot Gate	5.81	Army and NRS	
RS-KTA-02	Charlie 2 Gate to Alpha Gate	7.24	Army and NRS	MacUng
RS-KTA-04	Pupukea Gate to Foxtrot Gate	1.891	Army and NRS	
Property Name: Kawailoa Training Area				
RS-KLOA-01	Poamoho Road	2.871	NRS	
RS-KLOA-02	Kawaiiki Ditch Trail to Brian's Mtn House Road Jnc.	3.469	Army and NRS	ArtCil
RS-KLOA-04	Brian's Mtn House Road Jnc to Helemano Gate	3.439	Army and NRS	
RS-KLOA-06	Ashley Gate to Kawaiiki Ditch Trail	6.583	Army and NRS	
RS-KLOA-07	McCormick Gate to Ashley Gate	4.327	Army and NRS	SchAct
Property Name: Mokuleia Forest Reserve				
RS-KAALA-01	Kaala Road	10.353	NRS	HedGar
Property Name: Schofield Barracks East Range				
RS-SBE-01	East Range Road to Sch-Wai Trailhead	13.938	Army and NRS	
Property Name: Schofield Barracks South Range				
RS-SBS-01	South Range Roads		Army and NRS	SetPal
Property Name: Schofield Barracks West Range				
RS-SBW-01	West Range Firebreak Road	4.093	Army and NRS	

Potentially significant pests were found on a number of road surveys this year (see Table 2.2.1). *Macfadyena unguis-cati* was found on RS-KTA-02; it is not thought to be a particular threat at this time, but NRS will continue to monitor it. *Hedychium gardnerianum* was found on RS-KAALA-01. NRS control *H. gardnerianum* in the course of Weed Control Area (WCA) work at

Ka'ala. It is a significant threat, and NRS will investigate its location on the road and incorporate control into regular management. *Schefflera actinophylla* was found on RS-KLOA-07. NRS will determine if this species is widespread in the area, and if it is not, will initiate control measures. *Arthrostemma ciliatum* was found on RS-KLOA-02; it is a significant pest, and control work has already begun for this species. See the Incipient Control Area (ICA) Report for more information. *Setaria palmifolia* was found on RS-SBS-01; while not common in this area, this species is widespread elsewhere. NRS will determine its distribution in SBS and make a control decision in the coming year.

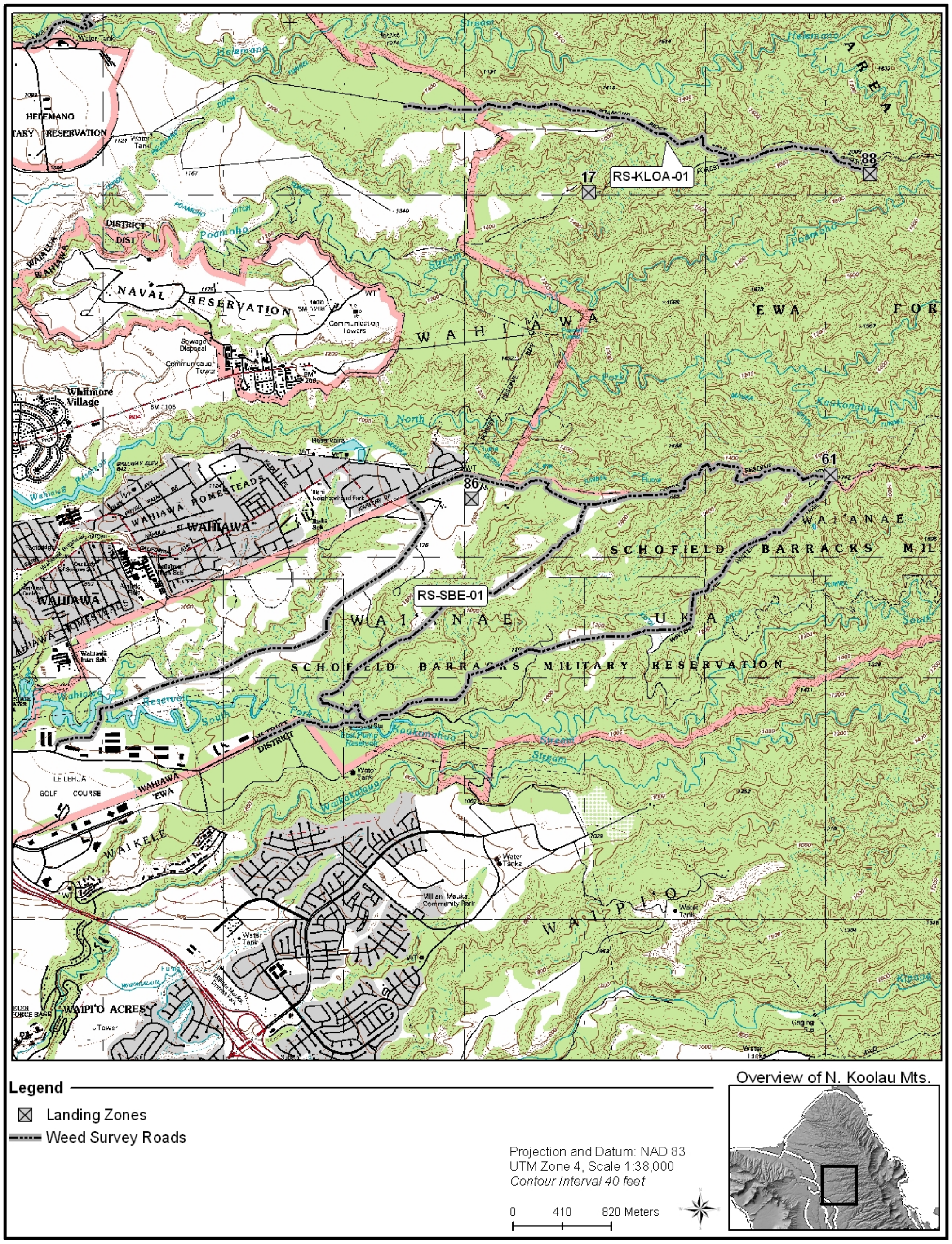


Figure 2.2.1 Landing Zone & Road Surveys, Poamoho to Schofield Barracks East Range

Figure 2.2.2 Landing Zone & Road Surveys, Kahuku and Kawailoa Military Training Areas

Landing Zone Survey Report

Landing zone (LZ) surveys are generally conducted quarterly. Some LZs are used by Army personnel, and some are strictly used by NRS. If LZs are not used in a given year, NRS do not conduct surveys at them. There are over 50 LZs associated with OIP actions; NRS survey only a portion of them. In the future, NRS plan to implement a policy of completing a survey every time an LZ is used, to achieve a more consistent weed spread picture across management areas. Several new LZs were surveyed this year, including LZ-KTA-101, Pu'u 1010. No significant pests were found on any LZs this year.

Table 2.2.3 Landing Zone Survey Summary

Between October 20, 2005 to August 10, 2006

SurveySiteCode	SurveySiteName	SiteLength (km)	SurveySiteType	First Survey Date	Significant New Pest Species
Property Name: Kahuku Training Area					
LZ-KTA-01	Water Tank Hill LZ		Landing Zone	2003-06-04	
LZ-KTA-101	Puu 1010 [LZ Durham]		Landing Zone	2006-03-15	
LZ-KTA-13	Canes LZ		Landing Zone	2003-04-15	
LZ-KTA-15	Summit Split Rock		Landing Zone	2001-08-14	
LZ-KTA-16	X-Strip		Landing Zone	2006-03-15	
Property Name: Kawailoa Training Area					
LZ-KLOA-18	Black		Landing Zone	2001-08-14	
LZ-KLOA-21	Elephant's Foot		Landing Zone	2001-08-14	
LZ-KLOA-28	Nixon		Landing Zone	2001-08-14	
LZ-KLOA-30	Peahinaia Summit LZ		Landing Zone	1999-02-09	
LZ-KLOA-35	Puu Kapu		Landing Zone	2004-02-09	
LZ-KLOA-37	Radio		Landing Zone	1999-05-12	
LZ-KLOA-38	Red		Landing Zone	2001-08-14	
LZ-KLOA-42	Weatherport Opaeula		Landing Zone	2002-10-16	
LZ-KLOA-42	Weatherport Opaeula		Landing Zone	2002-10-16	
Property Name: Schofield Barracks East Range					
LZ-SBE-44	Puu Kaaumakua East		Landing Zone	2006-08-10	
LZ-SBE-47	Schofield Waikane Summit		Landing Zone	2005-02-15	
LZ-SBE-63	LycNut_Schwai Trl		Landing Zone	2006-08-08	

Incipient Weed Report

Please refer to Table 2.2.4 and Figures 2.2.3-6 below for a picture of incipient species distribution.

Table 2.2.4 Overview of Incipient Taxa and ICA Distribution

Incipient Target	Location	Number of ICAs
Acacia mangium	KTA	4
Arthrostema ciliatum	KLOA	2
	SBE	1
Buddleia madagascariensis	SBE	2
Festuca arundacea	Ka‘ala	1
Hedychium gardnerianum	Kawailoa	1
	Kīpapa	1
Ilex cassine	SBW	1
Juncus effuses	Ka‘ala	3
Leptospermum scoparium	Poamoho	2
Melochia umbellata	KTA	5
Pennisetum setaceum	KTA	1
	SBE	1
	DMR	1
Rhodomyrtus tomentosa	KTA	1
	SBE	1
Senecio madagascariensis	SBS	1
Setaria palmifolia	Opaeula/Helemano	13
Smilax sp.	SBE	1
Tibouchina urvilleana	Whitmore Village	1

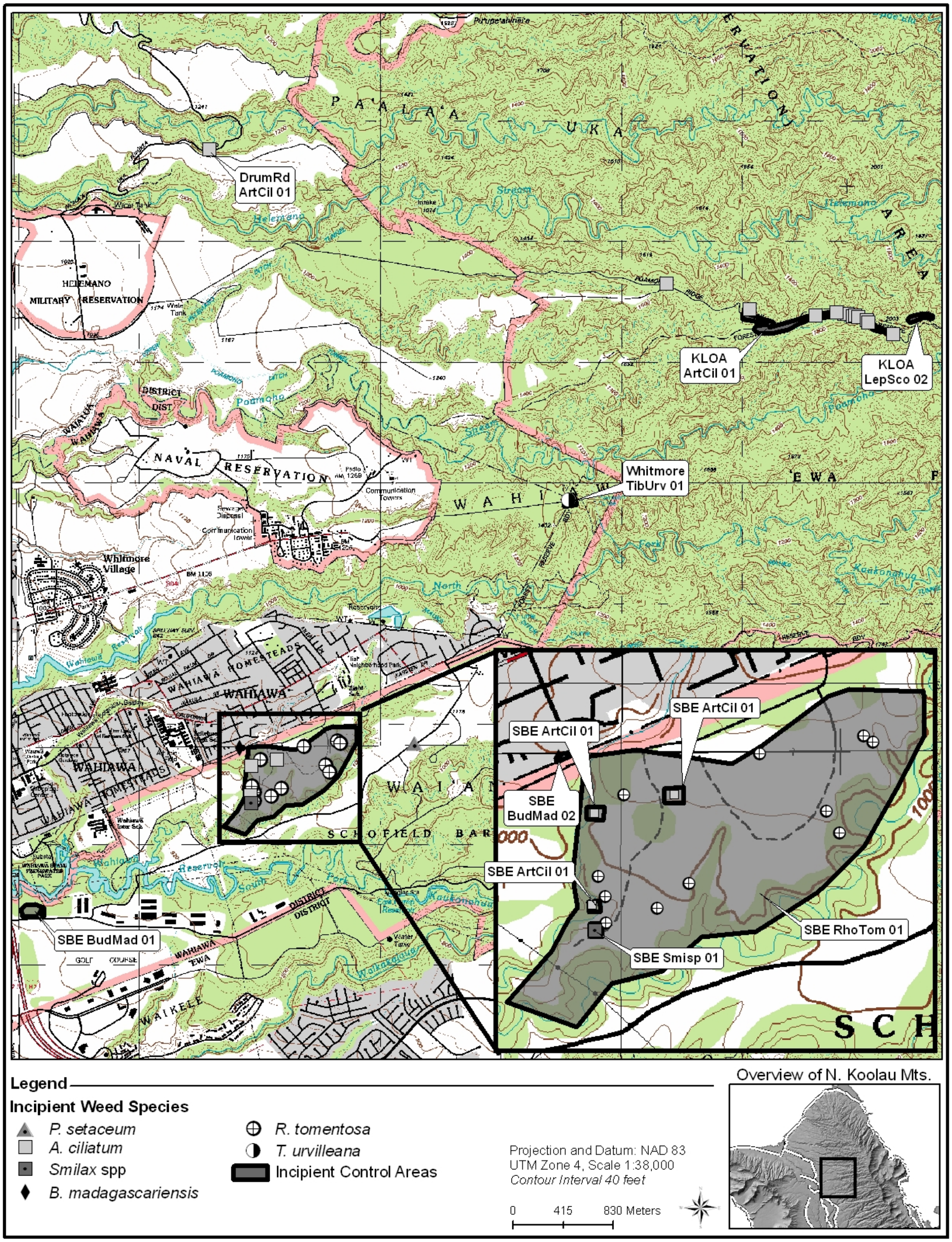


Figure 2.2.3 Location of Incipient Weed Species in KLOA & SBE

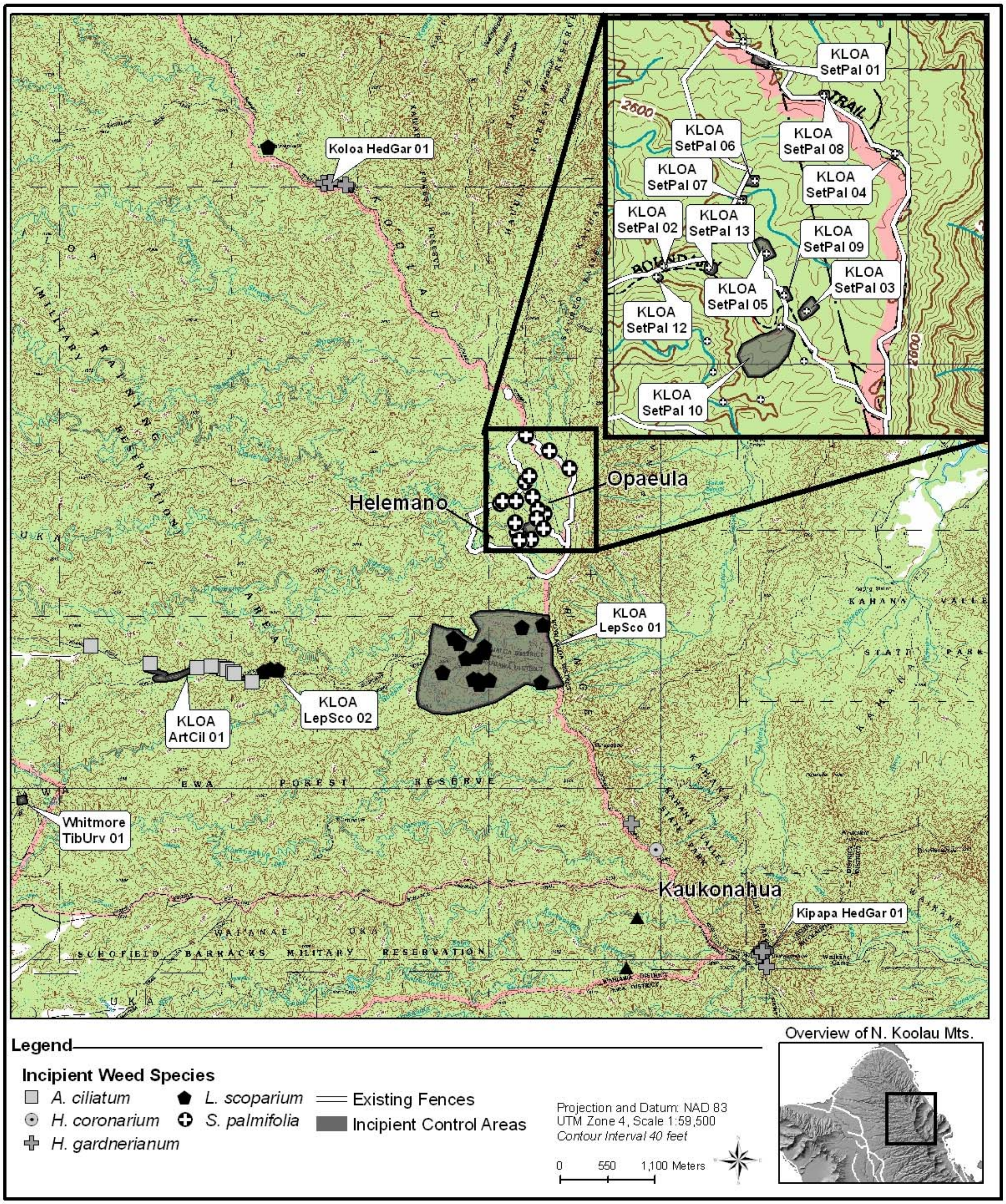


Figure 2.2.4 Location of Incipient Weed Species in KLOA

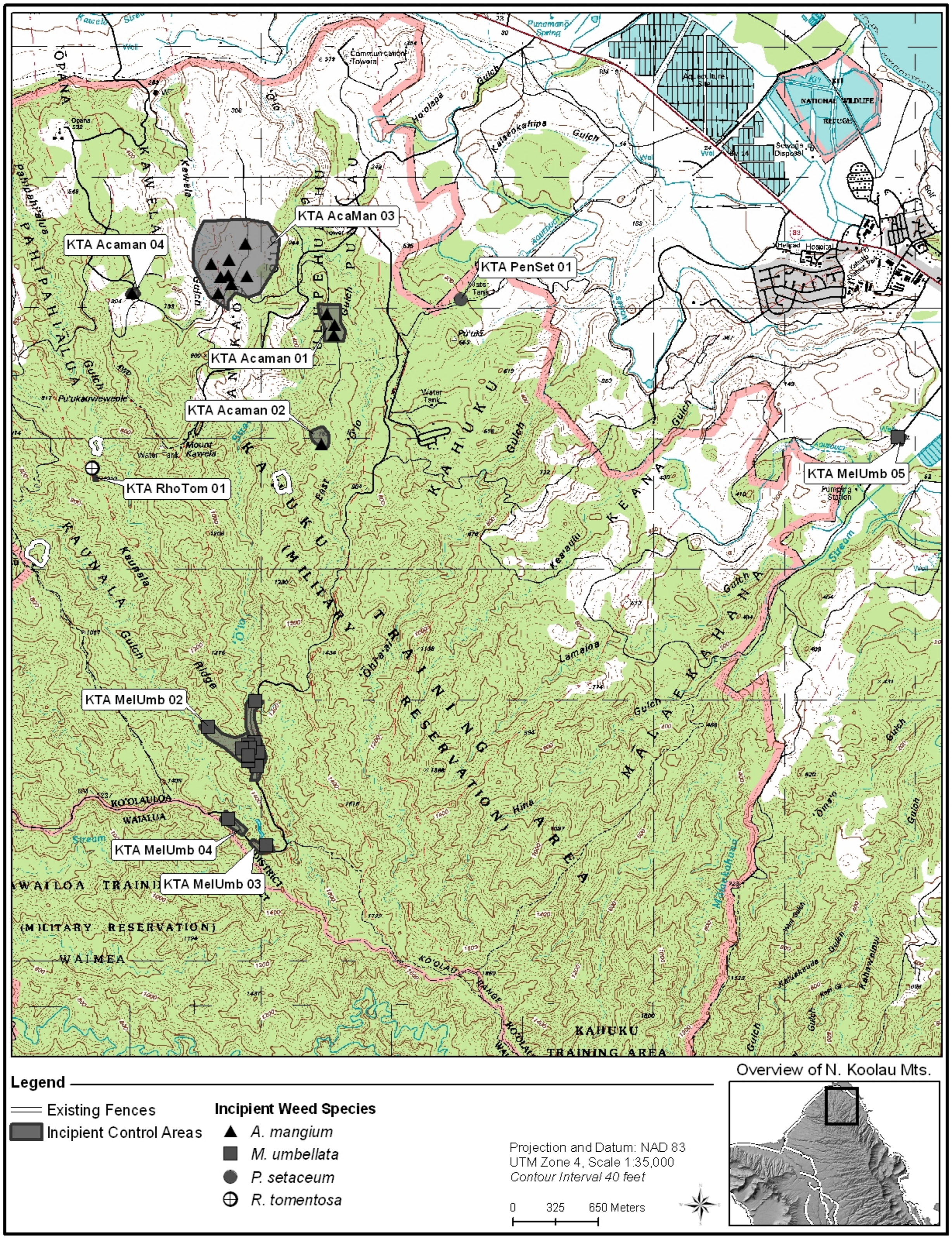


Figure 2.2.5 Location of Incipient Weed Species in Kahuku Training Area

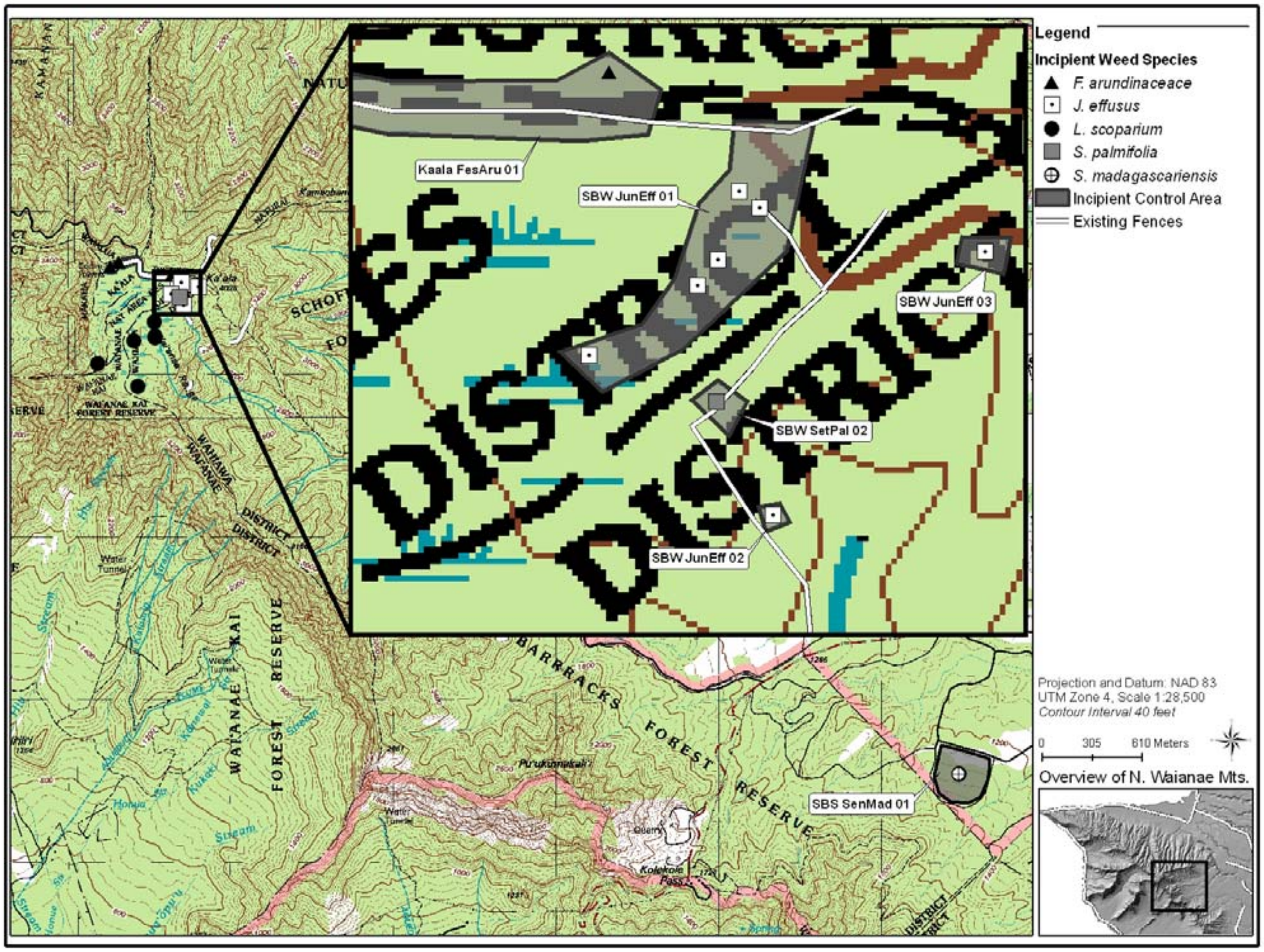


Figure 2.2.6 Locations of Incipient Weed Species in SBW & SBS

Incipient Control Discussion

Acacia mangium

A. mangium is a concern to NRS for a couple of reasons. Firstly, it exhibits qualities of an ecosystem altering weed: it is extremely fast growing, produces a large amount of viable seeds, and has seeds that persist in the seedbank for at least a few years. Secondly, the species is very closely related to the native *Acacia koa*, and there is a chance that the two would hybridize. For these reasons, *A. mangium* is considered a high priority weed for eradication. Found in 2000, and identified by Bishop Museum in 2003, *A. mangium* has been controlled and is currently restricted to four sites in KTA (Figure 2.2.5), two of which continue to produce new plants, while the remaining two did not yield new plants this year. Research is needed to find out the viability of *A. mangium* seeds in the seedbank.

<u>KTA -AcaMan-01; Kahuku AcaMan along Lower Oio Road</u>

Two trips were made to this ICA last year. An aerial survey was done on the first trip and a possible *A. mangium* was found. NRS went back on a second trip, discovered that the possible plant was not *A. mangium*, and swept through the thickest area portion of the ICA, but did cover the entire ICA. Next year, this area will be visited quarterly to perform more extensive sweeps.

KTA -AcaMan-02; Kahuku AcaMan along Upper Oio Road
Three trips were made to this ICA last year and no plants were found. The last immature plant was removed in 2003, and no mature plants were ever seen at this site. NRS will visit this area two times next year to check for any regrowth.

KTA -AcaMan-03; Kahuku AcaMan at Canes Complex
NRS visited this ICA five times last year. NRS performed an aerial survey of the area this past year and found a total of four plants in three previously weeded sites. Over the past year a total of three mature plants were found, and the ICA was expanded to encompass plants that were found nearby but were beyond previously known limits of the ICA (Figure 2.2.5). NRS will continue to weed and survey in this area quarterly. An aerial survey of this site in the coming year is recommended, as the area is large and new plants have been found outside the ICA.

KTA -AcaMan-04; Kahuku AcaMan near Puu 804
NRS surveyed this area three times last year and found no plants. The last mature plant was removed in 2001. NRS plans to survey this site two times in the coming year.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: AcaMan	**Acacia mangium**				
KTA -AcaMan-01	KTA No MU	2	3.00	2004-09-29	2006-06-27
KTA -AcaMan-02	KTA No MU	3	2.50		2003-01-29
KTA -AcaMan-03	KTA No MU	5	16.50	2006-06-27	2006-06-27
KTA -AcaMan-04	KTA No MU	3	1.50		2004-09-29

Arthrostemma ciliatum

Arthrostemma ciliatum is a member of the *Melasomataceae* family, along with two well known invasive species *Miconia calvescens,* and *Clidemia hirta.* The weed is widely naturalized throughout much of the Ko‘olau Mountains, but is uncommon in KLOA. NRS target *A. ciliatum* in areas where activities like foot traffic or vehicles might lead to the spread of this weed to places where it is not currently found (Figure 2.2.3).

SBE-ArtCil-01; East Range Coqui Area ArtCil Control East
The *A. ciliatum* at this site has the potential to be spread by troops, as the trail along which it spreads is still actively used by military personnel. NRS has seen flagging in the area, probably put up by training troops. NRS has had good seedling kill in this area but need to monitor and kill new seedlings. Extensive surveys of the area are needed to determine the entire extent of *A. ciliatum* at this site before a specific control plan can be made. NRS will consider using a pre-emergent if seedlings continue to appear.

KLOA-ArtCil-01; ArtCil along Poamoho Road
This site occurs along the Poamoho road. This ICA was weeded twice last year using a backpack sprayer. These plants are found roadside, which makes spraying them easy. Two trips will be made to this area next year to treat any regrowth. The weed is common in the area, but plants near the road are destroyed to avoid its transport to new areas via military traffic along the

road. Over the years, NRS control has markedly decreased the amount of *A. ciliatum* in this ICA.

DrumRd-ArtCil-01; ArtCil on Drum Road near Paalaa Stream
NRS weeded this area 4 times last year for a total of 2.1 hours. Twenty-eight plants were killed last year but none were seen on the last trip. NRS will visit this area 4 times next year to check for any regrowth.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: ArtCil	**Arthrostemma ciliatum**				
DrumRd-ArtCil-01	KLOA No MU	4	2.16	2006-05-29	2006-05-29
KLOA-ArtCil-01	KLOA No MU	1	2.00	2006-04-19	2006-04-19
SBE-ArtCil-01	SBE No MU	4	71.42	2006-07-20	2006-07-20

Buddleia madagascariensis

B. madagascariensis is rare on O‘ahu but is a widespread weed on Kaua’i. The O‘ahu Invasive Species Committee (OISC) targets this weed on O‘ahu, and it is considered to be one of Hawai’i’s most invasive horticultural plants. NRS feels it is important to control and eradicate this plant before it becomes established on this island. The plants that were found were probably from seeds introduced accidentally by military traveling from either Kaua’i or Maui. NRS currently controls this weed at two sites, both in Schofield Barracks East Range (Figure 2.2.3).

SBE-BudMad-01; East Range BudMad along Higgins Road
This site had no seedlings this year. It appears that this plant is dead and no longer a threat. NRS will continue to monitor every six months to verify that this area has no *B. madagascariensis*.

SBE-BudMad-02; East Range BudMad at Coqui site
This site’s plant was dead and no seedlings were found. OISC is also involved in the area and monitors this site as well. NRS will continue to monitor this site during its annual road survey and while visiting the *A. ciliatum* and *R. tomentosa* sites nearby.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: BudMad	**Buddleia madagascariensis**				
SBE-BudMad-01	SBE No MU	2	0.60	2004-03-15	2006-06-22

Festuca arundinacea

Festuca arundinacea is a deep rooted perennial grass from Europe. It is a cool-season, long-lived grass. There is no evidence of this grass invading large areas of bog, however, since the distribution of this species is so small on Army land, NRS will continue to implement control and monitor the effectiveness of this control.

SBW-FesAru-01

Seed heads were bagged and remaining stalks sprayed. NRS will need to monitor once per quarter. This plant is not a significant threat and will likely stay on the road fringes (Figure 2.2.6). NRS will continue to spray the area and work with the NARS Specialist to eradicate the population. It is likely that this may be a long-term process because of a probable persistent seed bank. If deemed necessary, research can be conducted on the seeds and a management plan developed accordingly. NRS is looking into using pre-emergent herbicide in other areas. The proximity to the bog may rule out using pre-emergent herbicide here.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: FesAru	**Festuca arundinacea**				
SBW-FesAru-01	Kaala	1	4.00	2006-06-22	2006-06-22

Hedychium gardnerianum

H. gardnerianum, or kahili ginger, is an invasive member of the ginger family (Zingiberaceae). In wet higher elevation forests of Hawai'i, it has become a serious ecosystem-altering understory pest. It is less common on O'ahu than other islands, and control of this weed in its known locations in Kaʻala bog and the Ko'olau summit is a high priority for NRS. *H. gardnerianum* control on Mount Kaʻala is discussed in the MU WCA Report; this taxa is so widespread at Kaʻala that it is no longer treated as an incipient.

Kipapa-HedGar-01; HedGar at Puu Kaaumakua

The goal of this eradication effort is to keep *H.garderianum* off the summit and limit it to the windward side (Figure 2.2.4). At Kīpapa, one seedling was found on the leeward side of the trail and one immature plant was found on the crest line of the summit. NRS will kill large patches on the windward side near the summit and continue to monitor the summit one to two times per year.

Koloa-HedGar-01; Kawailoa Kahuku Cabin

No seedlings or plants were found this year. NRS will continue to monitor once or twice per year. Monitoring efforts were focused on the trails. Sites were spotted off the trail in the past (Figure 2.2.4). NRS will survey the area thoroughly next year. Because plants are removed before seeds are produced, the identification of this population still needs to be confirmed.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: HedGar	**Hedychium gardnerianum**				
Kipapa-HedGar-01	Kipapa	1	8.00	2006-08-10	2006-08-10
Koloa-HedGar-01	Koloa	1	0.25	2005-03-17	2005-06-22

Ilex cassine

Ilex cassine is a member of the holly family (Aquifoliaceae) native to eastern United States. One individual was found this reporting year in Schofield West Range (SBW). It is possible that NRS will be able to successfully eradicate this weed from this MU. The only other place on the island that this plant is known is an old low elevation botanical site in Helemano, where it is a common component of the alien-dominated forest. It is unclear as to the invasiveness of this species, but NRS does not want new populations to get established in management areas.

<u>SBW-IleCas-01; Haleauau/Pulee Ridge Fire Area</u>
One mature plant was found this year during a fire survey. The site was visited shortly after and NRS killed the plant. The area around the *I. cassine* was monitored and no seedlings or immature plants were found. NRS will continue to monitor this site next year. There is an annual road survey in this area and numerous visits for the O‘ahu ‘Elepaio, *Chasiempis sandwichensis*, and rare native plants. NRS will make sure that all staff is aware of this new invasive plant and the site it was found to keep an eye out for it. NRS will also make time during regular management to check on this area for any resprouts of *I. cassine*. NRS will check this area at least three times next year and expand the perimeter survey to make sure no other plants exist.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: IlexCas		**Ilex cassine**			
SBW-IleCas-01	SBW No MU	1	0.10	2006-06-26	

Juncus effusus

Juncus effusus is a member of the rush family (Juncaceae), and is an invasive plant in higher elevations on O’ahu. NRS control it at three sites in the Ka’ala bog (Figure 2.2.6). It forms dense aggregations that inhibit natural regeneration of native bog flora. The current control technique for *J. effuses* is manual removal, however, in the coming reporting year NRS plans to experiment with using Rodeo herbicide (formerly Roundup) as a control of this weed.

<u>SBW-JunEff-01; Ka’ala Bog JunEff Core</u>
An Earthday volunteer group helped remove *J. effusus* around the beginning portion of the Ka‘ala boardwalk. There still is a large population, but efforts were very effective, if labor-intensive. More volunteer groups can seriously diminish the mass amount of this semi-invasive species.

<u>SBW-JunEff-02;Ka’ala Bog JunEff South</u>
This site will be monitored next year.

<u>SBW-JunEff-03; Ka’ala Bog JunEff Northeast</u>
The *J. effusus* was dug up, bagged, and carried out of the bog. This population had small resprouts a few months later and was retreated during a *H. gardnerianum* sweep. It looks as if this population can be eradicated with a few more visits.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: JunEff		**Juncus effusus**			
SBW-JunEff-01	Kaala	1	20.00	2006-04-22	2006-04-22
SBW-JunEff-03	Kaala	1	7.00	2006-04-22	

Leptospermum scoparium

On the PIER website, www.hear.org/pier, *L. scoparium* is given a weed risk assessment score of 3, and is deemed a high risk. Its fast growth, quick rate of maturation, and wind dispersed seeds make it highly invasive. Its wet forest habit means it threatens some of the most intact native forest on Oahu. This species is known from the extreme northern end of KLOA, Poamoho, and KTA. While it is very well established in the northern Koolaus, this weed is present in fairly low numbers in the Poamoho region. NRS control efforts focus on Poamoho, but in the future, NRS may expand efforts to the Puu Kainapuaa region of northern KLOA, the frontline of *L. scoparium* expansion in the northern Koolaus.

KLOA-LepSco-01; LepSco Poamoho

Despite a relatively low population in Poamoho, *L. scoparium* is distributed across one ridge and both bordering valleys, and reaching all plants is difficult. Efforts in previous years were successful at reducing population levels, but no control has been conducted in a couple years, and the infestation has rebounded in some areas. This year, NRS focused on clearing areas near the Poamoho trail with the aid of the Youth Conservation Corp. Future efforts will require much more off-trail work, and will be much more challenging. NRS will focus on continuing to sweep known infestation areas.

KLOA-LepSco-02; LepSco Poamoho Trailhead

No control was done in this ICA this year. It was swept last year, and NRS plan to sweep again in the next year.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: LepSco		**Leptospermum scoparium**			
KLOA-LepSco-01	KLOA No MU	2	75.00	2006-07-25	2006-07-25

Melochia umbellata

M. umbellata is an invasive tree native from southeast Asia and certain islands in the western Pacific Ocean. In Hawai'i, the major infestations are located near Hilo and Puna on the island of Hawai'i. On O'ahu it is only known from five sites, all located in Kahuku Training Area (KTA) (Figure 2.2.5). It is probable that the weed was inadvertently transported there by military personnel or vehicles coming from the Big Island. *M. umbellata* is a fast growing tree capable of invading disturbed areas and replacing native vegetation. It is possible that ICA's 03, 04, and 05 were established by dirt containing *M. umbellata* seeds spread around by vehicles traveling through KTA MelUmb-01. This makes eradication of plants along the road a high priority to avoid further spread of the weed to other areas, possibly even outside KTA.

KTA MelUmb-01; Kahuku MelUmb Along Road

This ICA is one of the highest priority incipient sites that NRS manage. This is the core site for *M. umbellata* in KTA. In the past reporting year a total of 6 trips were taken to survey the ICA for any *M. umbellata*. The seedbank appears to persist for a long time, as five out of the six trips found new seedlings and/or immatures. A total of 13.5 hours were spent surveying along the road. During this time no mature trees were found. NRS will return to the ICA quarterly to scope the area for any new seedlings or plants missed on previous trips. If sweeps are thorough, it is possible that NRS will be able to contain *M. umbellata* at a nearly non-existent level. To facilitate searches and to exhaust the seedbank, NRS regularly spray the weedy grasses and shrubs along the road.

KTA MelUmb-02; Kahuku MelUmb Below Road
This site is where the original mature *M. umbellata* plants were found. The area is thick with *Psidium cattlianum* and other non-native trees, making it unfavorable for *M. umbellata*, which prefers full sunlight. Two scoping trips were taken to this WCA during the 2005-2006 reporting year, one was a ground survey, and one was an aerial survey from a helicopter. The first trip re-located the dead stump of one of the original mature trees, but found no new live plants. On the aerial survey one large, possibly mature tree was seen in the WCA, with at least a couple other small ones nearby. NRS did not have time on the trip to locate and control the plants, but NRS will remove the tree early in the coming reporting year. The large area, dense habitat, and uneven terrain make surveying this ICA difficult and necessitate an aerial survey at least once per year, and ground surveys at least twice a year to ensure complete coverage.

KTA MelUmb-03; Kahuku MelUmb West Outlier
This ICA was created around a single outlying mature plant found in June 2006. The tree was near the road, approximately 700 meters from KTA-MelUmb-01. The tree was killed and the site was re-visited two times since then to look for other plants. None were found. On one of the re-visits the area around the stump was treated with a mixture of Garlon 3 and Roundup © herbicide, broadcast sprayed from a power sprayer to kill roadside vegetation and any possible unseen seedlings. NRS plan to do quick scopes of this ICA at least two times in the coming reporting year. This frequency should be sufficient to control any seedlings that come up before they become mature. An aerial survey of the site at least once in the following year would be optimal to search for any other mature trees in the area.

KTA MelUmb-04; Kahuku MelUmb East Outlier
This ICA is only 100 meters down the road from KTA-MelUmb-03, and like that ICA, was created with the discovery of a single mature tree found on the same day in June. The tree was killed, and like the previous ICA, the area was sprayed with herbicide. NRS plans to re-visit the site and sweep for seedlings at least twice a year. A yearly aerial survey in conjunction with the other sites would be recommended for the following report year.

KTA MelUmb-05; Kahuku MelUmb Delta Gate
Due to the closure of Delta Road during the past year, NRS did not re-visit this ICA. The road repair was completed late this year, and NRS plan to re-continue surveys of the area in the following year.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: MelUmb	**Melochia umbellata**				
KTA-MelUmb-01	KTA No MU	6	13.50	2006-06-27	2006-08-08
KTA-MelUmb-02	KTA No MU	2	3.00	2006-08-08	2006-08-08
KTA-MelUmb-03	KTA No MU	3	1.02	2006-06-27	
KTA-MelUmb-04	KTA No MU	3	1.02	2006-06-27	

Pennisetum setaceum
For a discussion of this incipient see MIP ICA section.

<u>SBE-PenSet-01; East Range PenSet</u>
NRS and OISC found one plant with a flowering head in 2004 on Centerline Rd. It was pulled and disposed of. The area has been monitored on Road surveys in 2005 and 2006 and no regrowth has occurred. NRS will continue to monitor this area.

<u>KTA-PenSet-01; Kahuku PenSet</u>
The area is thick with weedy vegetation, dominated by tall *P. maximum,* making surveys of this site difficult (Figure 2.2.5). However, no plants were found this year during any of the six trips to the area to search for the grass, indicating that *P. setaceum* may be extirpated from this area. However NRS will continue to survey the area in the coming reporting year to ensure its complete eradication from the ICA.

<u>DMR-PenSet-01; Dillingham Gate PenSet</u>
This site is monitored during the annual Road survey of the area. No plants were spotted. No plants have been seen since 2001, suggesting the taxon may be extirpated. NRS will monitor this site again next year.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: PenSet	**Pennisetum setaceum**				
DMR-PenSet-01	DMR No MU	1	0.50	2001-08-30	2001-08-30
KTA-PenSet-01	KTA No MU	6	7.75	2003-11-19	2004-09-29
SBE-PenSet-01	SBE No MU	1	8.00	2004-09-21	

Rhodomyrtus tomentosa
This species is a member of the Myrtaceae family, and was probably introduced to Hawai'i intentionally as an ornamental plant. It is a widespread weed on other islands, but on O'ahu it is locally common only in a few valleys on the Windward side of the Ko'olaus, where it forms dense monotypic stands in disturbed areas. It is a rare weed on NRS managed lands, occurring in only two currently known sites (Figures 2.2.3 and 2.2.5). It is important that NRS keep this weed out of management areas, and monitor for any reoccurrences.

<u>SBE-RhoTom-01; East Range RhoTom Control</u>
This site was monitored once this past year. Mature plant total was 25 individuals. NRS will continue to visit this site three times per year, focusing on killing seedlings near areas where mature plants were found. It is easier to spot the plant when it is taller than the grass, so re-visitation rate will be low to give small seedlings time to grow up to a more observable height. Another more laborious strategy would be to weed whack areas known to have had mature *R. tomentosa* to kill seedlings before they begin to mature. NRS will consider spraying pre-emergent herbicide to kill seeds in the soil and reduce seedling emergence. It is also recommended that NRS do more complete surveys of the area to ensure that all plants were found. This may include one aerial survey and extensive ground surveys in the coming year.

<u>KTA-RhoTom-01; Kahuku RhoTom at Puu 1010</u>
One mature individual was found at this site in June of 2005. The tree was killed, and since then NRS have made informal checks as to any sort of regeneration or appearance of seedlings, since the site is adjacent to a commonly used parking area. No plants have been seen since the original one was found. It is unclear how the plant could have dispersed to this location, possibly from mud in tires of motocross riders coming from the infested windward areas. NRS feel that eradication is necessary and possible. It may already be eradicated following the removal of the one mature individual, however, official declaration of the weed's extirpation will require study of the longevity of its seeds in the soil. In the following year NRS plan to scope the site periodically and make a decision as to its status.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: RhoTom	**Rhodomyrtus tomentosa**				
KTA-RhoTom-01	KTA No MU	1	0.10	2005-06-02	
SBE-RhoTom-01	SBE No MU	2	14.00	2006-06-28	2006-06-28

Senecio madagascariensis

Senecio madagascariensis, a member of the Asteraceae family, is listed as a noxious weed that colonizes disturbed areas such as pastures and roadways. It is of primary concern to ranchers, as the plant contains alkaloids that are potentially fatal to livestock if ingested. This weed is only known from one location on lands managed by NRS, although it is common on the islands of Hawai'i and Maui. It is probable that *S. madagascariensis* was introduced to O'ahu by the accidental transportation of contaminated soil by military personnel or vehicles coming from Hawai'i or Maui.

<u>SBS-SenMad-01; South Range SenMad at FP Halo</u>
This is the single area where *S. madagascariensis* is found on lands managed by NRS (Figure 2.2.6). This year only one trip was taken to the site, and only one mature plant was found. The most common form of control used is hand-pulling of individual plants. If larger populations are present, spraying of herbicide is necessary. The military has since done a lot of earth moving in the area, which may bring more buried seeds to the surface. NRS plan to return to the site early in the coming year to survey for any germination of seeds since the last trip and since the earthworks. In general plant numbers have been low at this site, and only one mature plant was seen on the last survey in February of 2006.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: SenMad	**Senecio madagascarensis**				
SBS-SenMad-01	SBS No MU	3	7.50	2006-02-27	2005-05-24

Setaria palmifolia

S. palmifolia is an invasive grass that can be found in moist areas throughout the lower elevations of the Ko'olau Mountains on O'ahu. It is an aggressive weed that forms dense monotypic aggregations, replacing native vegetation. It is rare in the higher elevations of the

Ko'olaus, where many valuable natural resources still remain. Controlling this weed in KLOA is a high priority for NRS.

Control methods for all the *S. palmifolia* ICA's include hand-pulling when population sizes are small, and backpack spraying when numbers are larger. The latter is the case at the KLOA SetPal-10 (Figure 2.2.4), where there is a large population. Spraying a solution of 1% roundup has been found to be very effective at reducing the population. Timely follow-up with repeat treatments has been the hardest thing to accomplish as the weather can be very unpredictable on the Ko'olau sumit.

The seeds of *S. palmifolia* are very small, which make it easily dispersed. It is possible that seeds will be dispersed to new areas if mature plants are not removed from populations. The probable vectors of dispersal include wind, pigs, humans, and stream flows. Research as to the longevity of *S. palmifolia*'s seeds in the soil would be very useful in designing control plans. Each trip seems to reveal a handful of new plants at many of the sites, suggesting that the seedbank may be persistent for a long time, or that surveys are too infrequent, necessitating continued and possibly more frequent visitation. It is recommended that NRS survey each ICA once a quarter to keep *S. palmifolia* at manageable levels.

<u>KLOA SetPal-01; Opaeula SetPal along northern fenceline</u>
One seedling was found here this year.

<u>KLOA SetPal-02; Opaeula SetPal along Peahinaia Trail</u>
This population was found prior to 2002 and was the largest of the five original *S. palmifolia* sites. In that year 90 mature and 42 immature plants were found. Since then numbers have been declining. In a survey in October of the past reporting year four matures and three juveniles were found and pulled. A second trip in July yielded no plants.

<u>KLOA SetPal-03; Opaeula SetPal at 260 Transect 12</u>
In October of this reporting year nine mature and three immature plants were found, while only three immature plants were found there in July.

<u>KLOA SetPal-04; Opaeula SetPal on Transect 14 Station 290</u>
In July of this reporting year only one immature plant was found at this site. This was the first sighting of *S. palmifolia* at this site, resulting in the creation of this ICA. A thorough survey of the area is needed in the coming reporting year.

<u>KLOA SetPal-05; Opaeula SetPal at 370</u>
Two trips made to this site, one in October and one in July of this reporting year, turned up no plants.

<u>KLOA SetPal-06; Opaeula SetPal at Goosehead</u>
The first trip sent to survey this ICA, in October of this reporting year, resulted in one mature and five immature plants being found. The second trip, in July, found no plants.

KLOA SetPal-07; Opaeula SetPal at Hypalon
This species was first found here in January of 2003 and no plants have been found on trips since then, including two surveys that happened in October and July of this reporting year.

KLOA SetPal-08; Opaeula SetPal at Shaka
The one trip sent to survey this ICA in July of this reporting year found no plants. No plants have been found at this site since the initial finding of one mature and two immature plants in January of 2003.

KLOA SetPal-09; Opaeula SetPal on Transect 12 Station 290
This ICA was not surveyed during this reporting year. NRS plan to resume efforts in the next year.

KLOA SetPal-10; SetPal Helemano bowl down to stream
This ICA contains the largest population of *S. palmifolia* known in the MU, and was discovered in August of 2003. Here, hand pulling is not feasible, and backpack spraying of Roundup herbicide at a 1% solution is the current control technique. Two days were spent spraying this population during the past reporting year, and it was noted that the population looked larger since the last treatment in March of 2005. Two outlying patches were found on one of the trips this year, indicating that a wider survey of the area is needed. Also, more frequent control is needed to reduce this population to a manageable level. Quarterly visits should be adequate to control the *S. palmifolia* in this ICA.

KLOA SetPal-12; North Helemano fenceline, west of LZ 66
This ICA was newly created this year, after the discovery of a new population of *S. palmifolia* while clearing the Helemano fenceline. The population consisted of eight matures, four immatures, and three seedlings. Since the population is right on the fenceline, the possibility of spreading seeds from that site via people or pigs walking along the line is high. For this reason extermination of this population is a high priority.

KLOA SetPal-13; Helemano fence/Peahinaia Tral SetPal
This population was newly found this year, on a trip to survey other *S. palmifolia* ICAs nearby. A total of six mature plants were found on that trip in July. A more extensive survey of the area is needed in the coming year.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: SetPal	**Setaria palmifolia**				
KLOA-SetPal-01	Opaeula/Helemano	1	0.25		2006-07-18
KLOA-SetPal-02	Opaeula/Helemano	3	3.00	2005-10-20	2005-12-06
KLOA-SetPal-03	Opaeula/Helemano	3	2.50	2005-10-20	2006-07-18
KLOA-SetPal-04	Opaeula/Helemano	1	0.25		2006-07-18
KLOA-SetPal-05	Opaeula/Helemano	3	1.75	2004-10-19	2005-05-03
KLOA-SetPal-06	Opaeula/Helemano	3	1.25	2005-10-20	2005-10-20
KLOA-SetPal-07	Opaeula/Helemano	3	0.60		2003-01-13
KLOA-SetPal-08	Opaeula/Helemano	1	1.00		
KLOA-SetPal-10	Opaeula/Helemano	2	8.50	2006-07-19	
KLOA-SetPal-12	Opaeula/Helemano	1	0.25	2006-03-20	2006-03-20
KLOA-SetPal-13	Opaeula/Helemano	1	0.50	2006-07-18	

Smilax sp.

This genera is a group of related species with woody climbing vines, tendrils and thorny stems originating from the Eastern United States. It appears this *Smilax* sp. can invade an area quickly with runners and seeds. NRS is monitoring this site closely. Formal identification of this species would require flower and/or fruit, neither of which have been seen by NRS. Rather than risking seed becoming established on site, NRS will continue eradication efforts.

<u>SBE-Smisp.-01</u>

NRS checks on this site at least twice per year (Figure 2.2.3). This *Smilax sp.* may just be vegetative. NRS has not observed plants flowering or fruiting. NRS is very concerned about this plant because it can be a nuisance with its thorns. It is also possible that it could hybridize with the native *Smilax melastomifolia.* NRS has been spraying the site with Roundup and will continue to do so at least two times next year.

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: SmiSp.	**Smilax sp.**				
SBE-Smilax-01	SBE No MU	2	3.00		2005-10-27

Management Unit Weed Control Area Report

IP MU: East of ʻŌʻio

This WCA is centered around a small population of *Eugenia koolauensis* within KTA. Since this population is not targeted as MFS, weed control efforts here are currently minimal.

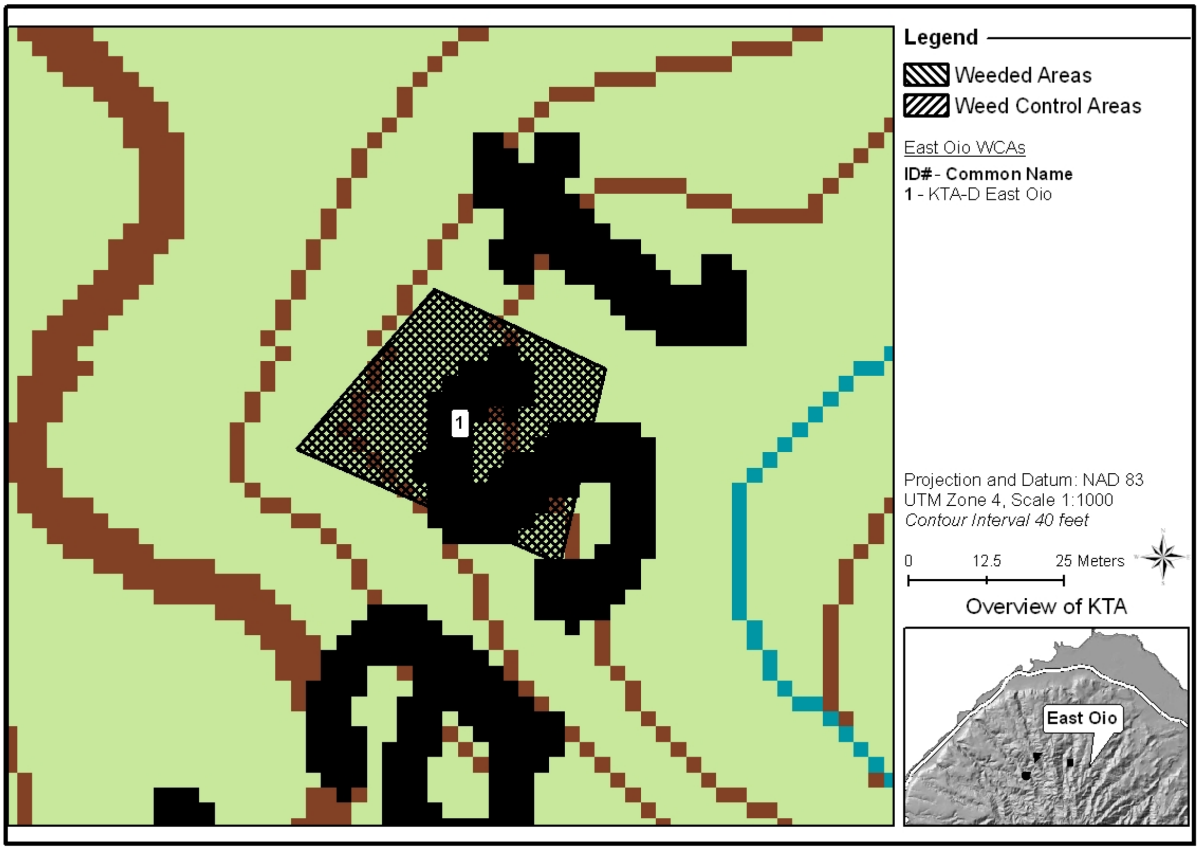


Figure 2.2.7 Weed Control Areas in East ʻŌʻio, Kahuku Training Area

<u>WCA Discussion</u>

<u>East ʻŌʻio-01; EugKoo KTA-D East ʻŌʻio</u>

Due to the predominance of *Psidium cattleianum* at this site, and the low numbers of *E. koolauensis*, weeding at this WCA is limited. The goal of weed control here is to make the area immediately around the plants more hospitable to *E. koolauensis* recruitment. This area was weeded once last year (Fig. 2.2.7). NRS targeted a variety of understory weeds and some small healthy *E. koolauensis* were uncovered. Previous grass control efforts were successful, and no *O. hirtellus* control was needed this year. NRS observed a noticeable increase in native *Carex* species at the site. This area will be visited once next year for weeding, as this level of effort seems to be effective. NRS will continue to focus on understory and grass control. NRS will consider outplanting native trees to reduce the need for understory weeding.

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
IP MU: East of Oio					
EastOio-01	3M	1221.016	1221.016	100.00%	EugKoo

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	3.00	ArdEll, ChrPar, CliHir, PasSub, PsiCat
Total	1	3.00	

IP MU: Kaleleiki

This WCA is drawn around a population of *E. koolauensis* found on State Forest Reserve land. NRS conduct management here in conjunction with State personnel. This site is not designated 'Manage for Stability' for *E. koolauensis*, thus NRS limit effort here.

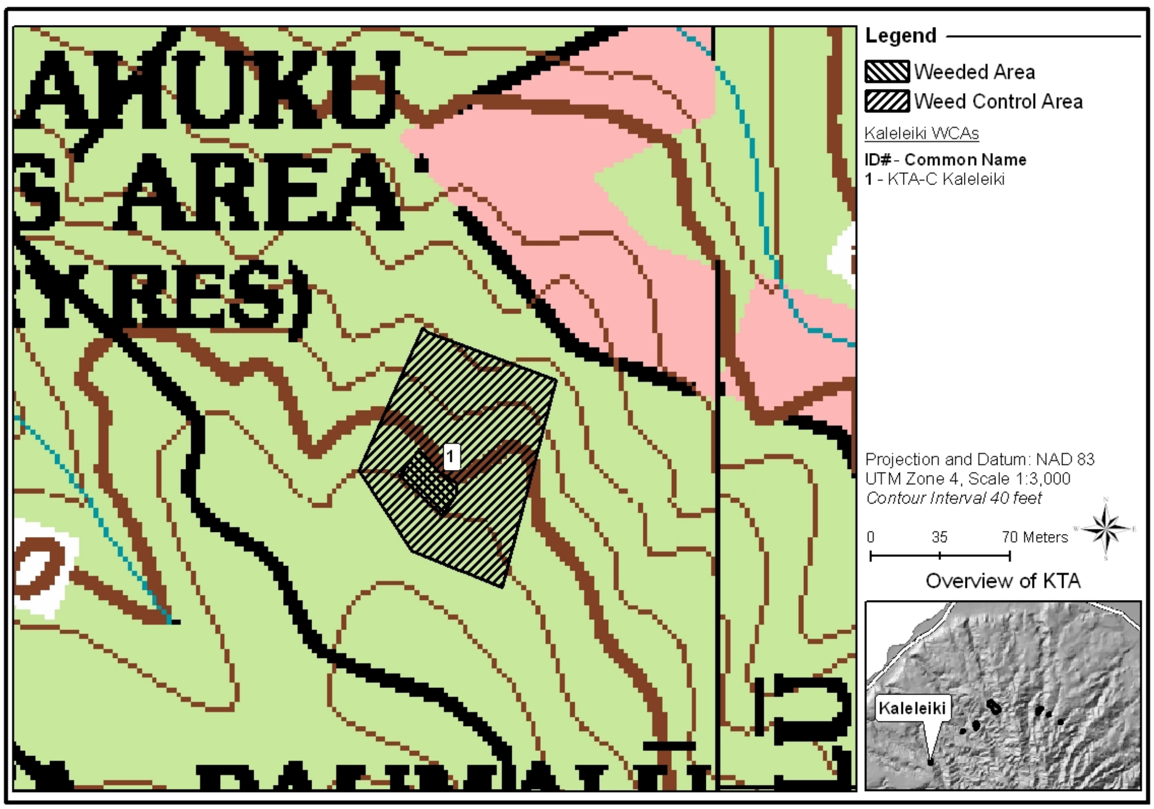


Figure 2.2.8 Weed Control Areas in Kaleleiki, Kahuku Training Area

WCA Discussion

Kaleleiki-01; EugKoo KTA-C Kaleleiki

This WCA is defined by a small ungulate-exclusion fence installed by the State. In the past year, weed control was only performed once at this site (Fig. 2.2.8). NRS targeted understory weeds and grasses around the core of the *Eugenia* population. Grasses appear to pose the most threat to small *E. koolauensis*, and many immature and seedling plants were found covered in *P. conjugatum*. Canopy weeding was minimized to prevent drastic alteration of microsite conditions. Previous fuel control efforts of *C. equisetifolia* were successful, and there is very little left within the fence. However, *C. equisetifolia* dominates much of the surrounding area; the potential fire threat to this site should be better evaluated in conjunction with the State. Encouragingly, NRS observed many *Rauvolfia sandwichensis* and *Scaevola gaudichaudii* seedlings in light gaps. In the future, NRS hope to visit this site at least twice a year. NRS will continue to focus on understory, grass, and fuel control.

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
IP MU: Kaleleiki					
Kaleleiiki-01	Habitat	7959.375	455.3222	5.72%	EugKoo

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	20.00	BudAsi, ChrOli, CliHir, PasCon, PasEdu, PsiCat
Kaleleiiki-01 **Total # of Visits and Person Hours**	1	20.00	

IP MU: Kaunala

One of the largest populations of *E. koolauensis* occurs in this MU. Weed control is centered around the greater part of this population in Kaunala gulch. No work is currently done at the smaller part of this population in Aimu‘u gulch. The Kaunala portion of this population is designated MFS, while the Aimu‘u portion is not. There are two WCAs designated in this MU (Fig. 2.2.9). Kaunala-01 is defined by a fence completed this year to protect *Eugenia*, while Kaunala-02 is around a newly created landing zone.

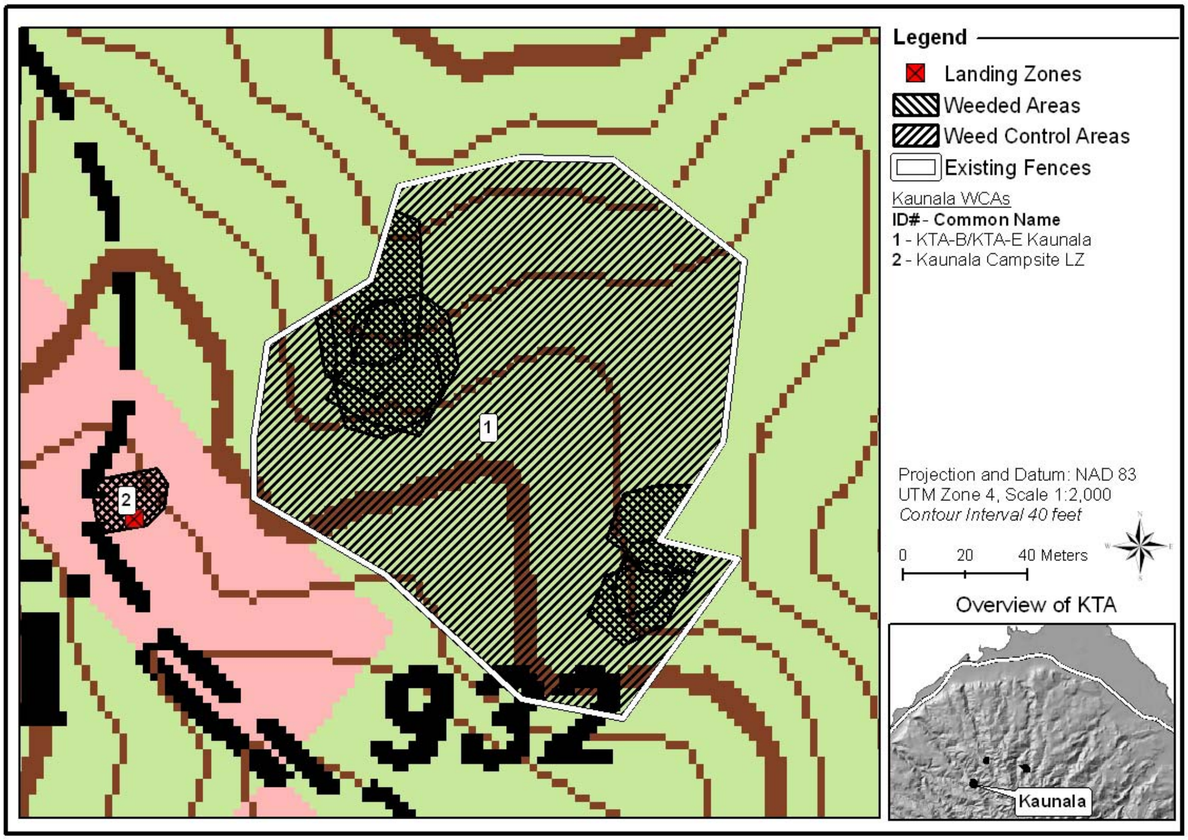


Figure 2.2.9 Weed Control Areas in Kaunala, Kahuku Training Area

WCA Summary Table

WCA Discussion

Kaunala-01; EugKoo KTA-B/E Kaunala

In the past year, NRS focused effort in this WCA on clearing fenceline and building an ungulate-exclosure fence. Hence, weeding effort was not as high as usual. Since this WCA is fairly large and has a very patchy native forest distribution, weed control has centered directly around two core groups of *Eugenia*. Common native forest elements are also targeted for weed control, as their relative rarity makes them vital to restoring the area. NRS hope to encourage growth and recruitment for both common and native species by reducing the weed biomass around them. Primary targets are understory weeds, vines, and grasses, while canopy weeding is limited to prevent a drastic increase in light which *Eugenia* may find harmful.

Fenceline clearing accounts for 20 hours of the 68 hours spent at this WCA. Chainsaws were used to create the fenceline and drop zones; some large open areas were created as a result. Not reflected in the Summary Table is the time spent conducting fuel control in the patch. NRS cut down between 40-50 large *C. equisetifolia*, *G. robusta*, *E. robusta*, and *M. quinqueveria*. Again, some large open areas were created in the process of eliminating these fuel-loading trees. Grass control was conducted on one trip where *O. hirtellus* was treated around the two core areas of *E. koolauensis*. Understory weeding efforts account for 46.5 hours.

Common native plant seeds were collected from this area to store for future outplanting. *Cibotium* species are being considered for future transplanting operations from areas outside the fence to within the fence. Cuttings were also taken from this area to get some plants ready for outplanting as soon as possible. Multiple species were chosen for cuttings and many were experimental. There is a lot of open area and it would be good to get native plants established before any weeds, which should decrease the amount of time spent on weeding in the area.

In the coming year, NRS hope to partner experimental common outplantings with regular weed control to reduce the total effort required at this site while improving overall habitat. NRS plan to visit this site quarterly.

Kaunala-02; Kaunala LZ

This area was cleared once this past year to establish an LZ and a campsite. NRS will continue to weed this area once a year to clear weeds that may get in the way of the helicopter.

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
IP MU: Kaunala					
Kaunala-01	Habitat	19761.45	3117.704	15.78%	EugKoo

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	1.50	OplHir
Ecosystem Weed Control	4	66.50	ArdEll, CasEqu, ChrPar, CliHir, PasSub, PsiCat, SchTer
Total	5	68.00	

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
Kaunala-02	Fenceline Clearing	383.5507	383.5507	100.00%	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	12.00	
Total	1	12.00	

IP MU: ‘Ō‘io

This IP MU contains one WCA, which is delineated by the newly completed ‘Ō‘io fence (Fig. 2.2.10). The fence protects a large population of *E. koolauensis* which is designated MFS. Other *Eugenia* plants in the PU are not designated for intensive management, and thus no weeding has been done around them yet.

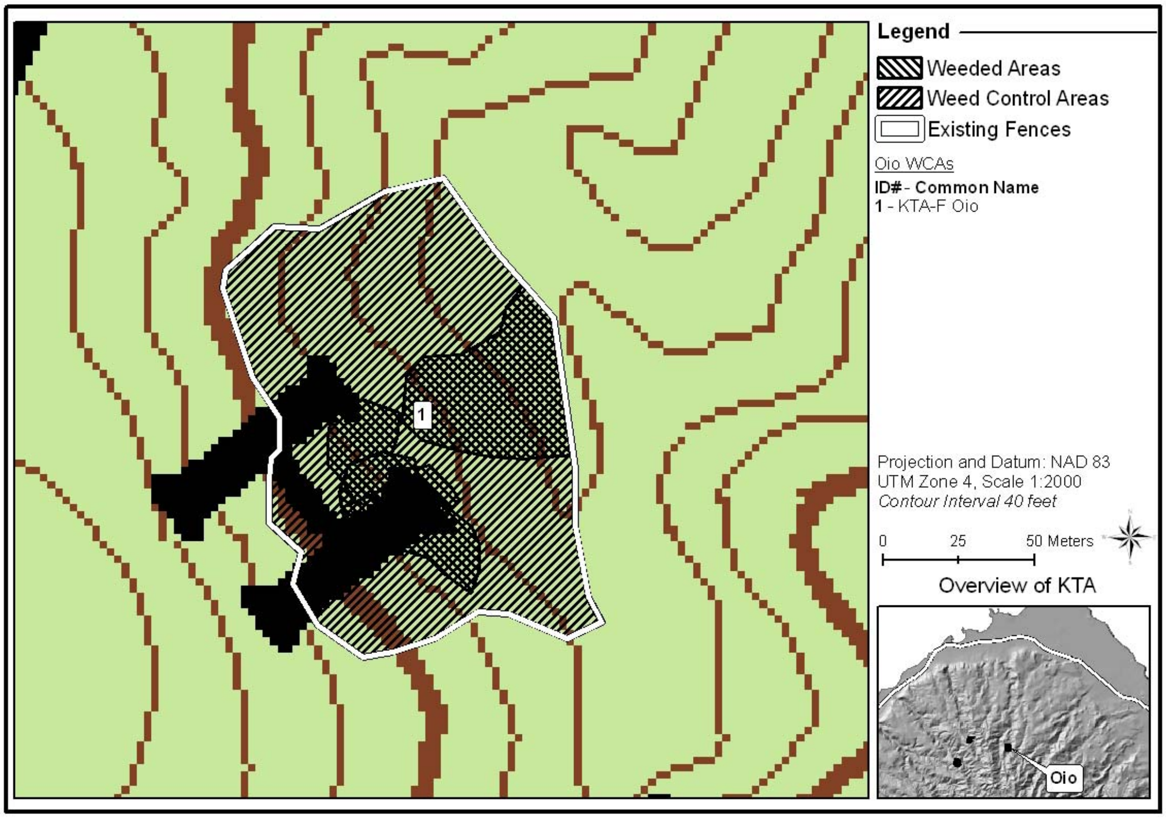


Figure 2.2.10 Weed Control Areas in ‘Ō‘io, Kahuku Training Area

WCA Discussion

‘Ō‘io -01; EugKoo KTA-F ‘Ō‘io

This year, efforts in this MU focused primarily on constructing a fence around *E. koolauensis*. Weed control efforts were much lower than normal. This WCA is very weedy and has few native forest remnants. Much of the patch is dominated by *P. cattleianum* and the WCA is surrounded by *C. equisetifolia*. As a result, the strategy for this site has been to weed understory, vine, and grass components around *E. koolauensis* clusters.

In the past year, NRS spent 34 hours weeding understory species, and retreating *P. cattleianum*. Since *P. cattleianum* is clonal, removing small portions of a stand at a time is not always effective. However, NRS are very cautious about opening the canopy further. *Christella parasitica* is proliferating as other understory weeds are killed, and more time was spent treating it this year. Fenceline clearing accounts for 9 hours of weed effort. Grass spraying accounts for another 8 hours.

In 2004, NRS contracted a tree-trimming service to remove about 40 very large *C. equisetifolia* for fuel control. This effort resulted in the creation of very large light gaps in the WCA. The canopy closure and light levels increased drastically. As a result, NRS witnessed major and diverse weed growth in the area over the past year, and were not able to keep up with the weeding. NRS have to drastically rethink goals for and approaches to the WCA. The area is so weedy that regular understory weeding will not suffice. Instead, in the coming year NRS hope to outplant common propagated natives into the site (*Acacia koa, Carex* sp.); thin-out and transplant naturally occurring *Raovulfia sandwicensis* seedlings from within the site; and transplant *Cibotium chamissoi* from other areas into the fenced area. Weed control will be conducted directly around outplantings. It is hoped that such outplantings will help restore some level of shade to the site in both the short and long term. Restoration of this site will be challenging. NRS plan to visit this site quarterly.

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
IP MU: Oio					
Oio-01	Habitat	13335.19	3683.653	27.62%	EugKoo

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	2	8.00	OplHir
Ecosystem Weed Control	3	43.00	AleMol, ArdEll, CasEqu, ChrPar, CliHir, PasEdu, PasSub, PsiCat, RubRos
Total	5	51.00	

IP MU: Pahipahiʻālua

This IP MU contains one WCA, which is delineated by the Pahipahiʻālua fence (Fig. 2.2.11), which was completed this year. The fence protects a population of *E. koolauensis*, consisting of a number of large mature individuals as well as younger age classes scattered throughout the exclosure. This site is designated MFS and is thus managed intensively.

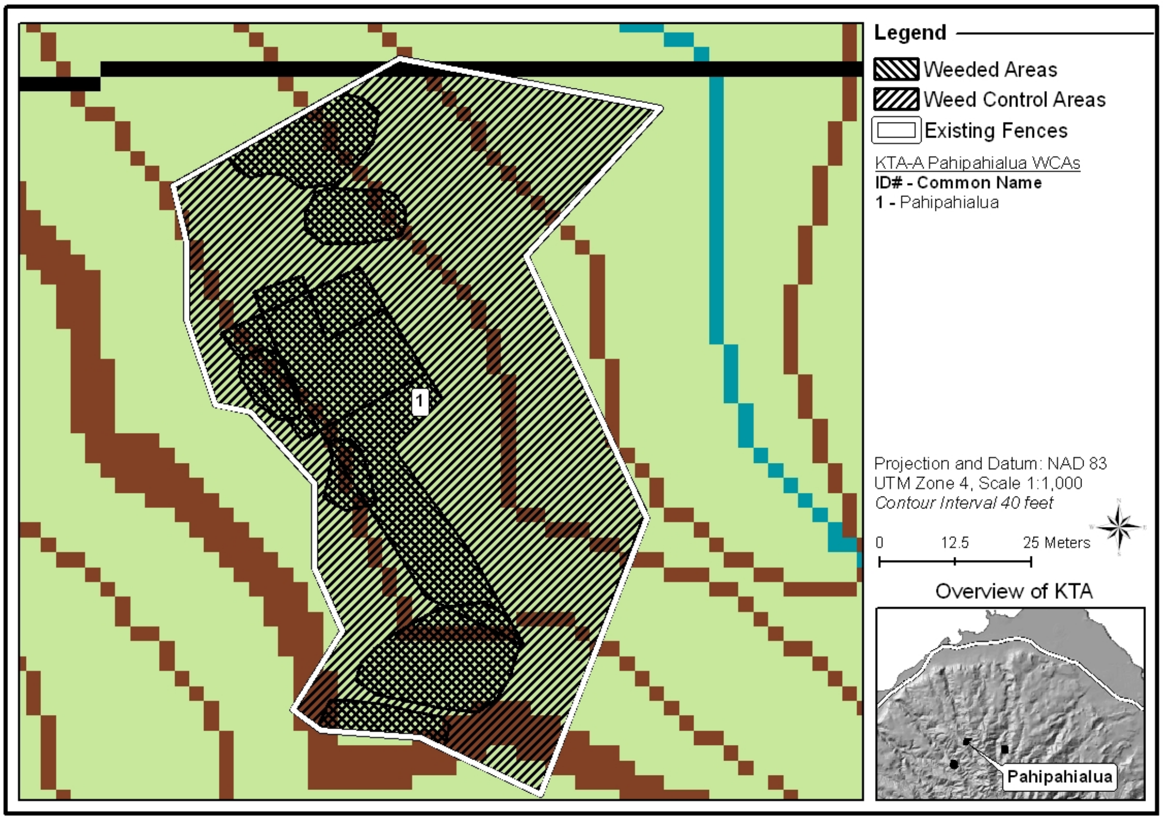


Figure 2.2.11 Weed Control Areas in Pahipahiʻālua, Kahuku Training Area

WCA Discussion

Pahipahiʻālua -01; EugKoo KTA-A Pahipahiʻālua

There are three main groups of *E. koolauensis* within this WCA, and hence there are three main target weeding areas. By observing the effects of light gaps on *E. koolauensis* created by weeding effort near the trees, NRS believe that *E. koolauensis* may be harmed by direct sunlight, and may prefer being in at least partial shade. For this reason, weeding strategy has focused on understory weeds directly around the *E. koolauensis* trees themselves, and canopy weeds away from them, to allow the native canopy trees to begin filling in around the *E. koolauensis* clusters.

In the past year, NRS spent a total of 41 hours of weeding in this WCA. The reason for this low effort is that NRS prioritized fence construction over weed control this year. With the fence complete and pig trampling eliminated, weeding efforts will be more effective. In early 2005, NRS experimented with using foliar sprays of Garlon 4 and Roundup at several dilutions to treat large banks of *A. elliptica* and *C. hirta*. These preliminary trials were effective, and NRS hope to test them further in the coming year. Current efforts use the much slower clip and drip technique. This tool will significantly change the way understory weed control occurs in KTA. One hour out of the 41 spent in this WCA was spent spraying *O. hirtellus*. *Oplismenus hirtellus* may inhibit germination and growth of *E. koolauensis* seedlings. NRS have seen significant *Carex* and mixed native recruitment in a portion of the WCA. NRS plan to control understory and canopy weeds here quarterly in the next year.

In 2003 a fire burned down from the ridge above the WCA, traveling through duff in the ironwoods which dominate the ridge top near the fenceline. In 2004, NRS contracted tree trimmers to remove most of the *C. equisetifolia* in the WCA. To date, the majority of these ironwoods have been removed. NRS continue removing the remainder of these trees and bucking up slash left by the contractors. In the coming year NRS will begin to push back the sea of ironwoods from the fenceline, as well as retreat any regrowth of cut ironwoods within the fence.

Pahipahiʻālua appears to be a perfect candidate for the experimental use of common native outplantings to augment weeding efforts by reducing non-native canopy and potentially reducing weeding effort. *Acacia koa* could be planted to provide native overstory while *Carex* sp. and *Cibotium* sp. could be planted to improve the understory. NRS plan to greatly expand the use of common native outplanting in the following year.

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
IP MU: Pahipahialua					
Pahipahialua-01	Habitat	5994.976	1806.075	30.13%	BobTim, EugKoo

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	1.00	OplHir
Ecosystem Weed Control	3	40.00	ArdEll, CasEqu, CasGla, ChrPar, CliHir, FicMac, GreRob, LanCam, PasEdu, PasSub, PsiCat
Total	4	41.00	

IP MU: ʻŌpaeʻula/Helemano

This large MU is divided into two regions, ʻŌpaeʻula, and Helemano. All three ʻŌpaeʻula WCAs are contained within the ʻŌpaeʻula exclosure (Fig. 2.2.12), which was completed in 2001. Over the past year NRS worked on fencing the Helemano WCAs (Fig. 2.2.12) so most of the weeding done in these WCAs was primarily to clear fenceline. Future weeding efforts of the Helemano WCAs will be similar to weeding in the ʻŌpaeʻula WCAs. Weeding within the ʻŌpaeʻula WCAs consists mainly of large scale sweeps for scattered *P. cattleinum,* which is a threat to the integrity of the ecosystem. Occasionally, NRS find other weedy tree species, such as *S. actinophylla,* on sweeps. All woody weeds are killed. In all WCAs, sweeps consist of preferably large groups of individuals armed with hand tools (clippers and hand saws) and applicator bottles of 20% Garlon 4 herbicide. Sweepers are advised to place decapitated parts (limbs, trunks, etc.) on top of other vegetation and to apply herbicide to the slash as well as the stump. NRS have in the past observed cut pieces lying on the ground sprout into trees. Usually, spotters with binoculars are placed strategically on neighboring ridge tops. The spotters locate *P. cattleinum* clumps and direct the sweepers to them. This method is necessary because sweepers navigating through gulches have severely limited visibility due to the dense nature of the vegetation. The Koʻolau summit environment is not easily infiltrated by most weeds, including *P. cattleinum,* and with ungulates excluded from ʻŌpaeʻula, weed dispersal vectors are severely limited. NRS are confident that with regular but infrequent sweeps of the exclosure, *P. cattleinum* will become an almost non-existent component of this summit ecosystem.

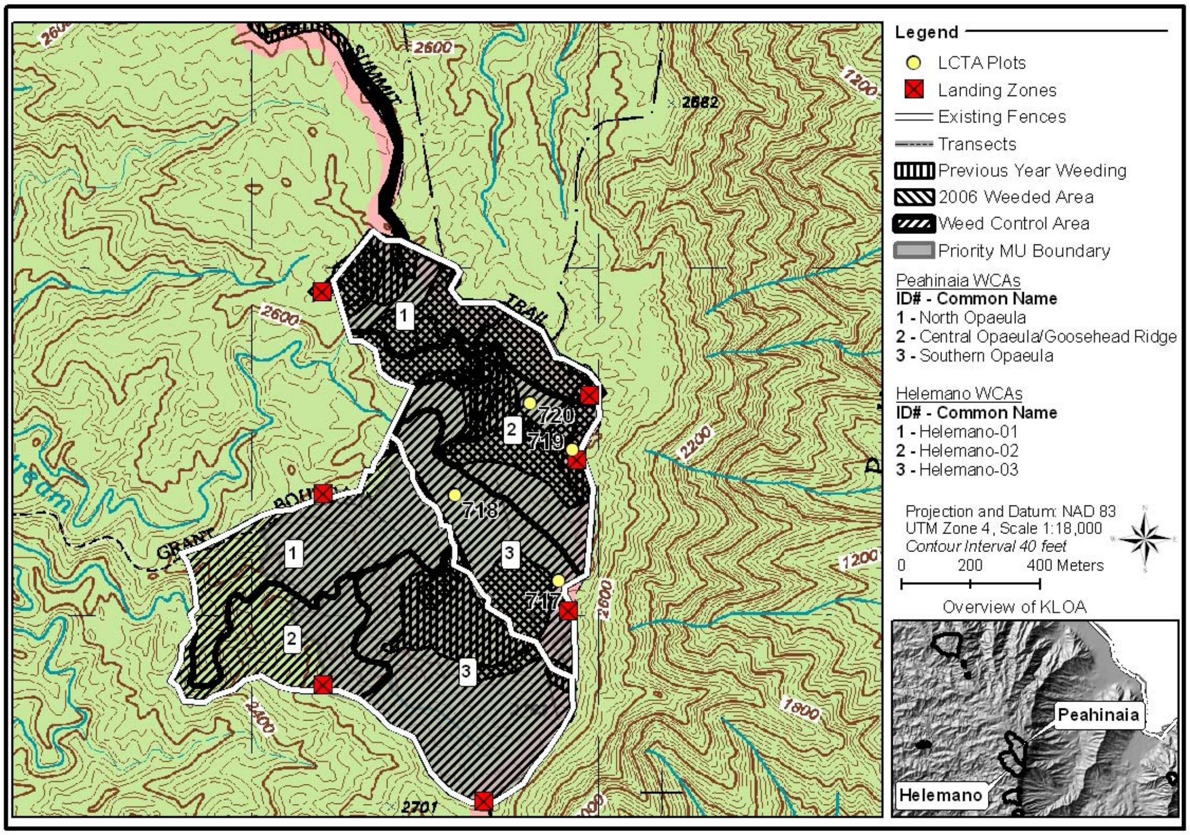


Figure 2.2.12 Weed Control Areas in Helemano & Peahinaīʻa, Kawailoa Training Area

Transect Discussion

Two transects are read in this MU. NRS found that an incipient invasive, *S. palmifolia*, was observed in new locations along one of the transects. *Setaria palmifolia* control is discussed in the OIP Incipient Weed Report.

WCA Discussion

ʻŌpaeʻula -01; Northern ʻŌpaeʻula

This year, nearly the entire area of this WCA was swept for *P. cattleinum* (Fig. 2.2.12). This WCA is the closest to the cabin constructed by NRS, and so is the easiest to access on camping trips. A total of 174.5 hours were spent weeding in ʻŌpaeʻula -01. NRS plan to sweep and treat the remaining areas of this WCA that were not covered this past year. This will require returning to the site at least two times with a large-sized crew. Some of the areas within this WCA are difficult to access due to steep terrain and thick vegetation, which make complete coverage nearly impossible.

ʻŌpaeʻula -02; Central ʻŌpaeʻula /Goosehead Ridge

This year NRS spent 142.5 hours weeding in this WCA through four trips, covering a large area (Fig. 2.2.12). In the coming year, NRS plan to sweep all the areas in the WCA that were not swept in the 2005-2006 year. This will require returning to the WCA at least four times with a large crew.

‘Ōpae‘ula -03; Southern ‘Ōpae‘ula

Efforts in this WCA are just beginning, and this year only one trip and 15 hours were spent weeding in this area. Much of the terrain in this WCA is gentle, covered in low, shrubby vegetation, making it easy to work in. However, there is a steep narrow stream gulch on the edge of WCA which may require special effort (Fig. 2.2.12). Next year NRS plan to increase the amount of time spent weeding in this WCA and cover at least half of the remaining area. NRS will return to weed here four times in the next year.

Helemano-03

NRS controlled *P. cattleianum* on one trip. More control will be conducted here when the fence is completed.

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present
IP MU: Opaeula/Helemano					
Helemano-03	Habitat	287013.7	15801.9	5.51%	ChaRoc, CyaHum, CyaKoo, CyaStj, CyrVir, JoiAscAsc, VioOah, ZanOah
Opaeula-01	Habitat	144226.9	109491.9	75.92%	CyaKoo, CyrVir, JoiAscAsc, LobGauGau, MyrJud, VioOah
Opaeula-02	Habitat	202874.3	97158.09	47.89%	CyrVir, VioOah
Opaeula-03	Habitat	144094	35834.21	24.87%	ChaRoc, CyrVir, JoiAsc, JoiAscAsc, VioOah

WCACode	Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Helemano-03	Ecosystem Weed Control	1	0.00	PsiCat
	Total	1	0.00	
Opaeula-01	Ecosystem Weed Control	7	174.50	PsiCat, SchAct, TooCil
	Total	7	174.50	
Opaeula-02	Ecosystem Weed Control	4	142.50	PsiCat
	Total	4	142.50	
Opaeula-03	Ecosystem Weed Control	1	15.00	PsiCat
	Total	1	15.00	

IP MU: Ka‘ala

NRS have been conducting *Hedychium gardnerianum* and *Psidium cattleianum* sweeps on and around the Ka‘ala Summit on Army land since 1999 and 1998 respectively. *Psidium cattleianum* is widespread but occurs in low numbers in the predominately native portions of Ka‘ala. Stumps are cut near the base and treated with a 20% concentration of Garlon 4 in forestry crop oil. Since the environment is very wet, NRS must also treat the ends of the slash and place the slash off the ground to prevent re-sprouting. *Hedychium gardnerianum* is cut above the pink growing zone of the stem and the rhizome slashed. It is then treated with a 12% concentration of Escort.

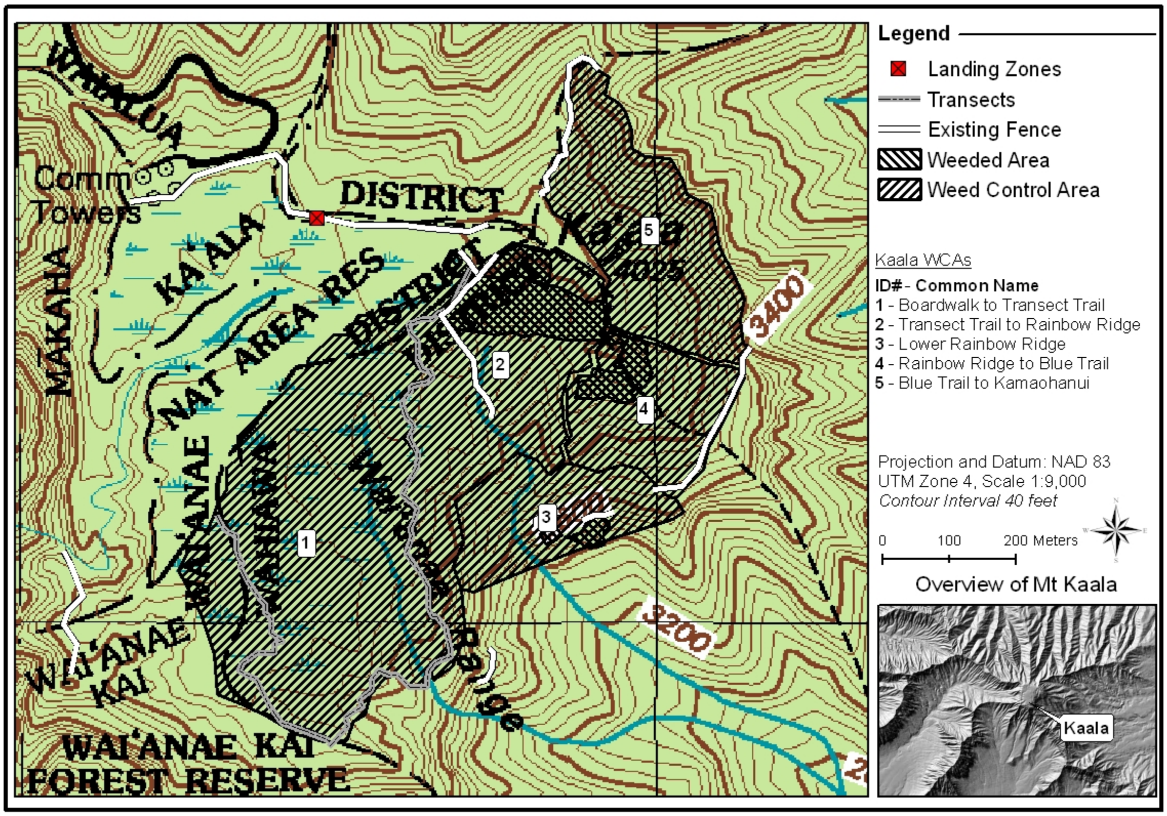


Figure 2.2.13 Weed Control Areas at Ka‘ala Summit, SBW

Hedychium gardnerianum was introduced to Ka‘ala via an ornamental planting at the Federal Aviation Administration (FAA) facilities. The bog and surrounding areas have been divided into five different WCAs to help NRS track management efforts and plan actions (Figure 2.2.1.3). Near this introduction site was a high density aggregation of *H. gardernarium* (WCA-2). Control efforts initially were focused around this core site. Subsequently, NRS discovered that the population spread south of WCA-3. This site is below the cliffs that encircle Ka‘ala. At the outset, the goal of these control efforts was eradication of *H. gardernarium* from Ka‘ala. After discovery of the large infestation in WCA-3, NRS have had to reconsider this goal and prioritize areas based on native habitat condition, overlap with target taxa from the OIP, terrain, and feasibility considerations. NRS will first eliminate all mature *H. gardnerianum* from within the fence then focus some effort on the satellite populations outside that will be a constant seed source for the Ka‘ala MU. WCAs should be re-treated on a two-year cycle because it takes just over two years for ginger plants to mature. Over the last year across Kaʻala WCAs, the count for immature plants treated was 667, the seedling count was 368 and, 27 mature plants were treated. In addition, 23 rhizomes that were not completely dead were re-treated.

<u>WCA Discussion</u>

<u>Kaʻala -01; Boardwalk to Transect Trail</u>

The current strategy for this WCA is to eliminate all *H. gardernarium* plants. This WCA contains good habitat for *Schiedea trinervis* and is gradually sloped. No sweeps were conducted in Kaʻala-01 this year as it was covered well the previous year. NRS will sweep this entire WCA over the next year.

<u>Kaʻala-02; Transect Trail to Rainbow Ridge</u>

Three sweeps were conducted during this reporting year. In order to bridge the gaps between sweeps, NRS will sweep a small skipped section remaining in this WCA. No mature plants were discovered in sweeps this year.

IP MU: Kaala

WCACode	WCAType	WCA TotalArea	Total Area Covered	% Area Covered	IP Taxa Present	Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Kaala-02	Habitat	91334.91	67967.73	74.42%	LabCyr, SchTri	Ecosystem Weed Control	3	82.00	HedGar
						Total	3	82.00	
Kaala-03	Habitat	40903.15	5947.144	14.54%	CyaAcu, LabCyr, Nermel, SchTri	Ecosystem Weed Control	2	30.00	HedGar
						Total	2	30.00	
Kaala-04	Habitat	42503.2	20267.08	47.68%	CyaCal, LabCyr, SchTri	Ecosystem Weed Control	3	66.25	EpiObr, HedGar, PsiCat
						Total	3	66.25	
Kaala-05	Habitat	68543.98	26279.47	38.34%	CyaAcu, CyaCal, LabCyr, SchTri	Ecosystem Weed Control	2	3.00	HedGar
						Total	2	3.00	

<u>Kaʻala-03; Lower Rainbow Ridge</u>

In WCA-3, 4, and 5, NRS will kill all mature plants but expect to have some low level of *H. gardernarium* presence. Terrain will dictate feasibility of control in these WCAs. The priority in these steeper WCAs is to keep *H. gardernarium* out of areas surrounding populations of *Labordia cyrtandrae*. In areas below WCA-3 where large infestations occur, NRS will investigate the use of aerial spraying to knock down numbers of seed-producing plants. Two sweeps were conducted this year. Only a small portion of the total area, 14.5%, was covered and 25 mature plants were killed. As stated above, this WCA has very high concentrations of *H. gardernarium*.

Ka‘ala-04; Rainbow Ridge to Blue Trail

One large sweep and three small sweeps were conducted this year. In the last year, one mature plant was killed in this WCA. This area requires experienced staff because the terrain is steep. More sweeps will be done next year.

Ka‘ala-05; Blue Trail to Kamaohanui

One mature plant was found this year for the first time since 2004. This area will be monitored next year.

Chapter 3.1.0: RARE PLANT STABILIZATION PLAN STATUS

General Rare Plant Issues

In preparation of this section, NRS attempted to touch on all of the parts of the MIP stabilization plan outlined for plants. This included a discussion on taxon status, genetic storage, outplanting and threats. For each rare plant taxa covered under the MIP, the minimum requirements are to implement Population Unit (PU) management and associated ecosystem level management to achieve stable population numbers at all 'manage for stability' PUs. The most current list PUs to be managed to stability (MFS) are outlined in the MIP Addendum 2004. General rare plant issues are discussed below. 27 Species Status Summaries follow the general discussion, one for each of the MIP target taxa requiring stabilization.

Propagation infrastructure

Significant progress was made on the construction of a greenhouse to house Army plants at the Pahole Mid-elevation Nursery. NRS and the NARS have been working cooperatively to complete this project. This effort saved the Army program tens of thousands of dollars in contracting expenses. The foundation was leveled, graveled and retaining walls were constructed. Drainage infrastructure was installed and a separate access road has been constructed to service this new greenhouse. NRS expect the construction of the greenhouse structure to begin in October should be completed before the New Year.

NRS continue to use two plant growth chambers for early stage propagation and germination trials. This approach has significantly increased overall survivorship.

Research

Research issues related to gastropods and black twig borer are addressed in Chapter 6 Research Activities.

Monitoring

Over the last year the Monitoring Program Manager has looked at the issues cited as high priorities in last year's report. These projects are bulleted again below.

- Development of monitoring techniques for *Sanicula mariversa.*
- Using high-resolution imagery to monitor population trends for very large populations on cliffs.
- Monitoring small size classes using a sub-sampling technique for *Cenchrus agrimonioides* var. *agrimonioides*
- Developing low-impact population monitoring techniques for populations such as the *Chamaesyce celastroides* var. *kaenana* population at Ka'ena point.

Monitoring efforts relative to the three taxon-specific bullets are discussed within those species status summaries. NRS will be conducting a pilot project with the U.S. Geological Survey in order to determine the application of high-resolution image analysis to monitoring rare plant populations on cliffs. This pilot project is now expected to take place in the spring of 2007. Any new monitoring projects not listed last year will be discussed within the appropriate species status summary. Priority monitoring issues for the coming year include:

- *Sanicula mariversa* demography studies, and
- *Phyllostegia kaalaensis* survivorship analyses, and
- *Chamaesyce celastroides* var. *kaenana* demography studies

Stabilization Strategy
In general, NRS follows the following guidelines when designing and implementing management for MIP taxa. The primary strategy remains to address limiting factors in the field. NRS attempts to restore natural processes and manipulate populations as little as necessary, but reintroductions and augmentations are often needed.

In order to determine how much work each taxon requires two attributes of each taxon are studied. Section "A" determines the status of the wild populations and section "B" looks at how many steps are required to secure collections in genetic storage. Section "C" projects the amount of effort that will be required to stabilize and collect for genetic storage from each taxon.

Section A-The *in-situ* status of each taxon is established by defining where the 27 MIP taxa fit into one of the three categories listed below. These categories define whether the taxon has the capacity to regenerate in the wild when controllable threats are managed. Typical threats control actions are ungulate fencing, weed control and predator control. Additional threats that impact germination for which NRS presently have no control measures include herbivory by slugs and invertebrate impact, such as, black twig borer impacts. A combination of a species characteristics and NRS management will determine whether the taxon reproduces itself in the field. The efficacy of the reproduction determines if augmentation or reintroduction is required.

A1- Taxa which have adequate juveniles and seedlings to regain healthy structure or reproduce vegetatively to a degree that will sustain populations:

Cenchrus agrimonioides var. agrimonioides	*Hibiscus brackenridgei subsp. mokuleianus*
Chamaesyce celastroides var. kaenana	*Melanthera tenuifolia*
Cyrtandra dentata	*Nototrichium humile*
Dubautia herbstobatae	*Sanicula mariversa*
Hedyotis degeneri var. degeneri	*Tetramolopium filiforme*
Hedyotis parvula	*Viola chamissoniana subsp. chamissoniana*

A2- Taxa that only seldom have seedlings in the wild, at reintroductions or only at certain PUs:

Chamaesyce herbstii	*Pritchardia kaalae*
Cyanea longiflora	*Plantago princeps var. princeps*
Cyanea grimesiana subsp. obatae	*Schiedea obovata*
Delissea subcordata	*Schiedea nuttallii*
Hesperomannia arbuscula	*Schiedea kaalae*
Neraudia angulata	

A3- Taxa that have never had seedlings in the wild or at reintroductions:

Alectryon macrococcus var. macrococcus	*Flueggea neowawraea*
Cyanea superba subsp. superba	*Phyllostegia kaalaensis*

Section B- To guide genetic storage collections, NRS defined two categories that guide strategies to attain storage goals.

B1- Taxa that have enough collectable mature seed from wild sites or reintroductions to reach storage goals:

Cenchrus agrimonioides var. agrimonioides	*Hedyotis parvula*
Chamaesyce celastroides var. kaenana	*Hibiscus brackenridgei subsp. mokuleianus*
Chamaesyce herbstii	*Sanicula mariversa*
Cyanea grimesiana subsp. obatae	*Schiedea kaalae*
Cyanea longiflora	*Schiedea nuttallii*
Cyanea superba subsp. superba	*Schiedea obovata*
Cyrtandra dentata	*Plantago princeps var. princeps*
Delissea subcordata	*Pritchardia kaalae*
Hedyotis degeneri var. degeneri	*Tetramolopium filiforme*

B2- Taxa that need an intermediate *inter-situ* or *ex-situ* stage to efficiently produce enough mature propagules to reach genetic storage goals. These taxa require maintaining plants at greenhouses or botanical gardens in order to produce seeds or cuttings to maintain collections.

Alectryon macrococcus var. macrococcus	*Neraudia angulata*
Dubautia herbstobatae	*Nototrichium humile*
Flueggea neowawraea	*Phyllostegia kaalaensis*
Hesperomannia arbuscula	*Viola chamissoniana subsp. chamissoniana*
Melanthera tenuifolia	

Section C- Combining the considerations above, NRS categorized the taxa into one of the following groups. In these groupings A2 and A3 are considered equally in this analyses as they both require reintroductions or augmentations. Beyond this first step A3 will require additional research.

C1- (Taxa in both the A1 and B1 categories)- These taxa do not need reintroductions and may just need fences and weed control to reach stability and secure collections from the wild:

Chamaesyce celastroides var. kaenana	*Hedyotis degeneri var. degeneri*
Cyrtandra dentate	*Hedyotis parvula*
*Cenchrus agrimonioides var. agrimonioides**	*Sanicula mariversa**
*Hibiscus brackenridgei subsp. mokuleianus**	*Tetramolopium filiforme**

* These species will require reintroduction establish stable numbers at all PUs or establish the required number of PUs.

C2- (Taxa in both the A1 and B2 categories)- These taxa do not need reintroductions just need fences and weed control, but require an intermediate *inter-situ* or *ex-situ* stage to collection for storage:

Dubautia herbstobatae *Melanthera tenuifolia*	*Nototrichium humile* *Viola chamissoniana subsp. chamissoniana*

C3- (Taxa that are in the A2 or A3 and B1 categories)- These taxa need reintroduction or augmentations to reach stability and where reintroductions or wild sites can be used to secure collections for storage:

Chamaesyce herbstii *Cyanea grimesiana subsp. obatae* *Cyanea longiflora* *Cyanea superba subsp. superba* *Delissea subcordata*	*Plantago princeps var. princeps* *Pritchardia kaalae* *Schiedea kaalae* *Schiedea nuttallii* *Schiedea obovata*

C4- (Taxa that are in the A2 or A3 and B2 categories)- These taxa need reintroduction or augmentation to reach stability and also require an intermediate *inter-situ* or *ex-situ* stage to facilitate collection for storage. These species pose the greatest challenge:

Alectryon macrococcus var. macrococcus *Flueggea neowawraea* *Hesperomannia arbuscula*	*Neraudia angulata* *Phyllostegia kaalaensis*

	A1	***A2***	***A3***
B1	***Chacel***	***Chaher***	***Cyasup***
	Cenarg	***Cyagri***	
	Cyrden	***Cyalon***	
	Heddeg	***Delsub***	
	Hedpar	***Schkaa***	
	Hibbra	***Schnut***	
	Sanmar	***Plapri***	
	Tetfil	***Prikaa***	
		Schobo	
B2	***Dubher***	***Hesarb***	***Alemac***
	Meltin	***Nerang***	***Fluneo***
	Nothum		***Phykaa***
	Viocha		

Example of Species Status Summary

The species status summary outlines all work conducted by NRS for a particular taxon. Each discussion has the same format. This format is explained in detail below.

Requirements for Stability:

- 3 Population Units (PUs) or 4 for species with presence in both Makua AA and Schofield AA (Example: Plantago princeps) and for some species in the high fire threat area of the Makua AA.
- [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

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

How many of the 4 MFS PUs have stable numbers of mature individuals?	How many of the 4 MFS PUs have stable structure?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
1/4	0/4	0/4	0/4	0/4

This table has been added this year in order to provide a general overview of progress on the stabilization of the MFS PUs. These questions are designed to give the reader a summary of how many of the proposed PUs have reached the goals for having a stable number of mature plants, whether they have stable population structure, if genetic storage goals have been reached and whether reintroductions are complete in those PUs that need them.

Taxon-Level Discussion

The taxon-level discussion covers the topics below related to taxon status:

- Are any of the threats controlled for all or any of the PUs? Is there a trend?
- Does the taxon or any of its' PUs have stable numbers of reproducing individuals? Stable population structure?
- Are any of the PUs in need of reintroduction or augmentation? If so, has this begun? How is it going?
- Significant propagation or genetic storage issues?
- New taxonomy issues?
- General prognosis for the taxon given current threat control trends.

Example 'Taxon Status' Table

Action Area: In

TaxonName: Cenchrus agrimonioides var. agrimonioides **TaxonCode: CenAgrAgr**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki and Pahole	Manage for stability	273	67	50	71	11	20	245	43	11	316	54	31	The big changes come from the large outplantings but the wild plants are mostly stable
	Total for Taxon:	273	67	50	71	11	20	245	43	11	316	54	31	

Action Area: Out

TaxonName: Cenchrus agrimonioides var. agrimonioides **TaxonCode: CenAgrAgr**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central Ekahanui	Manage for stability	36	30	16	30	3	16	56	0	0	86	3	16	Monitoring showed a decline in the wild site also many were planted in the last year
Makaha and Waianae Kai	Manage for stability	13	1	3	14	0	0	0	0	0	14	0	0	One additional plant was found in the known site
South Huliwai	Genetic Storage	21	0	0	21	0	0	0	0	0	21	0	0	Monitoring showed no change in the last year
	Total for Taxon:	70	31	19	65	3	16	56	0	0	121	3	16	

This table covers the current status of wild and outplanted plants. Population units are grouped into extant PUs in the AA and out of the AA, and new PUs established via reintroductions. In a number of cases NRS have not actually monitored a PU due to landowner permission issues. NRS will continue to pursue these permissions but are adapting plans with the expectation that access may not be granted.

<u>Makua Population Unit Name</u>: PUs names are based on decisions made at the January 2005 MIT meeting. Only PUs designated for management are shown in the table. Some reintroductions which have not yet begun are shown in the table with zeros for population numbers.

<u>Management Designation</u>: Management status is based on decisions made at the January 2006 MIT meeting. Most population units are either 'manage for stability', 'manage reintroduction for stability' or 'genetic storage'. The 'manage as a propagule source' category has been eliminated. NRS have designated four manage for stability PUs for taxa that fit one or more of the following criteria. PUs with more than one PU in an Action Area (includes the Makua AA and the Oahu AA). Taxa that occur in severely fire threatened habitat. Taxa that rely heavily on reintroduction for stabilization. When four MFS PUs are designated justification is given.

<u>NRS Mature, Immature and Seedling 2005</u>: NRS reports the <u>total number of wild and outplanted</u> mature, immature plants and seedlings observed, as reported in the MIP Status Report 2005 in the *Taxon Status* Table for each PU. For populations discovered since the 2005 MIP Status Report, this column is blank. If a PU was split, thus creating a new population division, a zero is used in order to distinguish it from entirely new PUs.

<u>Current Mature, Immature, Seedling</u>: These three columns reflect the most up to date individual plant numbers for each PU of the wild plants. In most cases these numbers are generated from Army monitoring data, but data from the O'ahu Plant Extinction Prevention Program (PEP), the Nature Conservancy (TNC) and the State of Hawai'i are used for some PUs. This is the case for

those PUs where other agencies have a management mandate and are conducting sufficient management and monitoring to meet MIP needs. Numbers reported have only changed since last year if new monitoring data was acquired since the last reporting period. If no additional monitoring was conducted in the last year, last year's number is used. A discussion of number changes since last year's MIP status report is included in the 'Population Trend Notes' column and the 'Population Unit Level Discussion' for each PU.

Current Augmented Mature, Immature, Seedling: The numbers of individuals NRS and partner agencies have outplanted into a PU. The number represents augmentations into the existing PU rather than reintroductions of genetic stock from that PU. In most cases, augmentations into a PU will be from that PU's genetic stock. Exceptions are discussed in the text.

Total Mature, Immature, Seedling: 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. The numbers also indicate whether recruitment is occurring within PUs.

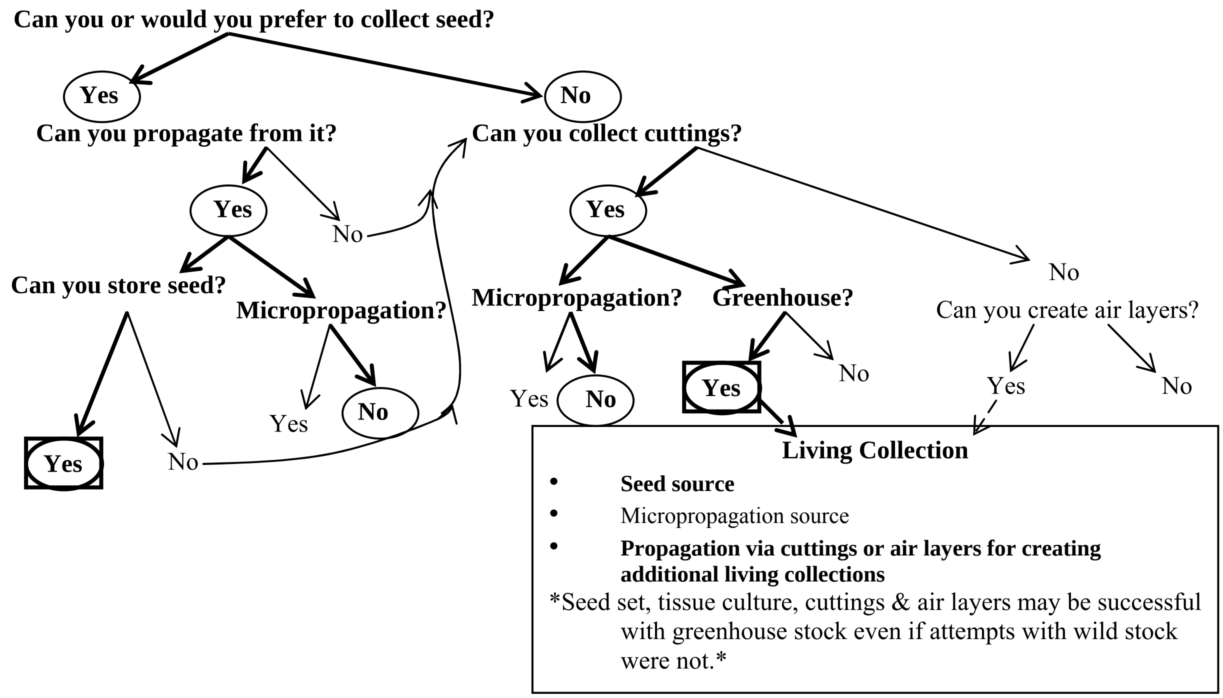
Population Trend Notes: Comments on the general trend of the PU is given here. This may include notes on whether the PU was monitored in the last year, a brief discussion of the changes in population numbers from the 2005 numbers to the current ones, and some explanation of whether the change is due to new plants being discovered in the same site, a new site being found, reintroductions or augmentations that increased the numbers or fluctuations in the numbers of wild plants. In some cases where the numbers have not changed NRS has monitored the PU and observed no change. In other cases when the PU has not been monitored the number from 2005 is used and this is noted in this column.

Propagation and Genetic Storage

This section provides an overview of propagation and genetic storage issues. In most cases seed storage is the preferred genetic storage technique; as it is the most cost-effective method, requires the least amount of maintenance once established, and captures the largest amount of genetic variability. For taxa that do not produce enough mature seed for collection and testing, micropropagation is considered the next best genetic storage technique. For those taxa that do not produce seed that can be stored and cannot be established in micropropagation, a living collection of plants in the greenhouse or an *inter-situ* site is the last genetic storage option. The format for this year's report includes the table and flow chart shown below, followed by brief text discussions of collection, propagation, seed storage research and genetic storage.

1) At this time, what is the preferred propagation technique?	**2) At this time, what is the preferred genetic storage technique?**	**3) Is more genetic storage testing needed?**	**4) Are additional steps required for obtaining enough seed such as pollination study or greenhouse collections?**
Seed, cutting, or airlayer (may differ between goal – reintroduction vs. living collection)	Seed, Micropropagation (seed or vegetative), Living Collection	Yes or No	What must occur if enough seed can not be collected from founders for genetic storage

Prioritizing Genetic Storage & Propagation Techniques



Ex: ***Cenchrus agrimonioides*** **var.** ***agrimonioides***

This chart appears in all of the 27 taxon sections. As a template, it is identical in all taxon sections and uses bold lines, circles, bold text and text boxes to illustrate issues unique to each taxon. The questions this chart addresses are:

- What propagation methods have been tested?
- What genetic storage methods have been tested?
- What are the preferred propagation and genetic storage methods?
- What still needs to be tested?
- What is the order in which propagation and genetic storage methods should be tested?

The chart navigates through these complex issues by posing a series of "Yes" or "No" questions which illustrate the process of determining the most efficient way to collect propagules and store material. The first question is "Can you or would you prefer to collect seed?" Many taxa in the MIP can be easily propagated from cuttings and seeds (i.e. *Cenchrus agrimonioides var. agrimonioides*.), and the preferred propagation technique for purposes other than genetic storage, such as reintroductions, may be different than the preferred propagation technique for genetic storage. All propagation techniques that have been tested for either purpose are displayed. Only the preferred technique for genetic storage is indicated as the most appropriate course of action. The arrows are used to identify which propagation and storage techniques have been tested. When a technique has been tested, the arrows are bold. If the answers have been determined, the "Yes" or "No" response is circled.

For example with *C. agrimonioides* shown in the example chart above. The question, "Can you store seed?" has been tested because the arrow is bold and the "Yes" is circled indicating that it has been determined that seed can be stored. There is also a bold arrow leading to the “Can you collect cuttings?” question indicating that NRS has and does collect cuttings. “No” is circled at the end of this arrow indicating that although it is possible to collect cuttings this is not the preferred storage technique. If the technique has been tried but not answered the arrow is bold but neither the ‘Yes’ or ‘No’ is circled. If the current preferred genetic storage method has been determined the ‘Yes’ under that question is boxed. For the example above, seed storage is the preferred technique and the ‘Yes’ is boxed. There are also bold arrows leading to micropropagation ending in a circled ‘No’, indicating that this technique has been tried and at the present time it is not feasible. If some or all founders for a species are maintained via living collection, the propagule preference for establishing this living collection is shown by the bold arrows leading to the “Living Collection” text box from a circled and boxed ‘Yes’. The bold text in the “Living Collection” box indicates what type of propagule the living collection will be used to produce. For *C. agrimonioides* living collections are used for generating seed as well as cuttings for reintroductions as well as additional storage. For some taxa, additional text boxes have been added to aide in the explanation of certain conclusions or specify circumstances for a particular decision. The text boxes are placed in the chart at the location to which they comment.

Collection: This section describes the best propagules for collection based on success rate and availability.

Propagation: Results from a variety of propagation methods and the relative success with each is summarized in this section.

Seed Storage Research: The status of seed storage research is summarized here. Germination rates from different storage regimes are reported.

Genetic Storage: This section includes the preferred genetic storage method or current research and steps underway to determine the most applicable method. For species with substantial seed storage data, a schedule is proposed for how frequently seed bank collections will need to be refreshed to maintain genetic storage goals. This schedule is solely based on storage potential for the species, and other factors such as threats and plant health must be applied in order to recalculate how frequent refresher collections need to occur for a particular plant. Viability trends for seeds in storage cannot be extrapolated because viability rarely has been observed to decline at a steady rate. Therefore, the frequency of refresher collections cannot exceed the number of years a taxon has been tested, and the frequency will constantly be adjusted to reflect the most current storage data. However, for a taxon that has shown little to no decrease in viability after a period of time, this length of time is obviously shorter than necessary to maintain genetic storage goals. For example, *Delissea subcordata* shows no decrease in viability after five years. NRS would not have to re-collect every five years as the number of viable seeds in storage would not have yet begun to drop. But since a storage trend cannot be predicted, it is impossible to select a more appropriate larger frequency for collections. Therefore, the recommended frequency remains five years. Where viability trends are not extensive and all data has not been gathered for a particular taxon, a collection schedule may be hypothesized.

Example 'Genetic Storage Summary' Table

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Cenchrus agrimonioides var. agrimonioides							
Central Ekahanui	30	3	1	15	0	26	6
Kahanahaiki and Pahole	71	11	15	47	0	35	29
Makaha and Waianae Kai	14	0	0	0	0	14	5
South Huliwai	21	0	0	11	0	9	6
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				73	0	84	46

This table shows the status of NRS's and partner agencies' (including TNC, Honolulu Board of Water Supply (BWS), GSN and the State of Hawai'i) collections.

Number of Potential Founders: This column lists the current live immature and mature plants which have been collected from or may be collected from in the future and the number of dead plants from which collections were made in the past. Immature plants are included as founders for all taxa because of database limitations, but they can only serve as founders for some taxa. For example, for *Hibiscus brackenridgei*, cuttings can be taken from immature plants for propagation. In comparison, for *S. mariversa,* cuttings are not taken and seeds are the primary propagule used in collecting for genetic storage. Therefore, the number of potential founders for *S. mariversa* is over-estimated. 'Manage reintroduction for stability' PUs may be on this list but have zero potential founders.

Partial Storage Status: 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 of up to 50 plants per population. Since the MIP is in the early stages of implementation, NRS felt it was important to show how many plants are part of the way to reaching this goal. The table displays the number of plants for which >10 seeds are 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. The goal for vegetative collections is a minimum of three clones per plant in either the Lyon Micropropagation Lab or the Army or Pahole Mid-elevation Nursery. Plants with one or more plant in either the Lyon Micropropagation Lab or the nursery are reported here.

Storage Goals Met: This column displays the total number of plants per PU that have met the MIP collection goals. The plant is included if it has 50 seeds in storage, or three clones in micropropagation or three in the nursery. For some PUs, the number of founders has increased in the last year, therefore; it is feasible that NRS could be farther from reaching our collection goals than last year.

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 relevant species are also discussed in this section. If there is no new information for a taxon, this section is not included.

Outplanting Issues

Observations of outplantings conducted by NRS or partner agencies are discussed here. Where outplantings have not been attempted, a discussion is included about future plans and possible challenges. Among the topics included are: outplanting site selection; optimal plant size for outplanting, outplanting success rates, post-outplanting care conducted, time to maturity and establishment of any F1 individuals. A brief overview of any outplantings conducted in the last year are included. Where informative a 'Founders Represented in Outplantings' table is included along with a discussion of founder-related issues. In most cases, zeros in the table indicate that no reintroductions have been attempted with founders from that PU.

Example 'Founders Represented in Outplanting' Table

TaxonName: Alectryon macrococcus var. macrococcus **TaxonCode: Alemacmac**

Total Num Plants based upon Plants that have been numbered

MakuaPopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Central Kaluaa (to Central Waieli)	Manage for stability	55	0
Kahanahaiki to West Makaleha	Manage for stability	46	0
Makaha	Manage for stability	22	0
Makua	Genetic Storage	17	2
South Mohiakea	Genetic Storage	6	0
Waianae Kai	Genetic Storage	5	0
	Total for Taxon:	151	2

Number of Founders = Number of Mature, Immature, and Dead founder plants.
Number of Founders Represented = Number of founder plants represented in reintroductions.

Research Issues

For many of the taxa, stability is limited by a lack of threat control techniques. NRS will support further research into discovering and implementing control methods. For example, NRS are currently supporting research of black twig borer and slug control methods. For some taxa, research about pollination biology or seed storage methods is recommended. Pertinent research needs for each taxon are recognized, and any on-going research is described.

Surveys

A summary of surveys that have targeted this taxon in the last year is discussed in this section. In addition, a brief summary of future survey plans is included. If no new surveys were conducted for a particular taxon, then this section is not included.

Taxon Threats

Threats to the taxon and progress in controlling these threats are discussed in this section. Possible threats include weeds, ungulates, invertebrates, fire, slugs and trampling. Problematic weed species for the taxon are cited.

Population Unit Level Discussion

Example 'Population Unit Threat Control Summary' Table

Action Area: In

TaxonName: Alectryon macrococcus var. macrococcus

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki to West Makaleha	Manage for stability	Partial	Partial	No
Makua	Genetic Storage	No	Partial	No
South Mohiakea	Genetic Storage	No	No	No

Action Area: Out

TaxonName: Alectryon macrococcus var. macrococcus

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Central Kaluaa (to Central Waieli)	Manage for stability	Partial	Partial	Partial
Makaha	Manage for stability	No	Partial	Partial
Waianae Kai	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. Naturally, more extensive threat control programs are in place at 'Manage for Stability' PUs and little if any threat control is in place at 'Genetic Storage' PUs. 'Partial' designations are explained within the PU discussions. For 'Manage reintroduction for stability' PUs, threat control conducted during site preparation as well as reintroduction site threat control maintenance is reported. This approach is a temporary way of demonstrating in general where effort is being spent. NRS anticipate that monitoring data will replace much of this information and improve this aspect of our reporting. Also, the database threat table does not indicate in any way if the threat is actually a concern for the taxon or PU. For example, many rare plant taxa are not threatened by rats.

Protected from Ungulates: 'Yes' is entered into the column if all of the individuals in the PU are fenced or otherwise protected from ungulates by natural barriers. If some of the individuals are at risk from ungulates, 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 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. An explanation is included in the PU discussions. 'No' indicates that NRS are not currently controlling weeds at the PU. An explanation for this lack of management is included in the text within PU discussions for 'manage for stability' PUs.

Rats controlled: '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. For taxa receiving rat control, a table summarizing rat bait and snap trapping data is included. 'No' may indicate that either rats are not considered a threat to the taxon or that NRS are not currently controlling rats at the PU. If 'Partial' or 'No' values are given, an explanation is included in the PU discussions for 'manage for stability' PUs.

In this section, the status of the population units are discussed. This section is split into two parts.

'Manage for Stability' PUs

In the first part, each 'manage for stability' PU is discussed. Any large changes in numbers of individuals from the Makua IP Addendum are explained. Management efforts at the PU are discussed, including any collections, augmentations, fencing, rat control or weeding in the vicinity of the PU.

Other PUs

In this section, other PUs are discussed. If NRS have not visited a site in the last two years, there is no discussion for that PU. Extirpated PUs will be discussed for two years and after that will no longer be discussed.

3.1.1 *Alectryon macrococcus* var. *macrococcus*

Requirements for stability:

- 4 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

How many of the 4 MFS PUs have stable numbers of mature individuals?	How many of the 4 MFS PUs have stable structure?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
2/4	0/4	0/4	0/4	0/4

Taxon-Level Discussion

This taxon has four MFS PUs because it is in both the MMR and SBW AAs. Two PUs, Mākaha and Central Kaluaʻā to Central Waiʻeli PUs both exceed the required stabilization target number of mature individuals, however, most of the trees are in poor condition, due primarily to the damaging effects of the black twig borer (BTB) (*Xylosandrus compactus*). Additionally, very few seedlings have ever been seen, and immature plants are very rare. In a few of the PUs there are trees that appear healthy and do not have major damage from the twig borer impacts. NRS has not observed recruitment of this species in the wild and have only collected mature fruit from eight trees in the last seven years.

Major Highlights/Issues for Year 2

- NRS have begun BTB research (see Chapter 6)
- Four successful air-layers were collected from two trees in the last year.
- Waiʻeli fence was completed, protecting several plants.
- Changing status of Mākua PU from Manage for Genetic Storage to MFS in order to preserve diversity within this taxon given the small fruiting stock found in this PU.

Plans for Year 3

- Continue to air-layer individuals from MFS PUs.
- Conclude BTB verbenone study (see Chapter 6).
- NRS plan to have BTB researchers examine individuals that appear unaffected by BTB.
- A large-scale Management Unit fence around the Mākaha PU will begin in the next year protecting the largest population of this taxon.
- Conduct a trial outplanting in Central Kaluaʻā to Central Waiʻeli PU with airlayered plants in a gulch bottom similar to the *Flueggea neowawraea* outplanting in Kahanahāiki (see Chapter 3, Section 11).

Action Area: In

TaxonName: Alectryon macrococcus var. macrococcus **TaxonCode: AleMacMac**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki to West Makaleha	Manage for stability	42	10	0	37	4	0	0	4	0	37	8	0	A few known mature trees and two outplanted immature plants have died
Makua	Manage for stability	20	0	0	33	0	0	0	0	0	33	0	0	Estimates were revised using survey records and they need to be checked in the field
South Mohiakea	Genetic Storage	6	0	0	6	0	0	0	0	0	6	0	0	No monitoring in the last year
	Total for Taxon:	68	10	0	76	4	0	0	4	0	76	8	0	

Action Area: Out

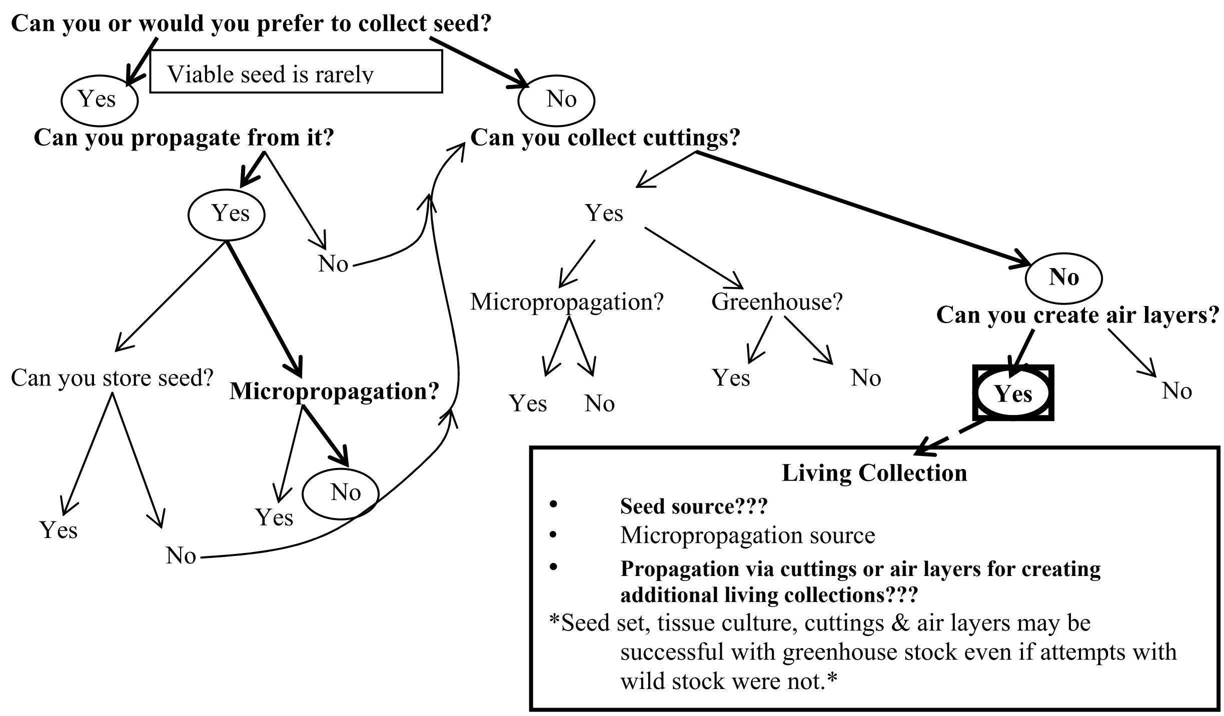
TaxonName: Alectryon macrococcus var. macrococcus **TaxonCode: AleMacMac**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central Kaluaa (to Central Waieli)	Manage for stability	56	9	1	52	1	1	1	8	0	53	9	1	Known trees have been observed dead
Makaha	Manage for stability	62	5	0	63	5	2	0	0	0	63	5	2	An additional plant and two seedlings observed in known sites
Waianae Kai	Genetic Storage	5	0	0	6	0	0	0	0	0	6	0	0	Records were reassessed showing an additonal plant but it was not observed
	Total for Taxon:	123	14	1	121	6	3	1	8	0	122	14	3	

Propagation and Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Seed (when available), and air-layers	Living Collection	Yes	Yes; research & living collections?

Prioritizing Genetic Storage & Propagation Techniques



Collection: Sixteen air-layers have been installed on four trees. Five of these have been collected, one of which has died, one is currently healthy in the nursery, and three are in the Army Nursery as they were just collected in August and September 2006. A total of six air-layers installed on trees have died prior to collection and five remain. Fruit have also been collected when available, but 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.

Propagation: Although micropropagation is not a preferred storage method, seeds have been successfully germinated in the lab, and plants were propagated at Pahole Mid-elevation Nursery and later outplanted. These plants are monitored and treated with an insecticide quarterly to address the BTB threat. Unfortunately, these trees are still impacted by the borer and many have died. Vegetative propagation of this taxon has been limited to air-layers because cuttings have been unsuccessful. Seventy-two seeds were collected from one prolifically fruiting tree in Mākaha in July 2004. These seeds were taken to the Seed Conservation Lab for seed storage testing. Unfortunately, most seeds appeared to have been eaten by the larvae of an unidentified insect. Despite the low possibility of germination, they were stored at 4C and 20% relative humidity. They were all withdrawn from storage in August 2006 and none have germinated to date. Fourteen seeds from this same tree were collected in August 2005. Three healthy, ripe fruit were sent to the Micropropagation Lab for propagation, of which two had embryos but neither one has germinated. The remaining 11 seeds went to the Seed Conservation Lab. Eight of these were rotten, including two with larvae inside. The remaining three are being stored in two different conditions known to be successful for other species of *Alectryon* that also have recalcitrant/intermediate seed characteristics.

Seed Storage Research: The genus *Alectryon* is known world-wide to have a majority of species that have either recalcitrant or intermediate seed storage characteristics. Fifteen seeds were sent to the National Center for Germplasm Research and Preservation (NCGRP) in 2001 for storage testing. Most seeds were not viable, but 2 of 5 seeds stored imbibed at 4C germinated after 5 months of storage. This taxon probably does not currently have high storage potential. More research, both pollination and seed storage studies, are necessary before seed storage can be ruled out as a genetic storage option.

Genetic Storage: All methods of genetic storage have been attempted. Micropropagation is not a good storage method for this taxon because it is not possible to subculture plants, and because plants quickly become too large to store in vials. Seed storage cannot be ruled out until further research is conducted. A large number of seeds may need to be frequently collected to achieve and maintain genetic storage goals due to low observed seed set, low viability and uncertainty in good storage longevity. Due to uncertainty of storage potential, NRS is propagating most collected seed and continuing to experiment with air-layers to add to the living collection. Three of the trees propagated from seed at the Micropropagation Lab have been successfully established at Waimea Botanical Garden.

Genetic Storage Summary Table

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Alectryon macrococcus var. macrococcus							
Central Kaluaa (to Central Waieli)	52	1	0	0	0	0	0
Kahanahaiki to West Makaleha	37	4	0	0	0	0	0
Makaha	63	5	0	0	1	0	0
Makua	33	0	0	0	0	1	0
South Mohiakea	6	0	0	0	0	0	0
Waianae Kai	6	0	0	0	0	0	0

Total # Plants w/ >=10 Seeds in Seedbank	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
0	1	1	0

Outplanting Issues

NRS would like to try a new planting site that is similar to the reintroduction site where *Flueggea neowawraea* are currently thriving in Kahanahāiki. NRS believe that *A. macrococcus* may respond similarly and hope that this taxon will also achieve vigorous growth to help out-compete the BTB. NRS plan to airlayer in South Mohiākea and Honouliuli for reintroduction in Honouliuli in the next year because these locations are where the taxon is the rarest.

Research Issues

For discussion of the most recent BTB control research, see Chapter 6 Research Issues. NRS also aim to study which factors are contributing to the high productivity and good health of the prolifically fruiting trees in Mākaha and Mākua. Such investigations may include research conducted on pollinators, soil nutrient differences, 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.

Given the large scale declines of this taxon, fertilization of remaining trees should be explored to possibly increase vigor and reproduction potential. Plants that are stressed are in general more susceptible to black twig borer impacts. NRS Research Specialist will conduct a fertilizing trial to address this issue.

Surveys

NRS also have a considerable amount of data in the form of GIS points, or rare plant monitoring forms for populations of this taxon that have not been updated in recent times. These points have been given to NRS by other botanists from surveys in years past, or are old NRS known locations. Therefore, this year surveys and monitoring trips will be emphasized to update numbers of this taxon. In Mākaha, the soon-to-be fenced portion of the management unit has been divided by trails to better facilitate monitoring of this relatively healthy population. In West Makaleha, a thorough count is underway to better discern the numbers of individuals within the MU.

Taxon Threats

The most serious threat to *A. macrococcus* is the BTB. All trees of this taxon are being affected by the BTB to some degree. Less than 10% of trees in both the Kahanahāiki to West Makaleha and Central Kalua‘ā (to Central Wai‘eli) Manage for Stability populations are considered ‘healthy’ by NRS. Most often, ‘poor’ trees have little or no remaining canopy due to black twig borer damage, but rather consist of few basal suckers that are also continually attacked by black twig borers. NRS has unsuccessfully attempted to control the BTB on *in situ* trees by using experimental treatments. See Chapter 6 for further discussion of promising control research being conducted.

Additional threats include rats and invertebrates that prey on the seeds of this taxon and reduce seed viability and germination. NRS has rat bait stations around trees in Mākaha and Central Kalua‘ā in conjunction with ‘Elepaio management, and will reactivate a bait grid around the small fruited population in Lower Mākua this year. Baiting will likely allow for greater fruit production of which can be used for seed storage trails as well as to encourage on site germination. *Alectryon macrococcus* is susceptible to ungulate browse, and weeds pose ecosystem-level threats for this species.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Alectryon macrococcus var. macrococcus

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki to West Makaleha	Manage for stability	Partial	Partial	No
Makua	Manage for stability	Partial	Partial	No
South Mohiakea	Genetic Storage	No	No	No

Action Area: Out

TaxonName: Alectryon macrococcus var. macrococcus

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Central Kaluaa (to Central Waieli)	Manage for stability	Partial	Partial	Partial
Makaha	Manage for stability	No	Partial	Partial
Waianae Kai	Genetic Storage	No	No	No

Manage for Stability PUs:

Kahanahāiki to West Makaleha: Many areas in this PU were monitored in the last year, but not all trees were revisited. The status table reflects the number from the most current count, which is not a complete assessment of the PU. Very few of the trees have ever been observed flowering and fewer still have been observed with mature fruit. In this PU, greater than 75% of the trees show a significant amount of BTB damage. All of the Pahole trees and some of the Kahanahāiki trees are fenced, while none of the Upper Kapuna or West Makaleha trees are fenced. Weed control has only occurred around the Kahanahāiki reintroductions. Many of the other sites in this PU are heavily degraded.

Central Kalua‘ā to Central Wai‘eli: Very few of the trees have ever been observed flowering and fewer have been observed with mature fruit. In this PU, more than 55 percent of the trees show a significant amount of damage from the BTB. There are additional areas to search and NRS believe that more individuals will be discovered. Some of these trees exist within the Central Kalua‘ā fence and the newly fenced North Kalua‘ā gulch, and are in areas where weed control is ongoing. This year NRS will attempt airlayers on a sample of trees across the PU with the goal of outplanting within the fenced management unit in Kalua‘ā. In order to boost founder numbers for this outplanting, stock from populations elsewhere in Honoluliuli such as in ‘Ēkahanui will be used reintroduced in this PU. Additionally, stock from airlayered plants in South Mohiākea will be added to this reintroduction as there are no other closer managed wild sites for this stock.

Mākaha: Mākaha is by far the richest and healthiest of all *A. macrococcus* sites. NRS recently started to thoroughly count this population to better assess the exact number of plants that will be included in the fence. The status table reflects the number from the most current count, which is not a complete assessment of the PU. Preliminary counts suggest that more than half of the known plants in the valley will be included within the fence. Future surveys scheduled for the upcoming year will undoubtedly result in additional plants and the final count will almost certainly contain more than the originally estimated 75 mature trees. Much of the habitat in this PU is intact.

Mākua: NRS began to air-layer trees in this PU this year and collected four from two trees in the last year. Three were from one tree on ‘Ōhikilolo and one from another in Lower Mākua. However, the Lower Mākua air-layer died before becoming established in the greenhouse. In Lower Mākua, NRS have an inactive rat bait grid around trees that will be reactivated this year to facilitate a more current collection of this small fruited population.

Other PUs:

South Mohiākea: NRS have observed a significant decline of the known trees in the last couple of years. NRS continue 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. NRS will airlayer plants in this PU when possible. This stock will be outplanted in Kalua‘ā when ready.

Wai‘anae Kai: The status table reflects the number from the most current count, which is not a complete assessment of the PU. There were no additional actions in the last year.

Inter-situ sites: A few trees remain at Waimea Botanical Garden and NRS assists Waimea staff with monitoring and drenching quarterly with the systemic insecticide Merit. The trees appear to be healthy.

3.1.2 *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

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have stable structure?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
2/3	1/3	0/3	1/3	0/3

Taxon-Level Discussion

Stabilization measures are proceeding successfully for this taxon. Ungulates and weeds are the most significant threats and there are proven control methods for these. Two of the three MFS PUs have stable numbers of mature individuals. The Wai'anae Kai and Mākaha PU management is pending completion of the Mākaha Subunit I fence. Reintroductions of this taxon continue to be successful and genetic storage and propagation are straight-forward. This taxon is the first of the MIP species to approach stability and thus is a good case example with which to consider long-term stability trends, and seed dispersal limitations. A priority for this taxon is to look more closely at these issues using the Kahanahāiki to Pahole PU.

Major Highlights/Issues Year 2
- Supplemental plantings were conducted adding a total of 63 new plants. A new site was established in Pahole gulch to increase the geographic spread of plantings.
- NRS investigated alternative monitoring techniques for large populations.
- New strategy developed for founder representation in augmentations (see outplanting section).
- Identified ideal number to plant in order to create a self-sustaining population.

Plans for Year 3
- Begin implementing ʻĒkahanui Subunit II planting strategy (ʻĒkahanui PU section).
- Acquire permission for additional planting site within Pahole gulch (Kahanahāiki to Pahole PU section).
- Begin implementing Kahanahāiki to Pahole PU planting strategy (Kahanahāiki to Pahole PU section).
- Initiate reintroduction in Mākaha Subunit I following fence completion.
- Use Makaha reintroduction to establish seed collections for Makaha to Waiʻanae Kai PU.
- Expand Pahole in-situ management actions.

Action Area: In

TaxonName: Cenchrus agrimonioides var. agrimonioides **TaxonCode: CenAgrAgr**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki and Pahole	Manage for stability	273	67	50	71	11	20	240	36	11	311	47	31	The big changes come from the large outplantings but the wild plants are mostly stable
	Total for Taxon:	273	67	50	71	11	20	240	36	11	311	47	31	

Action Area: Out

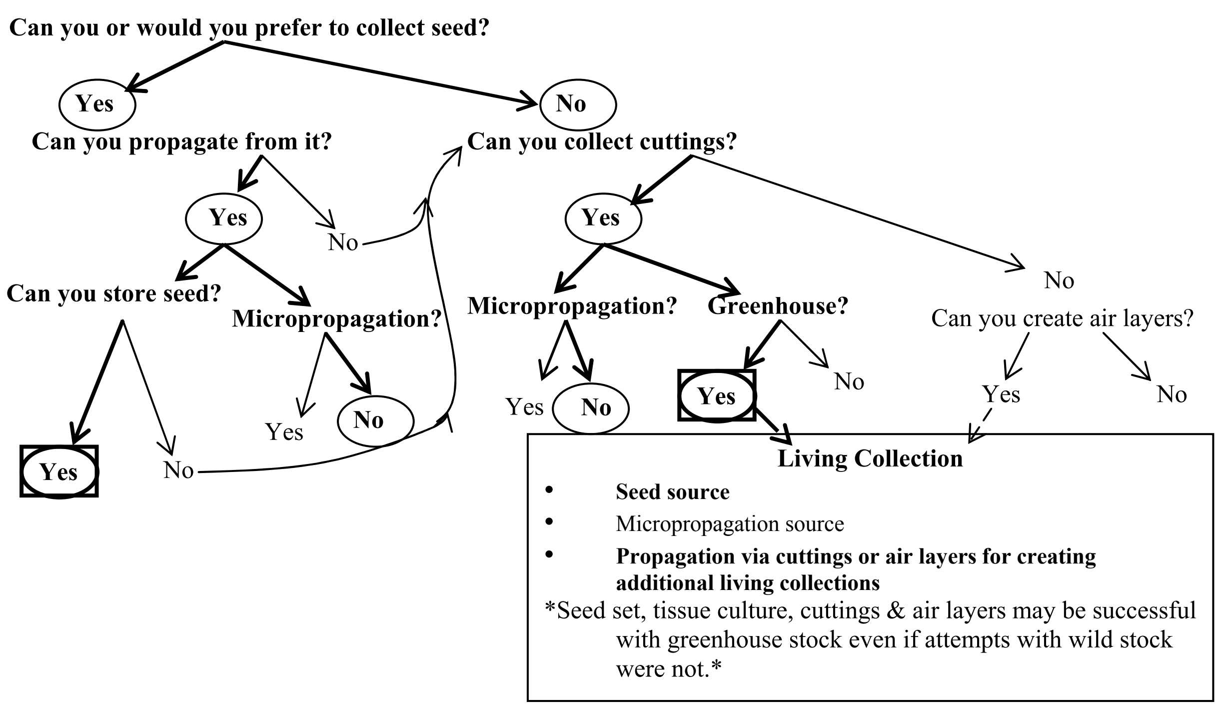
TaxonName: Cenchrus agrimonioides var. agrimonioides **TaxonCode: CenAgrAgr**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central Ekahanui	Manage for stability	36	30	16	30	3	16	56	0	0	86	3	16	Monitoring showed a decline in the wild site also many were planted in the last year
Makaha and Waianae Kai	Manage for stability	13	1	3	14	0	0	0	0	0	14	0	0	One additional plant was found in the known site
South Huliwai	Genetic Storage	21	0	0	21	0	0	0	0	0	21	0	0	Monitoring showed no change in the last year
	Total for Taxon:	70	31	19	65	3	16	56	0	0	121	3	16	

Propagation and Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Cuttings for living collection & reintroductions	Living collection and seed	No	Collect seed from living collections & reintroductions for genetic storage

Prioritizing Genetic Storage & Propagation Techniques



Collection: Cuttings are collected from all PUs not within a Natural Area Reserve to propagate for reintroductions and living collections. Seed is collected for propagation of founders within a Natural Area Reserve or if there is no available material for a cutting to be taken.

Propagation: Plants grow well from seed and cuttings and NRS have grown many plants for outplantings. Initial germination rates on fresh seeds average 60% from tests at the Seed Conservation Lab. Seedlings are easily transferred from agar to perlite/vermiculite when shoots and roots are over two centimeters long. It is also very easy to grow plants via cuttings from runners, or from divisions cut off of the root ball. The cutting success rate is typically over 50%. NRS prefer to grow plants from cuttings or divisions of robust plants for three reasons: 1) this technique produces clonal stock from wild plants that have not been affected by any selective pressures that may impact nursery-germinated plants 2) a larger seed bank remains in the field, 3) it is much faster to get a mature plant from a cutting or division (approx. three months) than from seed (approx. six months). Plants produced from clones of the Wai‘anae Kai and Mākaha PU have been grown and kept at the Army Nursery for years as a living collection. Although this is the preferred technique, if wild plants do not have many meristems and are not robust, then NRS will collect seed instead of a cutting.

Seed Storage Research: Bulk collections from plants growing in the courtyard at the Nature Conservancy's Kunia baseyard, the Pahole augmentation, and greenhouse stock plants were made in 2004 and used for storage testing. Results indicate that seeds store well for two years but may start to decrease in viability after this point. Seeds may store best at 24C and 20% relative humidity. These preliminary results may suggest that seed storage may not be the best long-term genetic storage method on its own, but will certainly support medium-term storage goals for reintroductions.

Genetic Storage:

There are seeds stored from reintroductions, many of which have been used for storage testing. There are also seeds stored from wild plants from all four PUs. A large number of seeds have been withdrawn over the last two years and successfully propagated for reintroductions from founders that were not represented in the greenhouse living collection. NRS plan to collect seed from the living collection once space permits. Adequate separation of population sites is required to ensure no mixing occurs. Since seed stores well after two years, collections do not have to occur this often to maintain genetic storage goals, and as tests continue the length of time between collections will most likely increase.

Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Cenchrus agrimonioides var. agrimonioides							
Central Ekahanui	30	3	1	15	0	26	6
Kahanahaiki and Pahole	71	11	15	47	0	35	29
Makaha and Waianae Kai	14	0	0	0	0	14	5
South Huliwai	21	0	0	11	0	9	6
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				73	0	84	46

Unique Species Observations

This taxon often forms new plants via ramets. Ramet reproduction is significant when looking at the longevity of an individual plant. In some cases, parent plants at reintroductions senesced and died but clones of those individuals persist as ramets nearby. Ramet formation in essence extends the "life-expectancy" of a parent plant. In general, ramets form off of mature parent plants, thus the ramet is also mature and immediately can contribute to the sexual reproduction underway within the population.

The seeds of this taxon have burrs, which suggest that an animal vector may have functioned as a dispersal agent. Prior to fencing within the Pahole and Kahanahāiki PU, plant distribution seemed to follow pig trails. Currently, distribution seems to follow human trails along fencelines and management trails. Although there is no data yet to support this, it seems that seedling generated F1 plants are more vigorous when they become established well away from their parent plants than when seeds fall below parent plants. It may be useful to intentionally disperse seed beyond the core planting areas somehow. An experimental seed sowing trial by TNC staff in 2004 using hundreds of seeds failed to generate any seedlings at sowing sites despite the use of viable seed.

Outplanting Issues

Reintroductions and augmentations have been conducted in all PUs except for Mākaha and Wai'anae Kai. NRS are awaiting the completion of the Mākaha fence and plan to reintroduce stock from this PU in the upcoming planting season. Last planting season, NRS supplemented the Kahanahāiki to Pahole PU with 38 additional plants and supplemented the 'Ēkahanui PU with 25 individuals. Thirty of the new plants put into the Kahanahāiki to Pahole PU were planted at a new reintroduction site in the Pahole MU portion of the PU. Natural recruitment occurs at the Kahanahāiki to Pahole PU where ungulate fences have been in place for almost a decade. No natural recruitment has been observed yet at the newer plantings in the 'Ēkahanui

MU, however recruitment has been observed at other older TNC outplantings of this species in the Kalua‘ā area. Site selection remains a crucial decision given potential crowding concerns and availability of suitable area for recruitment.

Founders Represented in Outplantings

TaxonName: Cenchrus agrimonioides var. agrimonioides **TaxonCode: CenAgrAgr**

Total Num Plants based upon Plants that have been numbered

PopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Central Ekahanui	Manage for stability	34	18
Kahanahaiki and Pahole	Manage for stability	97	61
Makaha and Waianae Kai	Manage for stability	14	0
South Huliwai	Genetic Storage	21	15
	Total for Taxon:	**166**	**94**

Number of Founders = Number of Mature, Immature, and Dead founder plants.
Number of Founders Represented = Number of founder plants represented in reintroductions.

The reintroduction success rate with this taxon continues to be high. The number of new wild plants is quickly increasing at the Pahole and Kahanahāiki PU due to successful threat abatement measures. As a result, NRS require some clarification from the IT on how to best approach balancing founders. The IP does not specify how to balance founders within a PU. There are two possible approaches:

1) Plant X number of progeny from each founder between the two extremes of the PU and consider founders balanced across the PU. However, founders will not be balanced within each outplanting site in the PU.
2) Plant X number of progeny from each founder at X number of small discrete sites between the extremes of the PU. With this approach, each site would have the full complement of founders. This is the approach taken at Kahanahāiki and Pahole thus far.

In the first situation there is flexibility in where planting of each particular individual occurs, you are not restricted to the boundaries of a “small site”, and the total number of plants required is greatly reduced. Tracking would be more challenging. In the second scenario, the goal is to equalize founders at all the sites and as founders increase space for additional plantings runs out. The more replicates of each founder NRS attempt to have the greater the effort and the greater the impact. After careful consideration, NRS feel that the first strategy is preferable. The following discussion illustrates why these choices are important and should be explicitly considered in creating reintroduction strategies.

Cenchrus agrimonioides var. *agrimonioides* management in the Kahanahāiki and Pahole PU is a perfect example to illustrate the above complications with founder balancing once applied in the field. The map below shows the founder distribution and outplanting sites within this PU.

Figure 3.2.1 Founders at Reintroduction Sites

NRS began planting this taxon in 1999. A few sites were chosen for reintroduction of Kahanahāiki stock. At this time the MIP did not exist and there were no plans to incorporate Pahole stock. NRS began with the goal of representing each Kahanahāiki founder with three individual plants. Even this goal was difficult to achieve as the numbers of wild founders increased each year. NRS continued to add founders at three per site and the sites became densely planted. In 2000, NRS established a new reintroduction at the Pahole Sandalwood ridge site, again with a mix of founders from Kahanahāiki Gulch. Now, this site is also crowded. Following these initial efforts, the MIP was finalized and the population unit was defined as Pahole to Kahanahāiki thereby including Pahole Gulch founders in the mix. In the last year, NRS established a new reintroduction site closer to the NIKE site with founders from Pahole populations. The current statistics on founders at reintroduction sites within this PU are shown in Table 3.2.1.

Table 3.2.1 Founder Statistics for Kahanahāiki to Pahole PU Augmentations

Stock Source for Kahanahāiki MMR-E Augmentation	# of Founders available	# of Founders represented in this site	Total outplants per pop ref site	Current survivorship
MMR-A	26	12	26	68
MMR-B	2	1	3	75
MMR-C	59	16	27	69
MMR-F	1	1	1	100
MMR-G	6	4	3	75
MMR-H	1	0	0	n/a
Stock Source for PAH-A Reintroduction	**# of Founders available**	**# of Founders represented in this site**	**Total outplants per pop ref site**	**Current survivorship**
MMR-A	26	9	26	81
MMR-B	2	1	2	50
MMR-C	59	18	36	51
MMR-F	1	1	1	100
MMR-G	6	6	6	100
MMR-H	1	0	0	n/a
Stock Source for PAH-D Augmentation	**# of Founders available**	**# of Founders represented in this site**	**Total outplants per pop ref site**	**Current survivorship**
PAH-B	27	14	25	100
PAH-C	12	3	5	100

NRS began reintroduction efforts trying to represent each founder with three individuals per planting. Had NRS foreseen that many more founders would be found in the coming years and the Pahole sites were to be added, perhaps strategy one would have been employed from the start.

- Does the IT agree that strategy one is preferred?
- Can NRS reduce the number of founders per site to one or two each?
- What number of founders from a PU is sufficient to consider the wild stock represented? For seed collection, fifty is the guideline; could that number apply to this situation as well?

Answers to these questions may require discussions about genetic communication and dispersal across the PU. If the MIP is strictly interpreted it seems that if the planting approach shifted toward scenario one, this would be consistent with the way the PU is defined and treated in the MIP. Considering this, NRS prefer scenario one and propose adopting this approach from this point forward. Figure 3.2.2 shows our proposed strategy for future augmentation at the Kahanahāiki to Pahole PU if the strategy one scenario is followed. The question remains of what to do about any existing imbalance between founders right now.

The current survivorship reported in Table 3.2.1 is broken out by founder. There are no apparent patterns associated with founders. The lower survivorship rates in general are related to the age of the outplants. In the next year, NRS will analyze survivorship data of reintroduced plants to try and establish an average life expectancy of *C. agrimonioides*.

Map removed,
available upon request

Figure 3.2.2 Future Reintroduction Strategy, Kahanahāiki and Pahole

Research Issues

A research topic from last year was to identify a monitoring technique that would eliminate the need to conduct a census at large reintroductions of this taxon. A pilot project was conducted in the winter of 2005 to determine if a sampling regime would have enough power to detect small changes in the number of individuals within a population. This was conducted at the Kahanahāiki MMR-E unit and consisted of several segmented quadrats, each 50 x 4 m, with 1 x 4 m segments. Each plant encountered was identified and its position, number of inflorescences and 2 perpendicular measures of size were recorded. In all, 10 quadrats were measured. Analyses of these data revealed that this method has insufficient power to detect meaningful changes in number of individuals, and the recommendation would be to census the entire area. NRS believes the nature of the outplanting leads to a clumped distribution of plants, making sample standard deviation high. Other sampling techniques may be employed to estimate seedling abundance; however population census seems to be the best way to get population size information. There was a relationship between the number of inflorescence and size where # inflorescence = 0.802(log of the sum of the perpendicular size measures) – 1.94 (R^2=0.31). Density was estimated to be 0.06 (± 0.07) plants per m^2 at this site. Actual density at this site is closer to 0.4 plants per m^2. NRS Monitoring will continue to investigate sampling methodologies that will aid in determining population structures of this species.

Surveys

No surveys specifically targeting this taxon have been conducted in the last year. However, new plants were found in known populations, and NRS continue to survey around known PUs for more plants during regular management work.

Taxon Threats

The major threats to *C. agrimonioides* var. *agrimonioides* are ungulates and weeds. Again when NRS monitored the Mākaha and Wai'anae Kai PU, this year, and all plants were chewed by pigs and there was intense pig rooting in the area. Alien grasses compete with this taxon and serve to increase fuels that may carry fire into native habitats. Alien grasses are difficult to control. Where grass specific herbicides have been used within three meters of outplanted *C. agrimonioides* var. *agrimonioides*, some negative affects were observed. The herbicide is applied using a backpack sprayer and non-target affects are hard to control with this application technique. NRS have discontinued use of these herbicides and will conduct control using manual techniques. This year's monitoring of a small and abandoned reintroduction site revealed some interesting information about the effect of weed control on *C. agrimonioides* var. *agrimonioides.* A reintroduction was established in the Kahanahāiki to Pahole PU in 1999 under a canopy of sparse natives mixed with dense *Psidium cattleianum*. NRS did not conduct supplemental plantings at this site as plants were small and spindly and there was little to no recruitment. In the last year, some intensive *P. cattleianum* removal was initiated. The amount of light reaching the understory following this removal increased dramatically. As a result the number of plants at the site increased from two mature to four mature, one immature and two seedlings. It is likely that this response resulted from the light increase associated with *P. cattleianum* removal.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Cenchrus agrimonioides var. agrimonioides

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki and Pahole	Manage for stability	Partial	Partial	Partial

Action Area: Out

TaxonName: Cenchrus agrimonioides var. agrimonioides

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Central Ekahanui	Manage for stability	Partial	Yes	No
Makaha and Waianae Kai	Manage for stability	No	Yes	No
South Huliwai	Genetic Storage	No	Yes	No

Manage for Stability PUs:

Kahanahāiki and Pahole:

Kahanahāiki : The maps below illustrate the distribution of wild and outplanted *C. agrimonioides* var. *agrimonioides* within this PU when initial management began versus the distribution now.

Figure 3.2.3 *Cenchrus agrimonioides* in Kahanahāiki and Pahole before Management

Map removed, available upon request

Figure 3.2.4 *Cenchrus agrimonioides* in Kahanahāiki and Pahole after Management

There are a few new naturally occurring nodes of plants shown in Figure 3.2.4. The southerly C-ridge node is most closely associated with the reintroduction site MMR-E. The middle node appears to have originated from the wild population nearby, MMR-D. The northernmost node is closest to the wild site MMR-A.

Overall there have been 96 *C. agrimonioides* planted at this site. Currently there are a total of 108 mature and juvenile plants alive today. Of these, 40 are F1 plants and 68 are planted. Of the forty F1 plants, 28 are mature and 12 are juveniles of substantial size. These numbers can help in planning for reintroduction size in order to achieve populations with stable numbers which are self-sustaining if site is successful and site conditions are right.

Pahole: In the last year NRS have not visited the wild *C. agrimonioides* site in Pahole gulch although NARS Biologist has monitored its status. While monitoring other rare plant taxa, NRS staff observed a new location of this taxon. This is the first year that Pahole stock of this taxon has been ready for reintroduction. NRS worked with NARS Biologist to choose some new reintroduction sites for *C. agrimonioides* in Pahole.

Mākaha and Wai'anae Kai: This population was heavily impacted by feral pigs in the last year. All of the plants were browsed. The habitat surrounding the plants was completely dug up by pigs. After Mākaha MU fencing is completed, NRS will reintroduce stock from this PU into the best habitat within the fence. Currently this PU is well-represented *ex situ* and plants are mature in the greenhouse. Other *C. agrimonioides* stock is also housed at the same facility making it impractical to collect pure seed for storage from Mākaha plants. NRS will make seed collections from the Mākaha reintroduction next year.

Central ʻĒkahanui: In the last year the South ʻĒkahanui reintroduction was supplemented with 25 additional outplants. Overall the plants at this reintroduction are performing well. Specific details about the stock represented in this reintroduction are shown in the table below.

Table 3.2.2 Founder Statistics for ʻEkahanui PU Augmentations

Stock Source for ʻĒkahanui EKA-B Augmentation	# of Founders available	# of Founders represented in this site	Total outplants per pop ref site	Current survivorship
EKA-A	42	17	26	96
HUL-A	22	15	29	94

Map removed,
available upon request

Figure 3.2.5 Ekahanui Founders at Reintroduction Site

In the next year the ʻĒkahanui Subunit II exclosure will be completed. This will make available much more appropriate habitat. NRS will plant using a similar strategy to the Kahanahāiki and

Pahole PU proposal (See Figure 3.2.4) NRS will apply lessons learned from the Kahanahāiki to Pahole to set planting goals to achieve self-sustaining populations and in the design of initial plantings in this PU. Success at ʻEkahanui sites may differ dramatically from Kahanahāiki to Pahole PU because the habitat quality is not as good. NRS will adjust planting numbers after initial survivorship rates are determined.

Map removed,
available upon request

Figure 3.2.6 ʻEkahanui PU Future Reintroduction Strategy

Other PUs:

South Huliwai: Additional collections were secured from this PU in the last year. This stock will be added to the South ʻĒkahanui reintroduction. Ungulate activity was not detected at this PU and this PU remains unfenced.

3.1.3 *Chamaesyce celastroides* var. *kaenana*

Requirements for Stability from MIP:

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

4 MFS PUs with stable numbers of mature individuals?	4 MFS PUs with stable structure?	4 MFS PUs with full genetic storage?	4 PUs with ungulates controlled?	Reintroductions complete?
Yes	No	No	Yes	No

Taxon-Level Discussion
Chamaesyce celastroides var. *kaenana* has stable numbers at six PUs. Four populations were designated as MFS because of the high fire threat to this species.The four populations designated as ‘Manage for Stability’ are Ka‘ena to Keawa‘ula (Ka‘ena), Ka‘ena (East of Alau), Waianae Kai and Mākua. There was considerable debate about which four should be designated. NRS continues to investigate the manageability of the Waianae Kai and Puaakanoa PUs and will make recommendations accordingly. NRS believe that there is no need for reintroduction or augmentation at any of the PUs to reach stability numbers. NRS has made many collections of seeds for storage by the bagging technique (see collection section for more information). Fire is the most challenging threat and NRS controls grass within the Mākua PU for fuel control and weed control is underway at the Ka‘ena site. The Keawa‘ula plants were not harmed by fire this year (Appendix III and IV). NRS began collections from Keawa‘ula and the East of Alau PU in the last year.

Major Highlights/Issues for Year 2

- The July 3rd arson caused fire burned within 50 meters of the Mākua PU.
- Collections have continued from the Mākua PU and NRS initiated collections from Ka‘ena (East of Alau), Ka‘ena to Keawa‘ula (Ka‘ena) and Ka‘ena to Keawa‘ula (Keawa‘ula) PUs.
- At least two plants burned in the Kaluakauila PU during the July Keawa‘ula fire (see appendix IV).

Plans for Year 3

- NRS will determine the least destructive monitoring techniques for dense populations such as Ka‘ena.
- Collect mature seeds from the remaining PUs to establish genetic storage.

Action Area: In

TaxonName: Chamaesyce celastroides var. kaenana **TaxonCode: ChaCelKae**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaluakauila	Genetic Storage	12	7	0	6	4	0	0	0	0	6	4	0	A thorough census found less plants than estimated last year
Makua	Manage for stability	89	45	20	89	45	20	0	0	0	89	45	20	Monitoring in the last year shows no change
North Kahanahaiki	Genetic Storage	177	0	0	177	0	0	0	0	0	177	0	0	No monitoring in the last year
Puaakanoa	Genetic Storage	145	10	0	160	10	0	0	0	0	160	10	0	A thorough census of the known sites found more plants in the last year
	Total for Taxon:	423	62	20	432	59	20	0	0	0	432	59	20	

Action Area: Out

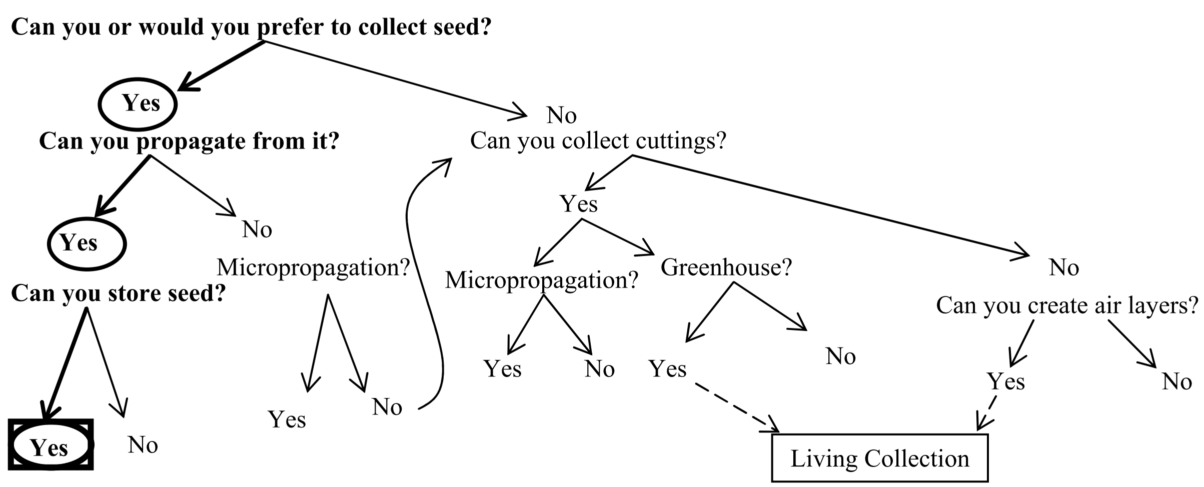
TaxonName: Chamaesyce celastroides var. kaenana **TaxonCode: ChaCelKae**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
East Kahanahaiki	Genetic Storage	2	0	0	2	0	0	0	0	0	2	0	0	These two plants have been observed in the last year
Kaena (East of Alau)	Manage for stability	21	4	20	21	4	20	0	0	0	21	4	20	Monitoring in the last year shows no change
Kaena and Keawaula (Kaena)	Manage for stability	300	0	0	300	0	0	0	0	0	300	0	0	Monitoring in the last year shows no change
Kaena and Keawaula (Keawaula)	Genetic Storage	24	1	0	56	2	2	0	0	0	56	2	2	A thorough census of the known sites found more plants in the last year
Waianae Kai	Manage for stability	33	0	0	33	0	0	0	0	0	33	0	0	Monitoring in the last year shows no change
	Total for Taxon:	380	5	20	412	6	22	0	0	0	412	6	22	

Propagation and Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	No	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: NRS has developed standard collection protocols at the Mākua PU for this taxon. Organza bags are placed over immature fruit in mid-summer when fruit production is consistent. Bags are then checked or collected between two and four weeks later, depending on the population site. Results vary, but enough seed to meet genetic storage minimums can be collected by installing three to six bags per plant. However, there are not always three-six inflorescences that are covered with fleshy red fruit at a given time (these would be ideal inflorescences for bagging). Therefore, several trips within a flowering season are necessary to adequately collect from a population site. The majority of plants within a population seem to flower and produce at a similar time and at similar intervals; but these characteristics have varied between population sites. Fruit can also be picked off the plant prior to dehiscence and in addition to bagging. However, timing and handling of collection is crucial in order to collect mature seed and not hinder storage potential. Fruit must be dark red and dry, not fleshy. Also, fruit must be placed in paper envelopes, not plastic, to allow to continual drying. Fruit should also be picked from the receptacle as to minimize contact with moist plant tissue.

Propagation: *Chamaesyce celastroides* continues to be unsuccessful with vegetative propagation trials. Plants are easily propagated from seed, and this method is still the preferred propagation technique for this taxon. Initial germination rates range from 30-75% for seeds sown on agar at the Seed Conservation Lab. Seedlings are easily transferred to potting media and grow vigorously.

Seed Storage: Since the bagging technique was developed, NRS acquired three substantial collections from the Mākua PU. NRS are approaching bagging slowly so as to allow for additional on-site recruitment. This year NRS was able to make a bulk collection for storage testing by bagging plants that already are significantly represented in storage. One collection that has been banked since 2001 was tested this year. Germination after 5 years at -18C and 20% relative humidity was 74%. More of the older collections will undergo viability testing next year.

Genetic Storage: There 102 plants represented in the seedbank from 5 PUs, and there are more new founders currently bagged, awaiting collection in the field this year. Seed is currently the best method of genetic storage for this taxon due to its good storage potential as well as the lack of success with cuttings in the Army Nursery.

Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	# of Potential Founders: Current Imm.	# of Potential Founders: NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	Partial Storage Status: # Plants >=1 Microprop	Partial Storage Status: # Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Chamaesyce celastroides var. kaenana							
East Kahanahaiki	2	0	0	0	0	0	0
Kaena (East of Alau)	21	4	0	5	0	0	4
Kaena and Keawaula (Kaena)	300	0	0	30	0	0	28
Kaena and Keawaula (Keawaula)	56	2	0	17	0	0	6
Kaluakauila	6	4	0	0	0	0	0
Makua	89	45	3	49	0	1	35
North Kahanahaiki	177	0	1	9	0	0	7
Puaakanoa	160	10	0	0	0	0	0
Waianae Kai	33	0	0	0	0	0	0
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				110	0	1	80

Research Issues

NRS will focus on determining a non-invasive technique for determining population structure and trends in dense patches in the coming year.

Taxon Threats

There were no additional observations in the last year.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Chamaesyce celastroides var. kaenana

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kaluakauila	Genetic Storage	Yes	No	No
Makua	Manage for stability	Yes	Yes	No
North Kahanahaiki	Genetic Storage	Yes	No	No
Puaakanoa	Genetic Storage	Partial	No	No

Action Area: Out

TaxonName: Chamaesyce celastroides var. kaenana

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
East Kahanahaiki	Genetic Storage	Yes	No	No
Kaena (East of Alau)	Manage for stability	Yes	Yes	No
Kaena and Keawaula (Kaena)	Manage for stability	Yes	Yes	No
Kaena and Keawaula (Keawaula)	Genetic Storage	Partial	Partial	No
Waianae Kai	Manage for stability	Yes	No	No

Manage for Stability PUs:

Mākua: NRS has done extensive fuel and weed management around this PU and the population is doing extremely well. Numbers have grown significantly from the numbers in the final IP. The number of immature plants has grown and with each new monitoring NRS tag new mature plants. Seedlings continue to come and go with the seasons. Although NRS has been effective at removing alien grasses and greatly reducing fuels, the threat of fire is ever present. Many broad leaf weeds as well as native grasses and shrubs have moved into the area (see Weed Chapter for discussion). In the summer of 2005, two fires burned in the vicinity of this PU and in July of 2006, a fire burned from Farrington Hwy. up to the crest of ʻŌhikilolo ridge (Figure 3.3.1). This area has burned every summer in the recent past and fires typically stops on the ridge crest. This is of great concern to NRS and NRS is working with the Wildland Fire Crew to prevent this from happening in the future (see Appendix III and IV). In the last year, NRS has continued to control weeds within the patch and has collected from many plants for seed storage.

Map removed,
available upon request

Figure 3.3.1 Burn perimeter in relation to *Chamaesyce celastroides* in Mākua.

Ka‘ena and Keawa‘ula (Ka‘ena): This 0.9-acre population of 300+ mature plants, protected within the Ka‘ena Natural Area Reserve, is located in a predominantly native coastal habitat. There is substantial on-site recruitment; with many 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 the brittle plants, NRS have not and will not conduct a census of this population each year as the number is well over the target number of 25 mature individuals. In the last year, NRS began collecting seeds for genetic storage from this PU. NRS does extensive weed control on this site. Fortunately, fire is not as large a threat as at the other PUs due the wind-swept strand vegetation and remoteness of the site. In the coming year, NRS will be working with NARS staff to determine the best monitoring approach for this PU.

Ka‘ena (East of Alau): This population was visited once in the last year and there was no change in population size or distribution. There is no grass in the area immediately surrounding this PU and the plants are protected by large rock talus. In the last year, NRS began seed collection for storage and will be working with NARS staff to determine the best monitoring approach for this PU.

Wai‘anae Kai: There are stable numbers of mature plants, but younger age classes are impossible to detect from aerial surveys. Some of the plants are located in very open portions of cliffs where weeds and goats are not a direct threat. Over 30 plants were counted during surveys by NRS and HINHP in Wai‘anae Kai in 2002 and no change in numbers was detected when the site was monitored in June 2005. In the coming year, NRS will determine if collections can be made and if any other management is possible.

Other PUs:

Kaluakauila: The estimated number of individuals in the MIP was based on a single observation with binoculars. 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. The upper edges of this PU are choked with alien grass and are at risk from fire; some plants were burned in previous years. In the fire of July 2006, two plants were burned and the fire burned within a meter of many other plants. See Figures 3.3.4-3.3.6 below. In the coming year, NRS will work to secure seed collections from this site. Grass control for fire prevention would be very difficult at this site as most plants are on cliffs surrounded with *Panicum maximum.*

Map removed,
available upon request

Figure 3.3.4 Burn perimeter in relation to *Chamaesyce celastroides* in Kaluakauila.

3.3.5 Burned *Chamaesyce celastroides* var. *kaenana* from the Kaluakauila PU

3.3.6 Burned habitat in Kaluakauila after the fire.

North Kahanahāiki: There have been no additional actions in the last year.

East Kahanahāiki: These plants were monitored in the last year but there are no other actions.

Pua‘akanoa: There have been no additional actions or observations in the last year. NRS will be visiting this PU in the next year to begin collections and investigate manageability.

Ka‘ena and Keawa‘ula (Keawa‘ula)*:* NRS began to establish genetic collections from this PU in the last year. There are no other additional observations.

3.1.4 *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

3 MFS PUs with stable numbers of mature individuals?	3 MFS PUs with stable structure?	3 MFS PUs with full genetic storage?	3 PUs with fences?	Reintroductions complete?
1/3	0/3	0/3	1/3	0/3

Taxon Level Discussion

The only remaining extant PU, Kapuna to Pahole, falls within the Action Area (AA), and will be managed for stability. This PU has stable numbers, however numbers have severely declined since the MIP was finalized. NRS believe a combination of factors, including weed impacts, ungulate impacts and low on-site germination, have led to this decline. NRS are working with the State to complete the fencing of the PU over the next year by assisting with the completion of the Kapuna fence. The State contracted out the majority of the fence construction and NRS will work with their new fencing crew to complete the unfinished portions of the fence. Weed control is ongoing at multiple sites within the PU. Reintroductions have been done in Pahole and will take place in West Makaleha and Mākaha MUs once fences are constructed. NRS will continue planting in Pahole this winter with approximately seventy-five plants. The Mākaha fence will be constructed this year and NRS plan to begin planting this winter with approximately twenty five plants. The West Makaleha fence is slated for year two of the MIP. It is too early to predict, but NRS hope that with reintroduction/augmentation and ungulate and weed control this species may reach stability.

Major Highlights/Issues Year 2

- Fence construction has begun around the remaining unprotected portions of the Kapuna to Pahole PU.
- Collections were made from 37 plants across the Kapuna to Pahole PU in the last year. These have been used to grow plants for outplanting and genetic storage.
- Augmentation has begun in the Kapuna to Pahole PU.

Plans for Year 3

- Supplement the Pahole augmentation with about 75 more plants.
- Complete the remainder of the Kapuna to Pahole fence and the Mākaha fence.
- Continue to collect from founders in the Kapuna to Pahole PU for supplementing the augmentation.
- Establish the Mākaha reintroduction using stock grown from seed.

Action Area: In

TaxonName: Chamaesyce herbstii **TaxonCode: ChaHer**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kapuna to Pahole	Manage for stability	40	5	0	49	17	1	2	18	0	51	35	1	A more thorough census of the known sites found more plants
	Total for Taxon:	40	5	0	49	17	1	2	18	0	51	35	1	

Action Area: Out

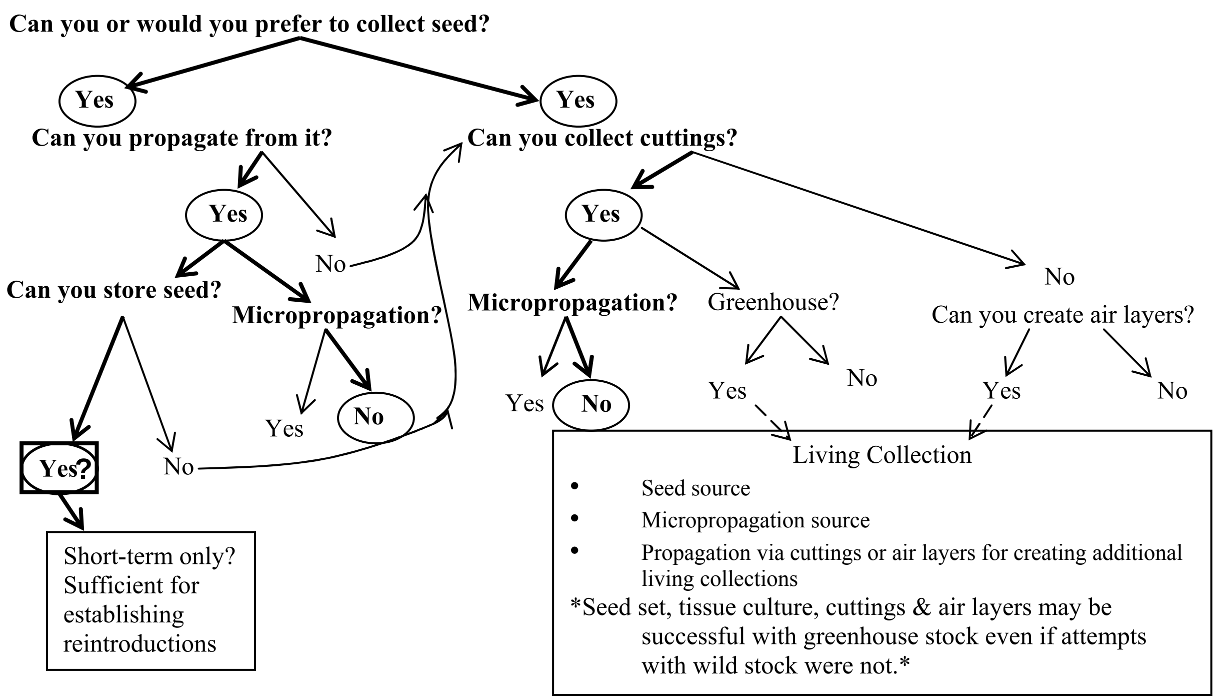
TaxonName: Chamaesyce herbstii **TaxonCode: ChaHer**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	0	0	0	To be reintroduced in 2007
West Makaleha	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	0	0	0	To be reintroduced when the MU fence is complete
	Total for Taxon:	0	0	0	0	0	0	0	0	0	0	0	0	

Propagation & Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Seed	Seed (short-term) & Long-term storage undetermined	Yes	Yes – need to collect from reintroductions

Prioritizing Genetic Storage & Propagation Techniques



Collection: There was a significant effort made to collect seed from as many plants in the Kapuna to Pahole PU as possible. Different collection techniques and frequent observations allowed for the determination of optimal collection practices. When the fruit are dry and brown, the seeds are mature and the fruit can be picked at this time. Inflorescences with red fruit can be bagged and seeds from the dehisced fruit can be collected from the bags about two weeks later. Bags should not stay on too much longer because seeds will germinate in the bags, possibly due to the mesic environment that plants in which plants are located as well as fruit maturation occur over winter months. Brown fruit that have not dehisced but have fallen off the tree and are on the ground or collected within the bag have aborted and there are no viable seeds in these fruit. The number of empty brown fruit that abort and fall off the tree appear to be larger than the number of fruit with mature seed. Many of the aborted fruit have small, shriveled, aborted seeds inside. Though there is the potential to have 3 seeds per capsule (fruit), this will rarely occur and dehisced fruit typically average 1-2 seeds per capsule. This is observed for other taxa in this genus and family, where fruit fully develops regardless of containing viable seed.

Propagation: Plants are easily propagated from seed. Seedlings are vigorous and reach outplanting size six months after germination. Tissue culture techniques for seed, both mature and immature, brought to the Micropropagation Lab, have not been successful. Attempts to root cuttings brought by NARS staff to the Micropropagation Lab greenhouse were not successful, but nursery stock has yet to be tested. This year NRS staff attempted to root one cutting by letting it air-dry overnight in an outside, sheltered location. The cutting was stuck the following morning and successfully rooted.

Seed Storage Research: Only small collections from many plants have been placed into short-term seed storage for ongoing propagation for reintroductions. Once reintroductions have mature individuals, seeds can be collected from these plants for storage testing. A large collection from one plant has been split into two additional storage treatments to be tested later this year. The remaining collections have all been stored at one storage condition. Germination results are hard to compare between collections due to the very small number of seeds sown for each plant (typically five-eight seeds). However, seven out of ten collections that were 18-20 months old had no germination compared to nine out of 39 collections that were seven-eight months old. This suggests that seeds may not store long-term conventionally, but much more research is needed in order to determine the reliability of seeds as a genetic storage method. Seeds that did not germinate within two months after sowing became rotten during this time. This observation, along with noticing that seeds germinated in the collection bags, suggests that this taxon does not form substantial soil seedbanks, but tests have yet to address this question in the lab.

Genetic Storage: Thirty-seven plants have been collected from in the Kapuna to Pahole PU. Seeds will continue to be collected from wild plants until the Pahole reintroduction goals are achieved. Seeds will then be collected from reintroduced plants for thorough testing and additional reintroductions. If seeds can not be stored long-term, NRS will take the necessary steps to determine the most appropriate genetic storage method.

Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Chamaesyce herbstii							
Kapuna to Pahole	49	17	0	17	0	2	6
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				17	0	2	6

Outplanting Issues

The State successfully outplanted into a small exclosure in Kapuna around 1995. These plants are growing vigorously and are reproductive. NRS initiated augmentation in the fenced portion of the PU in Pahole in February of 2006. As of the last monitoring there is high survivorship and plants are growing vigorously. NRS plans to supplement the reintroduction with approximately seventy-five individuals this year. Following the suggestion of the State, NRS is planting in gaps between existing wild plants. Ultimately NRS plan to reintroduce a total of one hundred and fifty across a series of ridges and small gulches between existing patches of wild plants. This would represent each founder with two progeny and result in a mostly continuous distribution of plants across the area. NRS plan to initiate reintroduction in Makaha this winter with approximately 25 plants. NRS have not yet determined the site for reintroduction, however there are extensive areas of appropriate habitat.

Research Issues

Research on seed storage needs to be conducted.

Surveys

No surveys where conducted specifically for this taxa in the last year although some had been planned. With limited survey time with the HINHP Botanist higher priority surveys were conducted. There are four survey days remaining for this taxa that will likely be conducted in the next year. NRS has been active in areas with appropriate habitat for this species and always keep an eye out while conducting other tasks particularly in the Northern Waianaes.

Taxon Threats

No additional threats have been noted in the last year.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Chamaesyce herbstii

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kapuna to Pahole	Manage for stability	Partial	Partial	No

Action Area: Out

TaxonName: Chamaesyce herbstii

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Makaha	Manage reintroduction for stability	No	No	No
West Makaleha	Manage reintroduction for stability	No	No	No

Manage for Stability PUs:

Kapuna to Pahole: The number of individuals in the final MIP was based on counts by the NARS specialist between 1991 and 1999. Based on extensive monitoring in Pahole last two years and discussions with the NARS Specialist, it is clear that this species has declined greatly in numbers in the last five years. Although stable numbers do exist there are few seedlings and immature plants known. NRS worked diligently in the last year to bag fruit for collection. The augmentation begun last year will be supplemented this coming year with approximately seventy-five plants. Only new founders will be collected from in the next year. This will help to ensure that from the plants with adequate number of seeds in storage, the wild seed remains on site to encourage in situ germination. Once the reintroduced plants become mature they maybe used as a source for seeds for genetic storage. As stated above NRS will work with the State to complete fencing in this PU in the next year. NRS will continue weed control within this PU in the next year under direction of the State.

Mākaha: Kapuna to Pahole founders will be used to initiate reintroduction in Mākaha this year with approximately twenty-five plants. NRS has not yet chosen a site however there is extensive areas with appropriate habitat. NRS will consult Joel Lau regarding the site once options are determined.

West Makaleha: Kapuna to Pahole founders will be used to reintroduce plants to West Makaleha, pending approval from the State. A fence will be constructed in West Makaleha in approximately two years.

3.1.5 *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

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have stable structure?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
1/3	0/3	0/3	3/3	0/3

Taxon Level Discussion

There have been no substantial changes in numbers of wild plants in the last year. Emphasis with this taxon has been on augmentation and rat control at populations where damage has been observed. None of the PUs have over 100 mature individuals and there is still limited recruitment at wild and reintroduced sites. In order to address this issue, development of a slug control technique is a priority. The overall prognosis for this taxon remains unclear as so much hinges on this research.

Major Highlights/Issues Year 2

- Supplemental plantings were conducted at existing reintroduction sites adding a total of 36 new plants.
- NRS removed pigs that breeched the West Makaleha *C. grimesiana* fence and upgraded fence sections where they entered.

Plans for Year 3

- Re-fresh genetic storage collections every four to five years until long-term storage data are obtained.
- Continue to balance founders at reintroduction sites. Try to acquire seed for storage and additional propagation from PAH-A-2 in order to maximize Pahole founders.
- Prepare PAH-B-1 stock for reintroduction. After mature, collect seed for use in additional reintroductions and storage.
- Implement the first augmentation at the West Makaleha portion of the Pahole to West Makaleha PU.
- Expand the Pu‘u Palikea MU fence to include more *C. grimesiana* habitat for use in additional augmentations.
- Initiate reintroduction with KAL-A stock from the “type” locale for this taxon at a new site in the Central Kalua‘ā MU.

- NRS will collect another voucher of the soft-bodied scale from affected plants in the Palikea PU for further identification and monitor the damage. It was previously identified as possibly native, however the sample was not in ideal shape. If the scale is an alien then NRS will consider control options.

Action Area: In

TaxonName: Cyanea grimesiana subsp. obatae **TaxonCode: CyaGriOba**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Pahole to West Makaleha	Manage for stability	23	17	0	7	1	8	24	2	0	31	3	8	The wild mature plants are all stable and new seedings were observed in a wild site. Also, additional plants were added to augment the PU.
	Total for Taxon:	23	17	0	7	1	8	24	2	0	31	3	8	

Action Area: Out

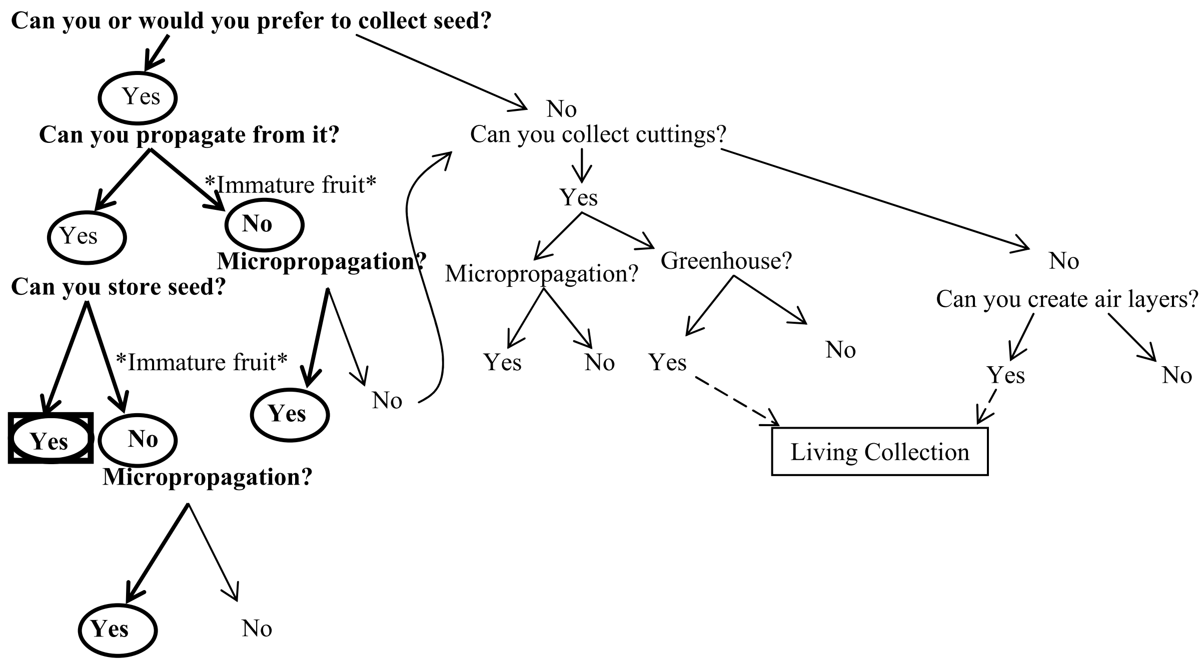
TaxonName: Cyanea grimesiana subsp. obatae **TaxonCode: CyaGriOba**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central Kaluaa	Manage for stability	1	70	0	1	0	0	26	40	0	27	40	0	The wild plant has been observed in the last year
Makaha	Genetic Storage	1	0	0	1	0	0	0	0	0	1	0	0	This plant has been observed in the last year
North branch of South Ekahanui	Genetic Storage	4	6	0	0	0	0	21	18	0	21	18	0	The wild plants are gone and additional plants were outplanted in the last year
Palikea (South Palawai)	Manage for stability	10	24	18	10	12	20	44	18	0	54	30	20	Two new seedlings were observed in the wild population and it has remained stable and the data for the oldest TNC reintroductions has been to the total in the last year
Palikea Gulch	Genetic Storage	0	1	0	0	1	0	0	0	0	0	1	0	This plant has been observed in the last year
South Kaluaa	Genetic Storage	1	0	0	0	0	0	0	0	0	0	0	0	The wild plant has been observed dead in the last year
	Total for Taxon:	17	101	18	12	13	20	91	76	0	103	89	20	

Propagation & Genetic Storage

1) At this time, what is the preferred propagation technique?	**2)** At this time, what is the preferred genetic storage technique?	**3)** Is more genetic storage testing needed?	**4)** Are additional steps required for obtaining enough seed?
Seed	Seed	No	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: Collections are made when fruit are orange and soft. (see picture below). For color photos please view the report on line at http://www.hawaii.botany.edu/faculty/ duffy/DPW.htm. Collecting fruit when too immature decreases storage potential. Immature seed, however, can be successfully germinated by the Micropropagation Lab and retained in tissue culture.

Mature fruit of *Cyanea grimesiana* subsp. *obatae*

Propagation: Seeds are easily germinated within the first month on 1% water agar with 80-100% germination. NRS currently germinate all seeds and grow seedlings in a growth chamber at the Natural Resource Center. The growth chamber is regulated for monthly average temperatures and day lengths at 2,000 ft elevation. This tool allows for greater environmental stability and higher success in germination and seedling establishment. Even in the growth chamber, seedlings grow very slowly. Seedlings remain in an environment-controlled growth chamber until one inch tall, when they are moved outside and onto the mist bench with very little to no mortality. Plants can be grown from cuttings, but since most plants have only one terminal branch this method cannot be widely used and is only attempted if there is an emergency threat to the site. Basal suckers do occur on larger health plants and offer the possibility of an additional source of material. Mature and immature fruit can also easily be propagated in micropropagation. Many wild and greenhouse cuttings have also been brought to the Micropropagation Lab, but with little success. Greenhouse stock may be more successful than wild stock.

Seed Storage Research: Seeds withdrawn this year from storage for propagation indicate that seeds can be successfully stored at 4C and 20% relative humidity. Seeds have been stored for over four years with little to no decrease in germination. Germination from older collections initially stored at -18C, however, is significantly lower. Extensive storage testing for many other species of *Cyanea* have indicated that seeds of this genus cannot be stored frozen. Therefore, seeds from older collections may have low germination not because of low storage potential, but rather due to the species' inability to be stored at -18C.

Genetic Storage: Both seed storage and tissue culture are successful methods of genetic storage. Seed storage is the primary method. Once a founder is adequately represented in seed storage, supplemental collections can be made once four years. A collection for testing would also be useful to determine seedbank potential and establish a viability curve. There have been several observations of fruit aborting before maturation and falling to the ground. Unripe seeds may have good initial germination but may be desiccation-sensitive and quickly lose viability in storage. Collections of immature fruit have been made and successfully germinated and maintained in tissue culture. They are easily subcultured, so it is possible to store many clones from one plant indefinitely.

Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Cyanea grimesiana subsp. obatae							
Central Kaluaa	1	0	0	1	0	1	1
Makaha	1	0	0	0	0	0	0
North branch of South Ekahanui	0	0	1	1	1	1	1
Pahole to West Makaleha	7	1	1	6	0	7	7
Palikea (South Palawai)	10	12	2	12	5	4	12
Palikea Gulch	0	1	0	0	0	0	0
South Kaluaa	0	0	1	1	0	1	1
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				21	6	14	22

Unique Species Observations

There is some variation amongst populations of this taxon in fruiting times. There is no obvious explanation for this trend. NRS present it in the map below merely as an observation. The largest plant in Central Kalua‘ā appears to be in a constant cycle of reproduction.

Corolla color also varies across the range of plants. As shown below, the Mākaha population displays corolla colors that are white with purple on the inside petals, the Southern Wai‘anae plants are purely white, and a plant in Central Kalua‘ā has corollas that are all-around more pinkish/purple. For color photos please view this report on line at http://www.hawaii.botany.edu/faculty/ duffy/DPW.htm.

Makaha wild plant

South ‘Ēkahanui reintroduced individual

Central Kalua'ā wild plant

Map removed,
available upon request

Outplanting Issues

Reintroduced plants across the Wai'anae Mountains continue to demonstrate survivorship over 75%. Supplemental plantings into existing reintroduction sites were conducted last season. At Kalua'ā, six plants were added to the expanded gulch 3 reintroduction site in order to balance founders. At 'Ēkahanui, 33 new plants were planted into the South 'Ēkahanui exclosure of pure 'Ēkahanui stock. Rat control is conducted to protect reintroductions in sites where rat predation has been observed historically. Recruitment at reintroductions has not yet been observed. NRS are working to develop slug control techniques in order to address seedling predation issues at wild and reintroduced sites (See Chapter 6). Fertilization by TNC staff of outplants at the Palikea area appears to have significantly increased their vigor as a number of the outplants are flowering for the first time this winter.

Founders Represented in Outplantings

TaxonName: Cyanea grimesiana subsp. obatae **TaxonCode: CyaGriOba**

Total Num Plants based upon Plants that have been numbered

PopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Central Kaluaa	Manage for stability	1	1
Makaha	Genetic Storage	1	0
North branch of South Ekahanui	Genetic Storage	1	1
Pahole to West Makaleha	Manage for stability	9	3
Palikea (South Palawai)	Manage for stability	24	3
Palikea Gulch	Genetic Storage	1	0
South Kaluaa	Genetic Storage	1	1
	Total for Taxon:	**38**	**9**

Number of Founders = Number of Mature, Immature, and Dead founder plants.
Number of Founders Represented = Number of founder plants represented in reintroductions.

Taxon Threats

The only additional threat observed for this taxon since last year is an unidentified (and possibly native) soft bodied scale. This scale has however been observed by TNC staff since at least 2000 (pers. comm. Dan Sailer). It is negatively impacting outplantings and naturally occurring plants at the Palikea PU by feeding on leaf tissues. NRS will collect another voucher for identification and monitor impacts. If the scale is confirmed as an alien then NRS will consider control options.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Cyanea grimesiana subsp. obatae

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Pahole to West Makaleha	Manage for stability	Yes	Partial	Partial

Action Area: Out

TaxonName: Cyanea grimesiana subsp. obatae

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Central Kaluaa	Manage for stability	Yes	Yes	Partial
Makaha	Genetic Storage	No	No	Partial
North branch of South Ekahanui	Genetic Storage	Yes	Partial	Partial
Palikea (South Palawai)	Manage for stability	Yes	Yes	Partial
Palikea Gulch	Genetic Storage	Yes	No	No
South Kaluaa	Genetic Storage	Yes	Yes	Yes

Manage for Stability PUs:

Pahole to West Makaleha:

Stock Source for existing augmentation (PAH-D)	Source stock plant #	Comments
Pahole (PAH-A)	2	Founder only represented as one plant in reintroduction. Founder is dead in wild. Collect as soon as plant matures to secure stock and balance with rest of founders.
	3	Propagating underway for planting this winter
	4	Propagating underway for planting this winter
Pahole (PAH-B)	1	Founder only represented in reintroduction. Founder is dead in wild. Plant is mature and will be collected from this October/November to secure stock and to balance founders in reintroduction in future.
	2	Propagating underway for planting this winter

The NARS Specialist monitors the wild populations of this taxon within Pahole NAR. There is stock representing five founders from Pahole sites. Approximately fifty plants of Pahole stock will used to supplement the Pahole snail exclosure reintroduction site this winter. NRS will work to secure stock from B1 and A2 and add this lineage to the reintroduction site.

NRS conduct rat control and weed control within the West Makaleha exclosure of this PU. Rat control data is shown in the table below. Bait stations and snap traps are maintained approximately every six weeks. No rat damage has been observed on plants since May 2002. Baiting was suspended in mid-February 2006 when two piglets were observed within the exclosure. One piglet was removed and the other was able to pass back through the fence. Additional fencing was added to the fence and baiting resumed at the end of April 2006. No damage was found on the *C. grimesiana* by the piglets or rats during the suspension of rat baiting.

West Makaleha *Cyanea grimesiana* subsp. *obatae* Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2002	8	292	120	41%	25	15	6
2002 - 2003	8	696	463	67%	26	16	7
2003 - 2004	8	1008	693	69%	42	16	8
2004 - 2005	8	1001	322	32%	43	16	10
2005 - 2006	8	695	376	54%	42	16	6

The population has been fenced since 2001 and is monitored quarterly to ensure that it remains pig-free. NRS will begin to augment the West Makaleha site this year if plants are ready. There is stock from six founders. Five of these founders are still alive in the wild, and one is dead, but is represented as a single small plant in the greenhouse. In-situ recruitment does occur at this site; as many as 7 seedlings have been seen at one time, however none have ever lived to become immature.

Palikea (South Pālāwai*):* This site is co-managed by TNC staff and NRS. The fence protection the population is monitored quarterly. In addition, weed control has been conducted since the fence was constructed and consequently, native ferns and shrubs dominate the understory in the area. There are however a number of weedy overstory weeds in the area such as *Morella faya* and *Araucaria columnaris*. These canopy weeds will be difficult to remove and therefore NRS focus on seedlings and immatures, and will let mature trees die on their own. Rat control has been underway since 2002. NRS maintain a rat baiting grid of 18 bait stations and 21 snap traps. The grid is maintained monthly and also serves to protect native *Achatinella mustelina* populations in the area.

Palikea *Cyanea grimesiana* subsp. *obatae* and *Achatinella mustelina* Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2004 - 2005	18	2151	525	24%	49	18	11
2005 - 2006	18	1887	626	33%	36	21	10

In the last year, NRS hired a fencing crew to construct planned MIP fences. Expanding the existing fence at Palikea is a top priority, should be completed by the spring of 2007. TNC staff and NRS have conducted augmentations. Currently there is limited space in the existing exclosure so supplemental plantings will have to wait until winter 2007-2008, after the fence expansion is complete. Seed has been germinated in preparation for this planting, and founders will be balanced considering the existing augmentation. In the taxon status table the number of augmented plants spiked for this PU because the TNC plantings were incorporated into the NRS database in the last year. Tags with Army population reference codes were added to each plant.

Central Kaluaʻā: There are two founders from Kaluaʻā gulch. One founder is from South Kaluaʻā (KAL-A) and is from the same site as, and is morphologically most like the type specimen of this taxon. The second founder is in Central Kaluaʻā (KAL-B). The MIT recommended that NRS conduct two reintroductions within the Central Kaluaʻā exclosure, one reintroduction to be established with KAL-A stock and the other with KAL-B stock. This was recommended in order to preserve the type stock at an isolated location. A reintroduction of the KAL-B stock was initiated in the winter of 2004-2005 and was supplemented last winter with six plants in order to balance founders. Plants from the initial reintroduction have matured and are producing fruit. NRS will have 10 plants ready of KAL-A stock to start a reintroduction this winter at a site that was selected by TNC staff. 24 more plants of KAL-A stock are being propagated for outplanting in the winter of 2007-2008. As both populations are started with only one founder, NRS plan to split the goal for stabilization at Kaluaʻā.

Other PUs:

South Kaluaʻā: The South Kaluaʻā PU plant died in the Fall of 2005. Seed is available from this PU. TNC outplanted stock from this KAL-A plant near the KAL-B founder before the plant was discovered. Cross pollination between the KAL-A outplanted stock and the wild KAL-B individual may already be occurring. Fruit continues to be produced from six geographically separated outplanted KAL-A plants and is a source of material for future propagation efforts.

North Branch of South ʻĒkahanui: TNC Staff and NRS have been monitoring and collecting fruit from the first reintroduction of this stock. This reintroduction was conducted using mixed ʻĒkahanui and Kaluaʻā stock. Collecting pure ʻĒkahanui seed was done by ensuring that none of the Kaluaʻā plants were in flower at the same time or by removing developing inflorescences. Pure seed of this stock is considered valuable because they have corollas unlike any other populations of this taxon and previous genetic analysis also highlighted significant genetic differences (Crooker, 2004). Rat baiting was conducted around this reintroduction in order to protect seed. Last winter, a pure ʻĒkahanui reintroduction was initiated with 33 outplants. They have already matured and produced fruit and are thriving. Although this is not a MFS PU, NRS have put significant resources into this PU because of its' unique morphology and because of available protected habitat and interest from TNC staff. NRS plan to add plants in the coming planting season to balance stock at the pure stock reintroduction. Once seed is secured for genetic storage NRS will continue to conduct management in the area for other populations and for other taxa, however, further reintroduction effort will not be necessary.

Palikea Gulch: All that remains of this PU is one immature plant. NRS have been monitoring it since February 1999 and the plant still small, and has not matured. A large log lies above the plant, and the plant shows signs of trying to grow around the log. This year, NRS will investigate removal of the log to increase vigor, and will consider fertilization of the plant. In the past, NRS have tried to reduce competition from alien plants through weed control but have seen no positive or negative response in vigor or growth as a result. No rat predation has been observed. NRS will continue to monitor this plant for signs of reproduction and at that time determine what subspecies it most closely resembles. The UXO discovered last year near the site has been removed by Army EOD.

Mākaha: The single plant in this population was discovered early in 2005. NRS were able to begin rat baiting while it fruited and collected 1 fruit last year. NRS are again baiting this year and have bagged several immature fruits to get a sizeable collection for seed storage. Other than rat control during flowering and fruiting, not other threats are controlled at this site.

3.1.6 *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

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have stable structure?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
0/3	0/3	0/3	1/3	0/3

Taxon Level Discussion

This taxon still recruits, leading NRS to have high hopes for its stability. Only the Pahole PU and part of the Kapuna to West Makaleha PU are fenced. The smallest PU, Mākaha and Wai'anae Kai, is still unfenced but permits have been secured and construction will begin in October. The Kapuna MU fence is currently under construction. NRS have conducted weed control in the habitat surrounding all remaining PUs of this taxon.

Major Highlights/Issues Year 2
- NRS outplanted 23 immature *C. longiflora* to augment the West Makaleha portion of the Kapuna to West Makaleha PU. This represents the first reintroduction conducted with *C. longiflora*.
- Five additional mature plants were discovered in the Kapuna to West Makaleha PU.
- A Conservation District Use Permit was acquired for fencing in Mākaha Valley. Now a small exclosure can be constructed to protect the majority of the plants at that location.

Plans for Year 3
- Construct small exclosure around Mākaha portion of Mākaha and Wai'anae Kai PU.
- Supplement the West Makaleha augmentation.
- Complete Subunit III of the Upper Kapuna MU.
- Develop a specific augmentation strategy for Keawapilau *C. longiflora*.
- Consider the need to augment the Pahole PU and seek permission if deemed appropriate.

Action Area: In

TaxonName: Cyanea longiflora **TaxonCode: CyaLon**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kapuna to West Makaleha	Manage for stability	23	27	0	28	8	0	0	20	0	28	28	0	Additional mature and immature plants were observed in known sites
Pahole	Manage for stability	30	52	13	49	39	14	0	0	0	49	39	14	Additional mature and immature plants were observed in known sites
	Total for Taxon:	53	79	13	77	47	14	0	20	0	77	67	14	

Action Area: Out

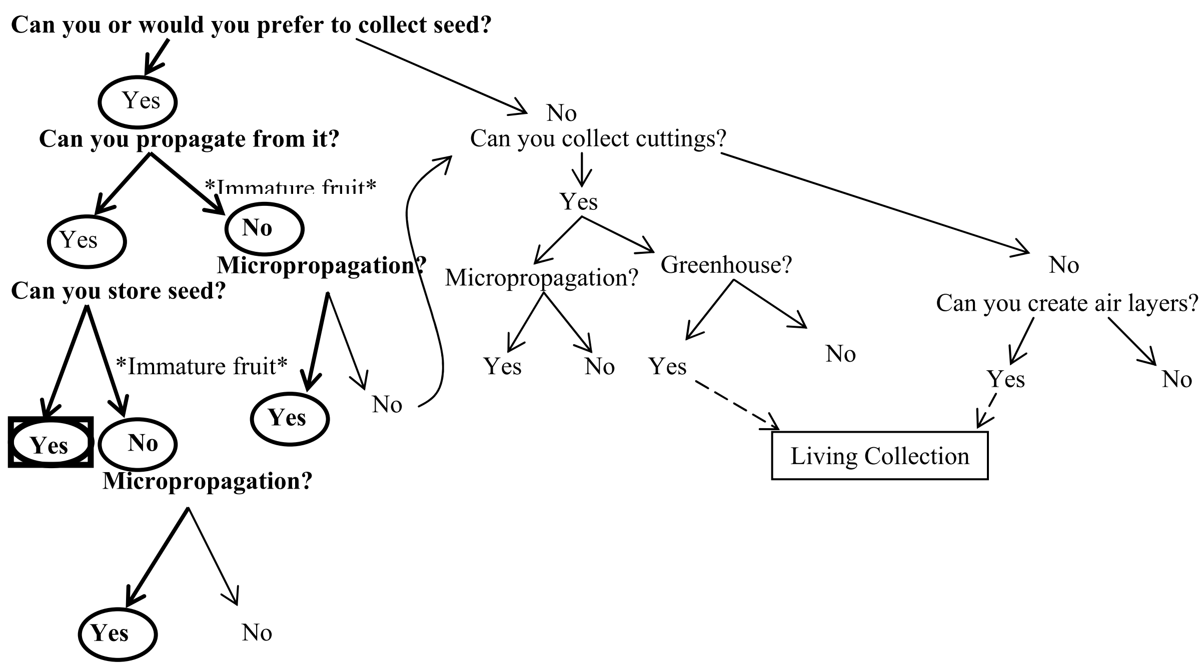
TaxonName: Cyanea longiflora **TaxonCode: CyaLon**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha and Waianae Kai	Manage for stability	3	8	2	3	6	4	0	0	0	3	6	4	Small changes were observed in the smaller size-classes
	Total for Taxon:	3	8	2	3	6	4	0	0	0	3	6	4	

Propagation and Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	No	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: For good germination, fruit must be collected when seeds are mature. Fruit progress from purple to red to orange. At seed maturity, the outside flesh of the fruit should be orange.

Propagation: Seeds germinate on 1% water agar. Initial viability varies between plants and it ranges from 68-100%. For a few collections initial germination was low, but this seems to be attributed to extent of maturity at time of collection and not to specific plants.

Seed Storage: Seeds were collected in October 2004 and August 2005 for storage testing. Until results indicate otherwise, banked seeds are stored refrigerated at 20% relative humidity, as this condition was determined most successful for all other tested species of *Cyanea.* Initial viability is high and no special germination treatments are required. Seedlings are easily transferred from Petri dishes in agar to pots in 50:50 perlite/vermiculite.

Genetic Storage: The Micropropagation Lab has been successful in germinating and maintaining stock in tissue culture and should be utilized if immature fruit needs to be collected. Plants have been successfully removed from culture and propagated. Tip cuttings taken from these plants have become re-established in tissue culture. Over 106,000 seeds have been banked in the Seed Conservation Lab from 35 out of 39 founders from all three PUs.

Mature fruit of *Cyanea longiflora*

Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Cyanea longiflora							
Kapuna to West Makaleha	28	8	0	9	2	2	8
Makaha and Waianae Kai	3	6	1	3	0	0	2
Pahole	49	39	1	27	1	3	27
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				39	3	5	37

Unique Species Observations

Several *C. longiflora* populations in Keawapilau seem to exhibit fluctuations of fruiting times. Past collection records show fruit maturing as early as June, and as late as the end of September. Reproduction of *C. longiflora* should be monitored each year, from June through September to maximize genetic storage collections.

Outplanting Issues

In February 2005, NRS outplanted 23 immature *C. longiflora* to augment the Kapuna to West Makaleha PU. So far 20 have survived. They were planted into a small pre-existing exclosure and two of the three nearby wild plants were used as founders. The size of the plants may have been a little smaller than ideal and in the future larger plants will be out-planted. Weed control continues at in this exclosure (see Chapter 2).

Founders Represented in Outplantings

TaxonName: Cyanea longiflora **TaxonCode: CyaLon**

Total Num Plants based upon Plants that have been numbered

PopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Kapuna to West Makaleha	Manage for stability	36	2
Makaha and Waianae Kai	Manage for stability	10	0
Pahole	Manage for stability	89	0
	Total for Taxon:	**135**	**2**

Number of Founders = Number of Mature, Immature, and Dead founder plants.
Number of Founders Represented = Number of founder plants represented in reintroductions.

Research Issues

Ongoing research on slug control will help to develop techniques to combat invertebrate threats to this taxon (see Chapter 6).

Taxon Threats

No additional threats have been noted in the last year. The same suites of threats cited in last year's report still apply.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Cyanea longiflora

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kapuna to West Makaleha	Manage for stability	Partial	Partial	Partial
Pahole	Manage for stability	Yes	Partial	No

Action Area: Out

TaxonName: Cyanea longiflora

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Makaha and Waianae Kai	Manage for stability	No	No	No

Manage for Stability PUs:

Pahole: This year NRS monitored and counted 45 mature plants, 39 immature plants and 14 seedlings. This population appears healthy, with plants of all size classes present. Where plants remain, the habitat is dominated by native species, and requires minimal weed control. Weed control at this site is ongoing, and NRS will continue to visit the area biannually. NRS plan to work with the NARS Specialist to collect fruit from all of the remaining plants next year. So far, over 50,000 seeds were collected from 14 individuals in Pahole. In order to expand the spread of this taxon in Pahole Gulch, NRS will pursue augmentations in our next NARS permit application.

Kapuna to West Makaleha: This PU encompasses three gulches: Kapuna, Keawapilau and West Makaleha. In the last year, NRS have monitored all known sites in this PU and collected from all the founders that produced fruit. This PU will be augmented with stock grown from these collections once adequate habitat is fenced. In the coming year, NRS will work with the NARS Specialist and the fence contractor to finish the fences in Kapuna and Keawapilau. This will not only provide much needed protection for the remaining wild plants, but also provide many sites for outplanting. The wild plants in the West Makaleha portion of this PU are not directly threatened by ungulates however the surrounding habitat is not yet secure. The West Makaleha fence is planned for year four of the MIP, and will secure much habitat and many adequate planting sites. A new founder from the West Makaleha site flowered this year and NRS will collect from this and any other founders in the coming year.

Reintroduction plan for the Kapuna to West Makaleha PU

Site	Stock to be used	Number of Founders	Number of plants per founder	Total number of plants for the site
Kapuna	Keawapilau	6	~10	~60
West Makaleha	West Makaleha	3	10	30

Mākaha and Wai‘anae Kai: The CDUP has been acquired for construction of the small exclosure to protect all but one mature plant in this PU. After completion, weed control will be conducted with care not to increase light levels in the understory. Augmentation will be pursued if the site is deemed safe from vandalism from neighboring hunting area users.

3.1.7 *Cyanea superba* subsp. *superba*

Requirements for Stability:

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

How many of the 4 MFS PUs with stable numbers of mature individuals?	How many of the 4 MFS PUs with stable structure?	How many of the 4 MFS PUs with full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions are complete?
2/4	0/4	1/1 (only one)	2/4	0/4

Taxon Level Discussion

As with other MIP taxa, NRS staff have determined that a fourth MFS PU is needed to meet stabilization goals. The primary reason for a fourth MFS is that all wild individuals are now dead and a fourth MFS PU offers far less risk than three MFS PUs given that all four MFS PUs will be established solely by reintroductions.

Major Highlights/Issues Year 2

- NRS began propagation for reintroduction in Mākaha.
- NRS are treating each of former NARS staff Bill Garnett's two outplantings in the NAR as separate founders. The goal is to maximize the possible genetic diversity by propagating from as many individuals as possible to meet targets. A total of four founders result from this decision.
- The last remaining F_1 individual from founder MMR-A-2 is flowering in the wild and NRS anticipate fruit collection this winter. This will be the first seed available from this founder for storage and eventual reintroduction.
- NRS are considering reintroducing staggered age classes by staggering propagation times.

Plans for Year 3

- NRS plan to begin seed plot experiments to investigate methods of controlling slug predation on seedlings.
- NRS plan to continue collection, propagation, and reintroduction efforts with the eventual goal of establishing balanced populations with the greatest possible genetic diversity.

Action Area: In

TaxonName: Cyanea superba subsp. superba **TaxonCode: CyaSupSup**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki	Manage for stability	78	62	0	0	0	0	99	56	0	99	56	0	Many plants have become mature in the last year and more plants were added to existing reintrodcution sites
	Total for Taxon:	78	62	0	0	0	0	99	56	0	99	56	0	

Action Area: Out

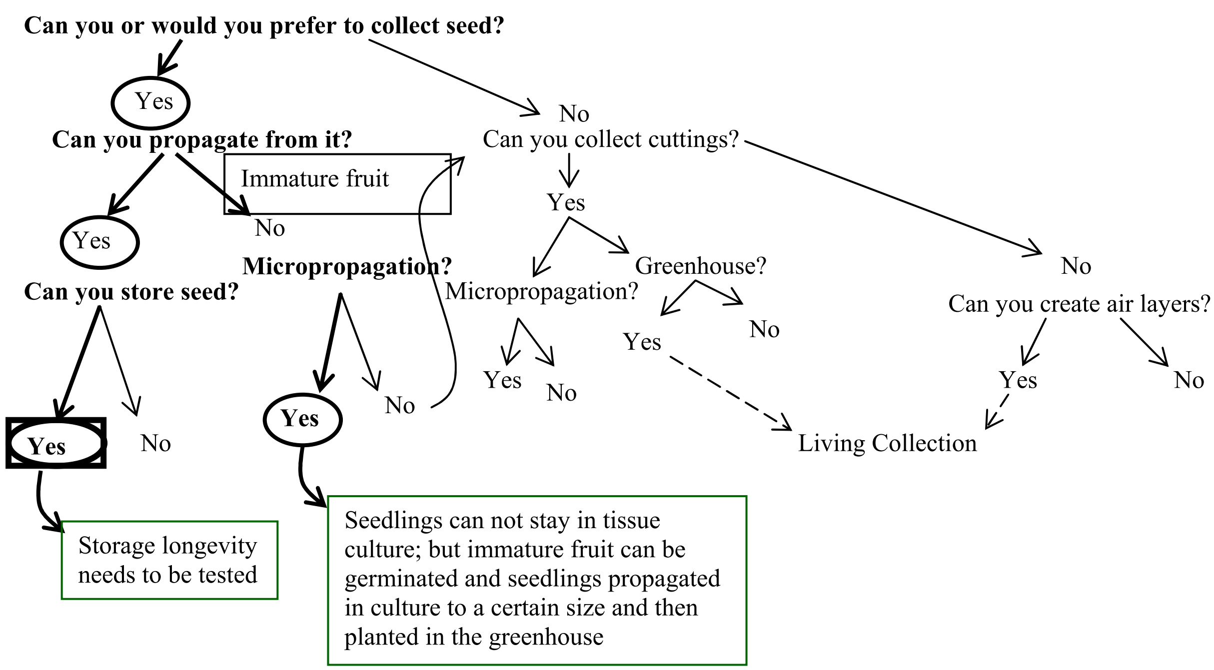
TaxonName: Cyanea superba subsp. superba **TaxonCode: CyaSupSup**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central and East Makaleha	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	0	0	0	This reintroduction will begin when the MU fence is complete
Makaha	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	0	0	0	This reintroduction will begin in the end of 2007
Pahole to Kapuna	Manage reintroduction for stability	29	148	0	0	0	0	72	84	0	72	84	0	Many of these plants became mature in the last year and some of the oldest plants were observed dead
	Total for Taxon:	29	148	0	0	0	0	72	84	0	72	84	0	

Propagation and Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	Yes	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: Collection of ripe, orange fruit is best for seed storage. Unripe seed may have a lower storage potential.

Propagation: NRS attempted to propagate this species via cuttings in the Army Nursery as well as at the Micropropagation Lab, but without success. Initial germination rates are moderate and variable, but the majority of germination rates are over 50%. Stored and fresh seeds have higher germination rates when gibberellic acid (GA3) is added to germination media ($P < 0.05$). Seedlings are successfully transferred from agar Petri dishes to perlite/vermiculite mix in pots. These potted seedlings are grown in the environment-controlled growth chamber for two months before they are large enough to transfer to the greenhouse mist bench. Plants being grown for reintroduction take about two years to reach optimum size in the greenhouse.

Seed Storage Research: Storage potential has been determined to be low for conventional storage treatments. Seeds tested after eight years of storage at room temperature and low humidity (10% RH) did not germinate. Seeds tested after five years of storage at refrigeration and 20% RH had 44% germination. However, testing this year determined that seeds stored for five years refrigerated at higher moisture levels had 75% germination. Seeds may have intermediate storage behaviors and might not tolerate low moisture levels in addition to freezing temperatures. Currently, the preferred storage condition is 4C and 33% RH. Further tests will help determine the optimal moisture level at this temperature. Until results from 4C / 33% RH are replicated and retain high germination rates, seeds from outplanted individuals should be collected once every three years in order to keep viable seed in the seedbank.

Genetic Storage: Due to lack of success from cuttings or subculturing seed material via micropropagation, seed is the preferred genetic storage method. Based on prior storage tests, seeds will be collected for genetic storage as well as for additional tests to determine the optimal storage condition for this taxon. NRS plans to collect this year from reintroductions for extensive seed storage testing.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Cyanea superba subsp. superba							
Kahanahaiki	0	0	6	3	3	2	3
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				3	3	2	3

The first group of about 20 plants grown at the Pahole Mid-elevation Nursery and outplanted by Bill Garnett into Kapuna Gulch were from an unknown lineage. The second group of plants came from collections from the Mākua plants in the Kahanahāiki PU starting in 1997. Since then, seed was collected from 3 founders (MMR-A-2, MMR-A-3 and MMR-A-4). Of about 360 plants that were reintroduced from these wild collections, only one plant was from MMR-A-2, while 60 were grown from MMR-A-3 and 295 from MMR-A-4.

Although lineage data was not available for the stock NARS staff used to establish two Kapuna reintroductions, genetic results indicate that stock collected from the Kahanahāiki PU is practically identical to stock from the Kapuna reintroductions. All the outplantings are extremely valuable as they came from collections from wild plants. In order to attribute all the existing reintroduced plants to a genetic founder NRS has treated the reintroduced Kapuna stock as if it were from one additional founder from the Kahanahāiki plants (MMR-A-10). The stock in the two Kapuna reintroductions will be represented as though it came from a single separate Kahanahāiki collection.

Outplanting Issues

Reintroductions will be designed to balance the four Kahanahāiki founders. NRS will continue to balance the existing reintroductions in the Kahanahāiki and Pahole PU with stock from all available founders. However, there is no wild collected stock available from two of the four original founders to balance these sites. For these two founders, F_2 plants will be used so that the first two sites will be established with both F_1 and F_2 plants. The other two sites will be established with all F2 stock grown from the first two reintroductions. These F_2 plants will be grown from as many reintroduced F_1 founders as possible.

Below is a table showing how the original founders can be used to select the necessary stock for balancing founders at existing sites and establishing a new reintroduction site at Mākaha using all four founders.

Original Founder	Current representation:	Plan to balance existing sites:	Makaha Reintroduction site: Goal of 100 plants using 25 individuals from each founder
MMR-A-2	Single F_1 planted in Kahanahāiki in 2005 will be collected this year for the first time	Use seed from the single F_1 plant to balance one site in each of the Pahole and Kahanahāiki PUs with F_2 plants	Use 25 seeds from single reintroduced F_1 plant
MMR-A-3	52 F_1 plants in Pahole and Kahanahaiki	Now germinating seeds from the wild that were stored at Lyon	Use 1-2 seeds each from 19 different F_1 plants in Kahanahāiki and Pahole
MMR-A-4	160 F_1 plants in Pahole and Kahanahāiki	Now germinating seeds from the wild that were stored at Lyon	Use 1-2 seeds each from 19 different F_1 plants in Kahanahāiki and Pahole
MMR-A-10	19 F_1 plants in Kapuna	Now germinating seed from the 19 F_1 plants to balance one site in each of the Pahole and Kahanahāiki PUs with F_2 plants	Use 1-2 seeds each from 19 different F_1 plants in Kahanahāiki and Pahole

Additional outplanting issues are summarized below:

- Given the infeasibility of backcrossing pollen from F_1 to founders, the maximum number of F_1 founders should be used to provide the seed stock for future F_2 reintroductions.
- The propagation material selected for the Makaleha reintroduction will follow the same selection process as outlined in the table above for the Mākaha population
- Given the very low amount of genetic variation, F_2 individuals at existing sites are not expected to differ significantly from F_1 individuals.
- Reintroductions that have only F_1 stock from one founder have value as 'safety net' sites in case other reintroductions fail as living collections of unmixed stock. These sites also provide propagule material for slug control research and offer more data on life history.
- The MMR-A-10 site may be mixed in the future as feasible after the establishment of other balanced reintroductions.

In addition to the Army's efforts with this taxon, the State of Hawai'i has reintroduced this taxon with success into the Pahole NAR over the last ten years and TNC has also conducted reintroductions at two sites using excess planting material.

Founders Represented in Existing and Proposed Sites in the Four MFS PUs

TaxonName: Cyanea superba subsp. superba **TaxonCode: CyaSupSup**

Total Num Plants based upon Plants that have been numbered

PopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Central and East Makaleha	Manage reintroduction for stability	0	0
Kahanahaiki	Manage for stability	6	4
Makaha	Manage reintroduction for stability	0	0
Pahole to Kapuna	Manage reintroduction for stability	0	0
	Total for Taxon:	**6**	**4**

Number of Founders = Number of Mature, Immature, and Dead founder plants.
Number of Founders Represented = Number of founder plants represented in reintroductions.

Research Issues

Research on the impact of slugs on this taxon is ongoing. NRS plan to further explore the impact of slugs by doing experimental seed plots with *C. superba* in the winter of 2006-2007. See discussion in the Research section.

Surveys

No surveys were conducted in the last year and no new plants were found.

Taxon Threats

No new threats have been determined for this species.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Cyanea superba subsp. superba

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki	Manage for stability	Yes	Yes	Partial

Action Area: Out

TaxonName: Cyanea superba subsp. superba

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Central and East Makaleha	Manage reintroduction for stability	No	No	No
Makaha	Manage reintroduction for stability	No	No	No
Pahole to Kapuna	Manage reintroduction for stability	Partial	Partial	No

Manage for Stability PUs:

Kahanahāiki: In the coming year, NRS will collect from as many founders as possible and continue all other ongoing management. This is the first year that the single progeny of MMR-A-2 will produce fruit. This site will be augmented with stock grown from the unrepresented founders in the next two years.

Pahole to Kapuna: Since 2001, 136 plants grown from Kahanahāiki stock were planted at one site in Pahole gulch. Survivorship is 55% and there are now at least 39 mature plants and 34 immature plants. NRS controlled weeds in this area in the last year. This site will be augmented with stock grown from the unrepresented founders in the next two years and collections of mature fruit will be made this year for storage and propagation.

There are two sites with reintroduced *Cyanea superba* in Kapuna Gulch. At least 33 of these plants are mature and there are 10 additional immature plants. NARS staff originally outplanted into these sites in 1997 and 1998. NRS supplemented the sites in 2001 with stock from more recent Kahanahāiki collections. Collections of mature fruit will be made this year for storage and propagation.

Other PUs:

Mākaha: Stock for this reintroduction is being germinated. The fence will be built in the coming year and NRS will begin this reintroduction in the winter of 2007 pending complete ungulate removals. A site needs to be chosen and NRS will work with Joel Lau to determine the most appropriate area.

Central and East Makaleha: No reintroductions will begin until the MU fence is built.

Honouliuli: As with other MIP and OIP taxa planted by TNC staff at Honouliuli, outplanting sites will continue to be maintained by remaining TNC staff with assistance by NRS as feasible.

3.1.8 *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

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have stable structure?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
2/3	2/3	0/3	1/3	0/1

Taxon Level Discussion

This taxon has stable numbers at Wai‘anae PUs. The Ko‘olau PU is not stable but will be included in the Lower ‘Ōpaeula MU fence that should be built in the next year. Based on recommendation from NARS staff, NRS began genetic storage collections this year within the Pahole NAR. No significant changes have occurred for this taxon in the last year.

Major Highlights/Issues Year 2

- Collections in Pahole NAR initiated.
- Initiated license agreement process for work at the Lower ‘Ōpaeula MU.

Plans for Year 3

- Complete Upper Kapuna fencing after State of Hawaii fence contractor finished their portion.
- Construct Lower ‘Ōpaeula fence after environmental paperwork completed.
- Establish collections from the Kawai‘iki and ‘Ōpaeula PUs as there is currently no representation ex situ.
- Continue genetic storage collections in the Kahanahāiki and Pahole PUs.

Action Area: In

TaxonName: Cyrtandra dentata **TaxonCode: CyrDen**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki	Manage for stability	156	57	27	156	57	27	0	0	0	156	57	27	Monitoring showed no change in the last year
Pahole to Kapuna to West Makaleha	Manage for stability	488	470	174	530	517	171	0	0	0	530	517	171	A thorough census of a few more sites increased estimates in the last year
	Total for Taxon:	644	527	201	686	574	198	0	0	0	686	574	198	

Action Area: Out

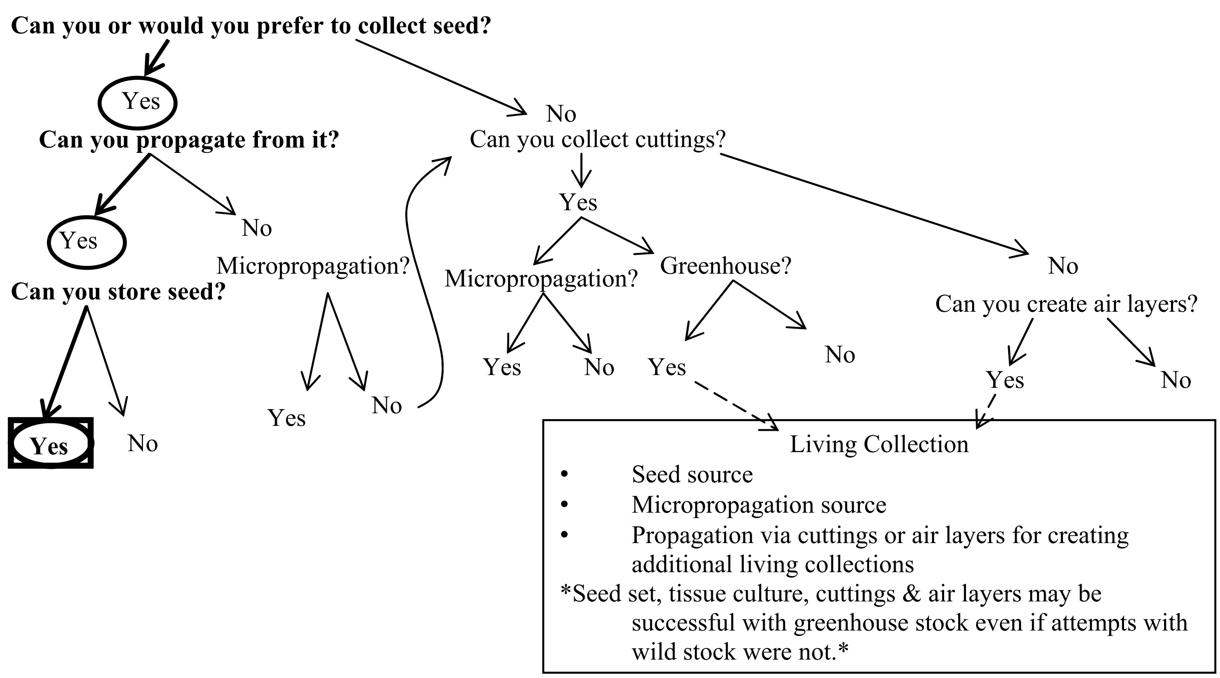
TaxonName: Cyrtandra dentata **TaxonCode: CyrDen**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kawaiiki (Koolaus)	Genetic Storage	19	35	43	19	35	43	0	0	0	19	35	43	No monitoring in the last year
Opaeula (Koolaus)	Manage for stability	16	12	0	16	12	0	0	0	0	16	12	0	No monitoring in the last year
	Total for Taxon:	35	47	43	35	47	43	0	0	0	35	47	43	

Propagation and Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	No	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: Fruit are collected when they are white but starting to brown and are softening and not very firm. Collection of mature fruit for this taxon is critical for optimal seed storage longevity.

Propagation: Initial germination rates are high, 75-100%, and germination is complete within one month. Seedlings are easily transferred from agar Petri dishes to perlite/vermiculite mix topped with grated moss.

Seed Storage Research: Seed studies began in 2003 and two collections have been tested after two years of storage. Seeds can be stored dry at 4C or -18C for at least two years with no decrease in viability. Soil seed bank tests indicate seeds can form persistent soil seed banks for at least two years.

Genetic Storage: Based on seed storage results and IT recommendations, NRS increased collection efforts this year in two of the four PUs. Collections are currently ongoing. NRS will collect from this taxon when convenient over the next year.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Cyrtandra dentata							
Kahanahaiki	156	57	0	9	0	0	9
Kawaiiki (Koolaus)	19	35	0	0	0	0	0
Opaeula (Koolaus)	16	12	0	0	0	0	0
Pahole to Kapuna to West Makaleha	518	487	0	19	0	1	20
				Total # Plants w/ >=10 Seeds in Seedbank	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
				28	0	1	29

Unique Species Observations

Leaf shape and sepal width varies between populations. Also, this taxon very closely resembles other *Cyrtandra* species, as well as hybridizes with other species in this genus. Therefore, collections are only made from positively identified *C. dentata.*

Research Issues

There are no new issues for this taxon. Slug research continues to be pursued, (see Chapter 6).

Surveys

Surveys and genetic storage collections were conducted by NRS in Keawapilau, Kapuna and Pahole (see Genetic Storage).

Taxon Threats

No new threats have been observed to this taxon.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Cyrtandra dentata

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki	Manage for stability	Yes	Yes	Partial
Pahole to Kapuna to West Makaleha	Manage for stability	Partial	Partial	No

Action Area: Out

TaxonName: Cyrtandra dentata

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kawaiiki (Koolaus)	Genetic Storage	No	No	No
Opaeula (Koolaus)	Manage for stability	No	No	No

Manage for Stability PUs:

Kahanahāiki: Plants in this PU continue to thrive. The MU remains ungulate free. NRS conducted weed control in the vicinity of *C. dentata* in the last year. Genetic storage collections were also made by NRS.

Pahole to Kapuna to West Makaleha: The plants in the Pahole gulch fenced portion of this PU continue to thrive and recruit vigorously. The MU remains ungulate free. Some weed control conducted for other rarer taxa in the last year also benefited *C. dentata*. Surveys were conducted by NRS in Kapuna and Keawapilau, and genetic storage collections were made from 36 plants.

‘Ōpaeula: There is no new information for this PU. NRS made a trip to the ‘Ōpaeula area in the last year for *Melicope lydgatei* surveys, but did not concentrate effort on *C. dentata*. NRS will establish collections from this PU in the next year.

Other PUs:

Kawai‘iki: NRS did not visit this site in the last year. NRS will establish collections from this PU in the next year.

3.1.9 *Delissea subcordata*

Requirements for Stability:

- 4 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

How many of the 4 MFS PUs have stable numbers of mature individuals?	How many of the 4 MFS PUs have stable structure?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
1/4	0/4	4/4	¾	0/4

Taxon Level Discussion

There are four PUs that are designated as MFS for this taxon because it is known from within the Action Areas (AA) of both Mākua and SBMR. Three of the MFS PUs are outside the AA of both installations and one is in the AA. NRS has proposed that the Pālāwai PU be selected as the fourth MFS PU. All PUs are being monitored and collected as this taxon is very rare and continues to decline in numbers. NRS and NARS have been successful in establishing genetic storage collections of seeds from all PUs with extant founders. This taxon does show occasional recruitment at wild and reintroduction sites. It is also possible this species has a persistent seedbank. Three MFS PUs have been augmented and outplanting has been successful. The largest threats to *Delissea subcordata* are pigs and goats. In addition, slugs are a threat to this taxon. Although declining, this taxon seems to survive in fairly weedy forest dominated by *Schinus terebinthifolius* and *Psidium cattleianum*.

Major Highlights/Issues Year 2

- Fence construction has begun in the Kahanahāiki to Keawapilau PU.
- Plants germinated for large scale reintroduction in the Kahanahāiki to Keawapilau PU.
- Storage goals met for 5 of 9 PUs from mature founders.

Plans for Year 3

- Pursue the genetic testing results on the Kahanahāiki plant to determine if it is a F_1 from the reintroduction or from a historic population.
- Establish an augmentation in the Kahanahāiki to Keawapilau PU using stock collected from several founders in Pahole and Kapuna.
- Establish a reintroduction of the Palikea stock into Pahole gulch as directed by NARS.
- Establish a reintroduction of the Manini Gulch stock into Kaluakauila gulch.
- Continue to supplement the ʻĒkahanui PU to balance founders.
- Collect mature seed from the additional Mohiākea founder that is in the greenhouse.

Action Area: In

TaxonName: Delissea subcordata **TaxonCode: DelSub**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki to Keawapilau	Manage for stability	25	1	0	4	0	0	18	0	0	22	0	0	One wild plant in Kapuna and a few outplanted plants have died
South Mohiakea	Genetic Storage	1	0	0	1	1	0	0	0	0	1	1	0	One new immature plant observed
	Total for Taxon:	26	1	0	5	1	0	18	0	0	23	1	0	

Action Area: Out

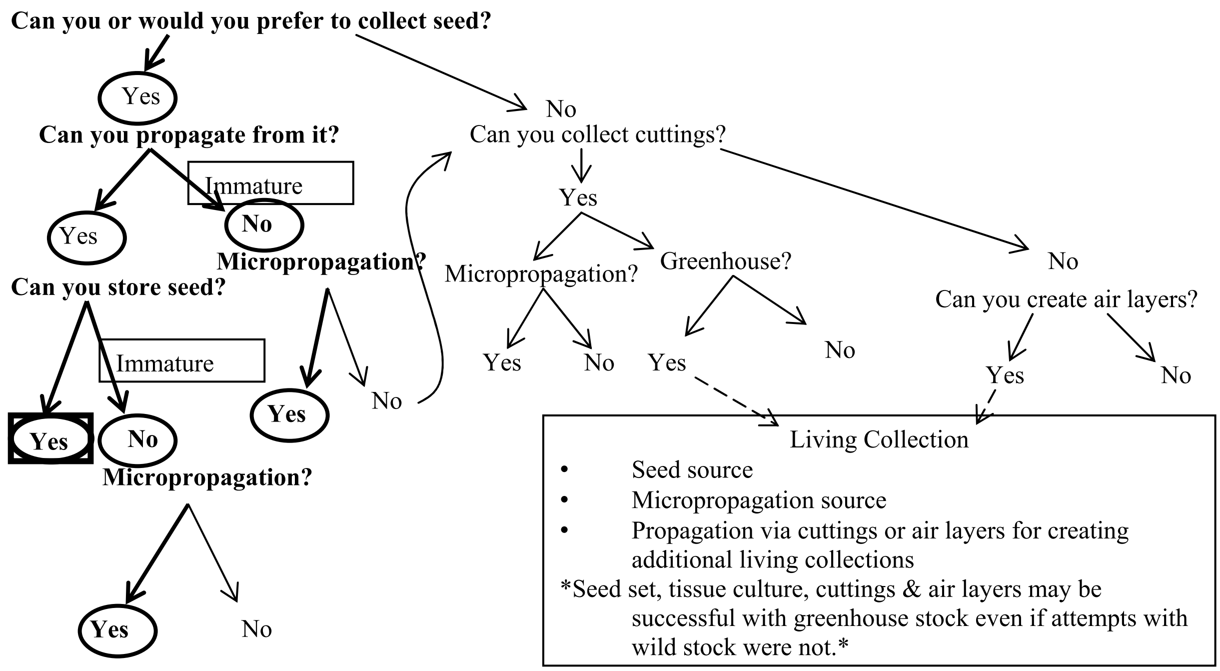
TaxonName: Delissea subcordata **TaxonCode: DelSub**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ekahanui	Manage for stability	85	0	0	4	0	0	109	0	0	113	0	0	No change in wild plants and an additional 28 were outplanted
Huliwai	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No observations in the last year
Kaawa	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No observations in the last year
Kaluaa	Manage for stability	35	1	0	1	0	11	27	0	0	28	0	11	A few plants in the augmentation have died and seedlings were observed in one outplanting site
Kealia	Genetic Storage	2	0	0	2	0	0	0	0	0	2	0	0	NARS observations show no change in the last year
Palawai	Manage for stability	2	3	0	5	0	0	0	0	0	5	0	0	The immature plants from 2005 matured in the last year
Palikea Gulch	Genetic Storage	1	0	0	2	0	0	0	0	0	2	0	0	One plant thought to be dead was relocated in the last year
	Total for Taxon:	125	4	0	14	0	11	136	0	0	150	0	11	

Propagation & Genetic storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	No	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: Fruit should be collected when none of the outside flesh is green. Coloring of outside flesh of mature fruit varies among populations from tan with pink/purple lines or patches to entirely dark purple. The number of seeds per fruit also drastically varies, from zero to over 250 seeds. Casual observations at the Seed Conservation Lab suggest that large fruit generally have a low number of seeds; while small to medium size fruits have a larger number of seeds. This applies to both wild-collected and greenhouse-collected seeds.

Propagation: Seeds germinate well in flats on vermiculite and perlite. Initial germination rates on agar during the seed storage trials at the Seed Conservation Lab were around 90%. It is also possible to grow plants from cuttings; however, plants usually have only one growing point, so cuttings are not the preferred method of propagation unless the parent plant is multi-branched or needs to be salvaged. Mature and immature fruit have been propagated at the Micropropagation Lab and seedlings can be subcultured indefinitely.

Seed Storage: Due to the efficiency and success of collections and storage, seed storage is the preferred method of genetic storage. Three different temperatures at two different relative humidity (RH) levels each have been tested for five years. Results indicate 4C (refrigeration) at around 20% RH yields the highest percent germination, while seeds that were frozen drastically lose viability after one year. Seeds can be stored for at least five years in refrigeration with little to no decrease in viability. Some of the older collections do not have high germination. All of these had been stored for some extended period of time (> one year) at -18C.

Genetic Storage: Extensive seed collection efforts have been made for this taxon from both wild plants and reintroduced plants (if founder is dead). The majority have reached genetic storage goals. Based on viability results collections for this taxon can be made every five years.

For founders, however, that are represented by only one collection and initial viability was either low or not known, NRS will re-collect earlier to make sure a viable collection is in storage.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Delissea subcordata							
Ekahanui	4	0	2	6	0	4	6
Huliwai	0	0	0	0	0	0	0
Kaawa	0	0	0	0	0	0	0
Kahanahaiki to Keawapilau	4	0	7	10	1	7	10
Kaluaa	1	0	0	1	0	0	1
Kealia	2	0	0	2	0	2	2
Palawai	5	0	1	6	1	2	6
Palikea Gulch	2	0	5	5	1	5	6
South Mohiakea	1	1	3	4	0	1	4
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				34	3	21	35

Outplanting Issues

Over the last five year, about 275 plants from four PUs have been reintroduced on O‘ahu. Kapuna stock has been reintroduced into Kahanahāiki. ‘Ēkahanui stock has been used to augment the ‘Ēkahanui PU. South Mohiākea and ‘Ēkahanui stock has been reintroduced into Central Kalua‘ā by TNC. Palikea Gulch stock has been reintroduced into West Makaleha. Details on the individual outplantings are discussed below in the ‘Population Unit Level Discussions.’ All reintroductions have had at least 80% survivorship and seedlings have been observed in Kahanahāiki and Central Kalua‘ā.

In the coming year, NRS will use stock from several PUs (Pahole, Kapuna, Palikea and Ke‘ālia) to establish reintroductions and augmentations and to balance the founders at existing sites. As immature wild plants grow to maturity, the number of founders will increase.

Notably, in the ‘Ēkahanui PU, the NRS goal of balancing founders continues to be problematic given that TNC staff had planted a large reintroduction with a heavily unbalanced number of founders in the same reintroduction area. TNC goal was the reintroduction of as many plants as possible without the same emphasis on balancing founders.

At all proposed reintroduction sites, the goal remains a balanced representation of founders from each source population. For example at the proposed PAH-C reintroduction site, five source populations exist with varying number of founders at each source population. Twenty plants total from each source population will be planted at this reintroduction site. For example, two founders from the PAH-B source population exist, therefore 10 plants from one founder and 10 plants from the other founder from the PAH-B source population will be used to comprise the 20 plants total.

The following tables show stock sources at existing and proposed planting sites. It is presented here as a guide for MIT members that illustrates the process of balancing source populations.

Kaluaʻā

Stock Source for existing augmentation (KAL-C outplanting site)	# of Founders available	# of Founders currently represented at KAL-C outplanting site	Total outplants per pop ref site	Current survivorship
Mohiākea (SBW-A)	4	2	(3,25)	65%

Stock source for proposed augmentation (KAL-D outplanting site)	# of Founders available	# of Founders to be represented at KAL-D outplanting site	Target # of plants from each source population	Current survivorship
Kaluaʻā (KAL-B)	1	1	50	N/A

ʻĒkahanui

Stock Source for existing augmentation (EKA-D outplanting site)	# of Founders available	# of Founders currently represented at EKA-D outplanting site	Total outplants per pop ref site	Current Suvivorship
ʻĒkahanui (EKA-A)	4	3	(5,64,47)	95%
ʻĒkahanui (EKA-B)	1	1	4	100%
ʻĒkahanui (EKA-C)	1	1	45	93%

Kahanahāiki

Stock Source for existing augmentation (MMR-A)	# of Founders available	# of Founders currently represented at MMR-A outplanting site	Total outplants per pop ref site	Current survivorship
Kapuna (KAP-A)	3	4	(2,1,1)	69%
Kapuna (KAP-B)	1	1	6	33%

Pahole

Stock source for proposed augmentation (PAH-C)	# of Founders available	# of Founders to be represented at PAH-C outplanting site	Target # of plants from each source population	Current survivorship
Pahole (PAH-A)	1	1	20	N/A
Pahole (PAH-B)	2	2	20	N/A
Kapuna (KAP-A)	3	3	20	N/A
Kapuna (KAP-B)	1	1	20	N/A
Kapuna (KAP-C)	2	2	20	N/A

Stock source for proposed reintroduction (PAH-D)	# of Founders available	# of Founders to be represented at PAH-D outplanting site	Target # of plants from each source population	Current survivorship
Palikea (ALI-A)	1	1	5	N/A
Palikea (ALI-B)	4	4	5	N/A

Kaluakauila

Stock source for proposed augmentation (MMR-D)	# of Founders available	# of Founders to be represented at MMR-D outplanting site	Target # of plants from each source population	Current survivorship
Keālia (LIA-A)	2	2	15	N/A

Summary of Founders Represented in Outplanting

TaxonName: Delissea subcordata **TaxonCode: DelSub**

Total Num Plants based upon Plants that have been numbered

PopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Ekahanui	Manage for stability	6	5
Huliwai	Genetic Storage	0	0
Kaawa	Genetic Storage	0	0
Kahanahaiki to Keawapilau	Manage for stability	11	4
Kaluaa	Manage for stability	1	0
Kealia	Genetic Storage	2	0
Palawai	Manage for stability	6	0
Palikea Gulch	Genetic Storage	7	1
South Mohiakea	Genetic Storage	5	2
	Total for Taxon:	**38**	**12**

Number of Founders = Number of Mature, Immature, and Dead founder plants.
Number of Founders Represented = Number of founder plants represented in reintroductions.

Research Issues

For more discussion on slug impacts see the Research Section Chapter 6.

In 2005, Thomas Lammers proposed the revision of the classification of *Delissea* based on macromorphological data, both quantitative and qualitative (Lammers 2005). Lammers proposed that the southern Wai‘anae populations now be recognized as two distinct species, *D. takeuchii* and *D. waianaeensis*. The *D. takeuchii* population is presumed extinct. In the central and northern Waianae Mountains, Lammers proposes that *D. sinuata* be applied to specimens collected from Makaleha Gulch near Mt. Ka‘ala and Haili Gulch at Ka‘ena. *D. sinuata* is also presumed extinct. According to Lammers, *D. subcordata* should be strictly applied to the Ko‘olau Mountains specimens of which no extant individuals are known.

Genetic analysis of all individuals from extant and extinct populations is sorely needed to further clarify taxonomic issues and resolve NRS questions regarding the proper balancing scheme for northern, central, and southern Wai‘anae Mountain PUs.

Surveys

No surveys were conducted for this taxon in the past year. NRS will continue to look for new plants in the course of ongoing management. Exact locality information will be sought for extinct populations of newly proposed *Delissea* species in the Wai‘anae Mountains and surveys at these historic sites will be considered by NRS.

Taxon Threats

No additional threats have been noted in the last year.

Population Unit Level Discussion

Action Area: In

TaxonName: Delissea subcordata

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki to Keawapilau	Manage for stability	Partial	Partial	No
South Mohiakea	Genetic Storage	Yes	Yes	No

Action Area: Out

TaxonName: Delissea subcordata

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Ekahanui	Manage for stability	Yes	Yes	No
Huliwai	Genetic Storage	No	No	No
Kaawa	Genetic Storage	No	No	No
Kaluaa	Manage for stability	Yes	Yes	No
Kealia	Genetic Storage	Partial	Yes	Partial
Palawai	Manage for stability	Yes	Partial	Partial
Palikea Gulch	Genetic Storage	No	No	No

Manage for Stability PUs:

NRS are considering designating the Manuwai Gulch area as a MFS PU to replace the Pālāwai MFS PU. The Pālāwai area is severely degraded and does offer the advantage of the Manuwai Gulch area which would also encompass other MIP and OIP taxa.

Kahanahāiki to Keawapilau: This PU covers four gulches on Army and State NAR lands. The sites are discussed separately below.

Kahanahāiki: Wild plants were observed in this gulch by HBMP Botanist Joel Lau in 1993, however no plants were seen when NRS began management here in 1995. Since 1999, NRS has reintroduced 31 plants into Kahanahāiki. These were grown from collections made by NARS from plants in Kapuna Gulch site. In 2000, a 15 cm. tall juvenile was discovered 100 meters from the nearest reintroduced plants. Monitored regularly, this plant is now mature and seeds from collections are stored at the Seed Conservation Lab. The origin of this single plant is still unclear. It may be an F_1 plant from the nearby reintroduction, transported to the site by a bird, or it may be a wild plant from the historic population. NRS collected leaf material from the plant for genetic analysis by Dr. Cliff Morden at the University of Hawaiʻi. NRS will treat this individual plant as unique and significant pending results from genetic analysis.

There are two reintroduction sites in Kahanahāiki Gulch, both were established with plants from within this PU. At the larger of the two sites (MMR-A) site, 16 of the 31 outplanted individuals are still alive and healthy. Seedlings were observed at this site. One F_1 plant has matured and seeds were collected in the past year. Seed were collected for storage from many plants at this site since the parental stock died at the Kapuna site. At the other site (MMR-B), six plants were planted, but only one outplant remains and is in healthy condition.

Pahole: NARS staff report that one mature plant is currently alive in Pahole. Collections were made and are in storage at Lyon. Seeds from these NARS collections are being germinated for reintroduction into Pahole this winter. Stock from three founders from this site will be mixed with four founders from Kapuna to establish an augmentation site in Pahole in the coming year.

Kapuna: There are three historic sites in Kapuna. Two plants are still living at one site and these plants will be protected by the last sub-unit of the Kapuna fence when completed. Collections of mature seeds from these two plants and as well as one plant that was observed dead in the last year at a second site are being stored at Lyon. In addition collections from plants at the Kahanahāiki reintroduction site are being stored. These reintroduced plants were grown from three founders from the third historic Kapuna site. All wild plants died by 2004 at this third historic site. Seeds from all of these collections will be used to establish an augmentation in Pahole in the coming year (see above tables).

ʻĒkahanui: There are currently four living wild mature plants at two sites. NRS and TNC staff built fences around these sites in 2004. This past year, seed collections were made from two plants to reach storage goals. Both sites are highly degraded and only minimal management is done to encourage the plants to mature and produce seed for reintroduction into higher quality managed habitat. A large planting exists in the 40 acre ʻĒkahanui fence. This planting was begun in 2003 and since then TNC and NRS have planted 180 individuals from 5 of the 6 founders. As TNC goals differed from NRS staff a balancing of founders at this site may not be feasible. Seeds were collected from reintroductions for storage. NRS will continue to monitor the wild and reintroduced plants at these sites and collect seeds for storage and future outplantings. This site will be supplemented in the coming years with additional plants to ideally balance the number of founders as feasible.

Kaluaʻā: One plant was discovered in this site in 2003. In the past year NRS were able to collect fruit from this plant for the first time since discovery. Previously, the buds aborted before flowering. 11 large seedlings are also growing at this site and collections will be made as these plants hopefully reach maturity. The seeds collected this year will be reintroduced with South Mohiākea stock into the Kaluaʻā reintroduction sites. Weed control continues to be conducted at the reintroduction site in Kaluaʻā.

Pālāwai: Fences are being maintained around all plants at two sites in Pālāwai. Collections were secured from all of the six founders in this PU. These collections were made from five of the six plants from the wild and the remaining founder is represented with seeds collected from greenhouse plants grown from the wild founder. Weeds are controlled at one site with native components. The other site is dominated by *S. terebinthifolius* weeds are controlled only 2 m around the plants. NRS will be developing an augmentation strategy to stabilize this PU in the coming year.

Other PUs:

South Mohiākea: There is currently one mature and one immature plant in this PU. In January 2005, one mature and four small immature plants are at the site. NRS monitored the PU again in April 2006. Along with the one mature plant, only one much larger immature plant was observed, the other 3 immatures are presumed dead from unknown causes. NRS are controlling weeds within the small exclosure protecting this PU. Collections of mature seed were made from four founders and stored at Lyon. Stock from this PU was been planted into Kalua‘ā.

Huliwai: The HBMP Botanist monitored this site in 2004, and no plants were found. The habitat is severely degraded by weeds and ungulates. No stock from this PU remains.

Ka‘awa: NRS and the HBMP Botanist surveyed the historic location for this species in 2004 and 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 it will not be a target for management. The habitat at this site has been heavily impacted by feral ungulates.

Palikea Gulch: Two mature plants are left in this PU at two separate sites. Both sites were monitored in the last year. Neither site is protected by a fence and pigs are a noted threat at both. Mature seed has been collected for storage and germination by NARS and NRS from both sites in the past. Stock from this location is currently represented in a reintroduction in the West Makaleha exclosure. In the coming year, NRS will work with NARS to establish another planting with this stock.

Ke‘ālia: NRS have never visited this site as NARS Specialist Talbert Takahama is handling the collections from this site. NRS requested permission from the State to fence the site but were asked to wait until the land changes from unencumbered land to Forest Reserve in the near future. Seed from this stock was germinated for a reintroduction planned for Kaluakauila in winter 2006-2007.

West Makaleha*:* Twenty plants from Palikea gulch stock were planted inside the small West Makaleha exclosure in January 2003. Rat and slug predation has been a problem at this reintroduction site and a number of the outplants died possibly due to poor soil conditions for this species. Some of the Palikea founders represented in this reintroduction are now extirpated so the seed from reintroduced plants is valuable for genetic storage. Collections of mature seeds were made in the last year for this purpose. The West Makaleha site will not be supplemented because the site is not in preferred *D. subcordata* habitat.

Rat control was initiated in May 2003 after rat damage was found on wild *Cyanea grimesiana* plants within the same exclosure. Bait stations and snap traps are maintained approximately every six weeks (see table below). Baiting was suspended in mid-February 2006 when two piglets were observed within the exclosure. One piglet was removed and the other was able to pass back through the bottom of the fence. Additional skirting was added to the fence and baiting resumed at the end of April 2006. There was no damage to the *D. subcordata* by the piglets or rats during the suspension of rat baiting.

West Makaleha *Delissea subcordata* Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2003	5	80	30	38%	0	0	2
2003-2004	5	640	336	53%	12	10	8
2004-2005	5	660	228	35%	15	10	10
2005-2006	5	486	355	73%	23	10	7

Despite the high bait take and snap trap rates, D. subcordata plants are not being predated by rats. A larger rat population is presumed given a higher food availability following the March 2006 rains. If any predation of wild or outplanted plants occurs, baiting and snap trapping efforts will increase.

3.1.10 *Dubautia herbstobatae*

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

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have stable structure?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
2/3	2/3	0/3	3/3	0/0

Taxon Level Discussion

The ʻŌhikilolo Mauka and Makai PU's both have stable numbers of reproducing individuals, whereas the the Mākaha PU currently has 36 known reproducing individuals. The Mākaha PU currently has 36 known reproducing individuals. However, with more surveys an acceptable stable population number may be reached. NRS will assess the threats to this population to see if they can be mitigated to achieve population stability. Augmentation may also be considered, once threats have been assessed. The remaining PUs will be managed for genetic storage. NRS believe that with management, stability is attainable for this taxon.

Major Highlights/Issues Year 2
- Conducted pollination study to determine importance of cross pollination and the degree of self incompatability within the taxon.

Plans for Year 3
- In the coming years, NRS will continue to survey for new plants, particularly in the Mākaha PU and refine the counts.
- Assess threats to the Mākaha PU to determine whether stability can be attained through threat mitigation.
- Consider augmentation in the Mākaha PU.

Action Area: In

TaxonName: Dubautia herbstobatae **TaxonCode: DubHer**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Keaau	Genetic Storage	70	0	0	70	0	0	0	0	0	70	0	0	Monitored in the last year and population appears stable.
Makaha/Ohikilolo	Genetic Storage	350	0	0	350	0	0	0	0	0	350	0	0	No monitoring in the last year
Ohikilolo Makai	Manage for stability	357	0	0	358	0	0	0	0	0	358	0	0	One additional plant observed
Ohikilolo Mauka	Manage for stability	328	20	0	382	6	0	0	0	0	382	6	0	A thorough census of one known site found more plants
	Total for Taxon:	1105	20	0	1160	6	0	0	0	0	1160	6	0	

Action Area: Out

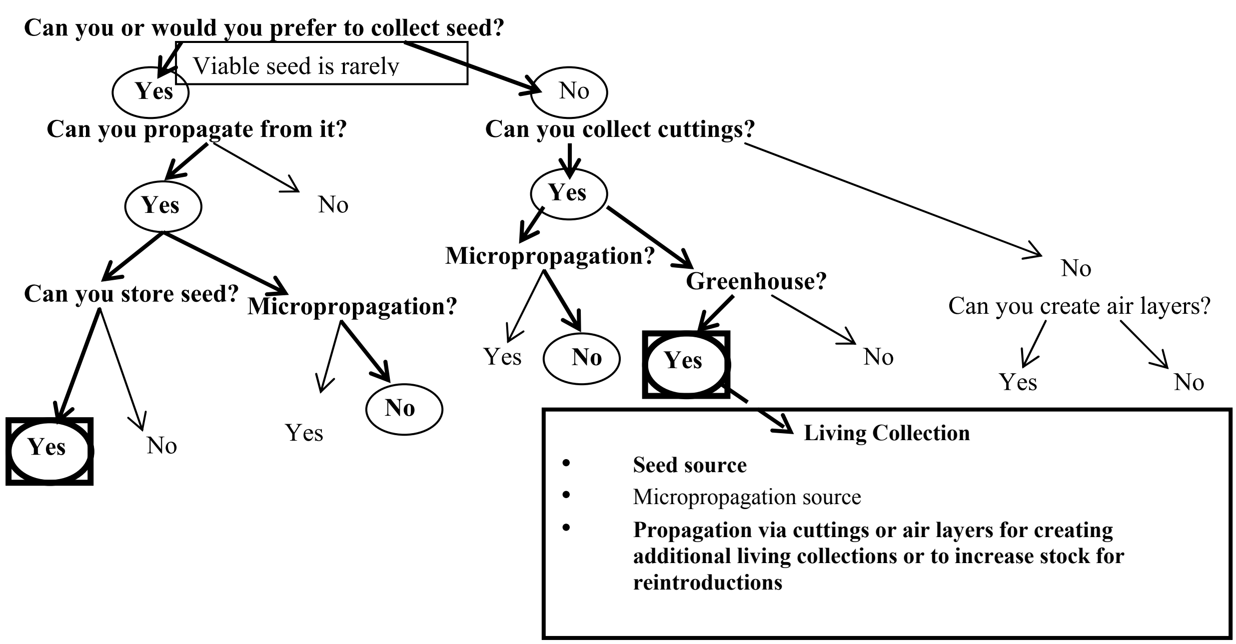
TaxonName: Dubautia herbstobatae **TaxonCode: DubHer**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kamaileunu	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring since 2001
Makaha	Manage for stability	36	1	0	36	1	0	0	0	0	36	1	0	No monitoring in the last year
Waianae Kai	Genetic Storage	10	4	0	10	4	0	0	0	0	10	4	0	No observations in the last year
	Total for Taxon:	46	5	0	46	5	0	0	0	0	46	5	0	

Propagation and Genetic Storage

At this time, what is the best preferred propagation technique?	At this time, what is the preferred genetic storage technique?	Is more genetic storage testing needed?	Are additional steps required for obtaining enough seed?
Cuttings	Seed & Living Collection	No	Yes, pollination studies to determine if seed set will increase

Prioritizing Genetic Storage & Propagation Techniques



Collection: Collections are difficult to obtain from this species because all sites are located on tall cliffs and this taxon does not produce fruit year round. Seeds have low viability, and most collections usually contain few to no viable seed (see Research Section for pollination study). Mature achenes are grey and should be loosely held within the head. Due to low numbers of viable seeds and difficulty in accessing plants, NRS is propagating this species from cuttings. NRS will continue to collect cuttings to be grown *ex situ* as a living collection for seed production studies.

Propagation: Cuttings from wild plants are very successful in the greenhouse. Cuttings were taken to the Micropropagation Lab to determine the viability of tissue culture as an alternate storage option for this species, but none could be established. Initial viability of seed collected from a 1999 ‘Ōhikilolo Mauka collection was 23%.

Seed Storage Research: Seed collected in 1999 from the ‘Ōhikilolo Mauka PU had high enough viability to undergo storage testing. Three temperatures have been tested and seeds stored refrigerated and frozen show no decrease in viability after two years and a 5% decrease in viability from initial germination after five years.

Genetic Storage: Due to the success of cuttings, the living collection will be maintained in the nursery for founders from the Mākaha and Wai‘anae Kai PUs. Hand-pollination attempts will continue to determine if good seed set can be achieved, since seeds can most-likely be stored. A seed collection from 12 Mākaha founders is currently in seed storage, but viability is unknown and some appeared empty as well as filled. If seed storage is not an option, and tissue culture results do not change, NRS will continue to propagate via cuttings.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Dubautia herbstobatae							
Kamaileunu	0	0	1	1	0	1	1
Keaau	70	0	0	0	0	0	0
Makaha	36	1	0	12	0	2	10
Makaha/Ohikilolo	350	0	0	1	0	0	0
Ohikilolo Makai	358	0	0	0	0	0	0
Ohikilolo Mauka	382	6	0	1	0	0	1
Waianae Kai	10	4	0	3	0	6	5
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				18	0	9	17

Unique Species Observations

No unique observations were taken by NRS in the past year (see 2005 MIP report for unique obs.).

Outplanting Issues

No outplanting actions were taken by NRS in the past year. NRS are not proposing to do any reintroductions with this species at this time.

Research Issues

A pollination study using plants from the nursery living collection has been initiated this year. Last year seed was collected from Pahole Mid-elevation Nursery stock for testing and storage, but none of the seeds germinated; and none of the seeds that were collected were viable (no embryos found). At this time, all of the plants in the nursery were clones from one Mākaha founder. After consultation with Dr. Gerry Carr, emeritus professor of UH, NRS attempted selfing plants as well as making intra- and inter-population site crosses. This taxon may have a significant level of self-incompatibility, and plants that cannot receive pollen from another source may suffer from inbreeding depression and may not be able to produce viable seed (Carr pers.comm. 2006). Standard Asteraceae pollination techniques were used (Carr pers.comm. 2006, Pico & Koubek 2003, Costin *et.al.* 2001). Crosses are ongoing, but the majority of plants that flowered were from the same Mākaha founder that was studied last year. One other plant, a clone of a different Mākaha founder (different population site), had one cluster of heads flower. Of the 50 seeds collected from this cluster of heads, one seed germinated. None of the selfed flowers produced viable seeds. This study is inconclusive and will continue as plants representing new founders flower in the nursery.

Surveys

While surveying for *Tetramalopium filiforme,* NRS found 10 new mature plants in Kea‘au. NRS plan to conduct further surveys in Mākaha in the next year.

Taxon Threats

No new threats were identified this year (see 2005 MIP report for previous known threats).

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Dubautia herbstobatae

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Keaau	Genetic Storage	No	No	No
Makaha/Ohikilolo	Genetic Storage	Partial	No	No
Ohikilolo Makai	Manage for stability	Yes	No	No
Ohikilolo Mauka	Manage for stability	Yes	No	No

Action Area: Out

TaxonName: Dubautia herbstobatae

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kamaileunu	Genetic Storage	No	No	No
Makaha	Manage for stability	Yes	No	No
Waianae Kai	Genetic Storage	Yes	No	No

Manage for Stability PUs:

ʻŌhikilolo Makai and ʻŌhikilolo Mauka:

No action was taken in this PU by NRS in the past year. This PU is fenced, and protected from ungulates. NRS will continue to monitor the fence on ʻŌhikilolo ridge and keep the area goat free.

Mākaha:

No action was taken in this PU by NRS in the past year.

Other PUs:

Keaʻau:
No action was taken in this PU by NRS in the past year.

Kamaileʻunu:
No action was taken in this PU by NRS in the past year.

Waiʻanae Kai:
No action was taken in this PU by NRS in the past year.

3.1.11 *Flueggea neowawraea*

Requirements for Stability:

- 3 Population Units (PUs)
- 50 reproducing individuals in each PU (long-lived perennial, dioecious, low to no reproduction, all senescent, major pest problems)
- Threats controlled
- Complete genetic representation of all PUs in storage

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have stable structure?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
0/3	0/3	0/3	0/3	0/3

Taxon Level Discussion

Both the Kahanahāiki to Kapuna PU and portions of the Mākaha PU are within the MMR AA. The Central and East Makaleha PU is out of the MMR AA. The known trees are all mature and no juveniles or seedlings have ever been observed by NRS. There are only two trees that have produced mature viable seed. This taxon is dioecious and usually found alone, far from plants of the opposite sex. Most trees are found in degraded unprotected habitat with ungulate and weed threats. Trees are typically in poor health because of damage from the black twig borer (BTB) (*Xylosandrus compactus*) and its associated fungus (*Fusarium solani*). This appears to weaken many trees so that they are unable to produce flowers and fruit. Due to the overwhelming threat posed by the BTB, stabilizing this taxon will be challenging. Currently, NRS are focusing on collecting cuttings and air-layers from all the known trees and securing habitat with large-scale fences. Research on controlling the threat from the BTB is underway. The outplanting sites in the wild and at Leeward Community College and Waimea Botanical Garden have done well and NRS plan to establish a few replicates of all known trees in botanical gardens and other *inter situ* sites. Hopefully these trees will flower and NRS will be able to develop a plan to mix the collections so they naturally cross to produce viable seed. Seeds will be used to continue propagation and storage testing. In addition, seed collected from these trees will be used to begin new augmentations.

Major Highlights/Issues Year 2

- Collections have been established and are being held in a living collection at the Pahole Mid-elevation Nursery from 15 of the 38 known trees.
- Plants grown from vegetative propagation that are in the living collection in the greenhouse have begun to flower. Plants grown from seed have not yet begun to flower.
- NRS are cooperating with Department of Agriculture specialists on a BTB control treatment.

Plans for Year 3

- Conclude BTB verbenone study (see chapter 6).
- Continue to try propagate unrepresented wild individuals.

Action Area: In

TaxonName: Flueggea neowawraea **TaxonCode: FluNeo**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki to Kapuna	Manage for stability	7	42	0	7	0	0	0	59	0	8	59	0	NARS records and NRS observations show one additional tree
Ohikilolo	Genetic Storage	2	0	0	1	0	0	0	0	0	1	0	0	One known tree was observed dead in the last year
West Makaleha	Genetic Storage	5	0	0	6	0	0	0	0	0	6	0	0	One additional tree reported in the last year
	Total for Taxon:	14	42	0	15	0	0	0	59	0	15	59	0	

Action Area: Out

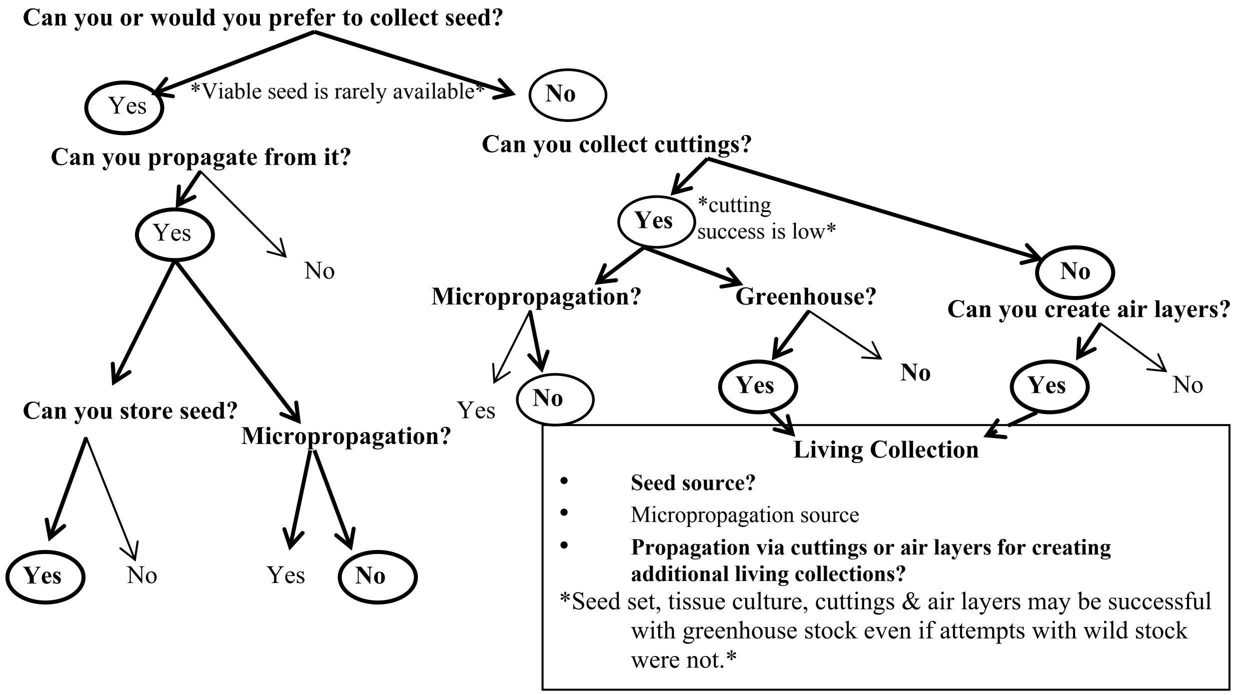
TaxonName: Flueggea neowawraea **TaxonCode: FluNeo**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central and East Makaleha	Manage for stability	6	0	0	6	0	0	0	0	0	6	0	0	Monitoring showed no change in the last year
Halona	Genetic Storage	2	0	0	2	0	0	0	0	0	2	0	0	Monitoring showed no change in the last year
Kauhiuhi	Genetic Storage	1	0	0	1	0	0	0	0	0	1	0	0	No observations in the last year
Makaha	Manage for stability	9	0	0	10	0	0	0	0	0	10	0	0	One additional tree found in the last year
Mikilua	Genetic Storage	1	0	0	1	0	0	0	0	0	1	0	0	Monitoring showed no change in the last year
Mt. Kaala NAR	Genetic Storage	4	0	0	4	0	0	0	0	0	4	0	0	Monitoring showed no change in the last year
Nanakuli, south branch	Genetic Storage	1	0	0	1	0	0	0	0	0	1	0	0	Monitoring showed no change in the last year
	Total for Taxon:	24	0	0	25	0	0	0	0	0	25	0	0	

Propagation & Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Airlayer / Cuttings	Living Collection	Yes	Yes – living collections

Prioritizing Genetic Storage & Propagation Techniques



Collection: All possible methods of propagation and genetic storage have been attempted for this taxon. Few trees have been observed in flower and fewer still produce mature viable fruit. Viable fruit has been collected from two trees.

Propagation: Plants are easily propagated from viable seed. In 2001, one of the West Makaleha trees had hundreds of fruit. Over 600 fruit were collected at three different times over two months during a single season. These seeds were either grown in the Army Nursery or sent to the Micropropagation Lab and Seed Conservation Lab for storage testing. Initial viability of this collection at the Seed Conservation Lab was 84% on 1% water agar. Seeds require no special germination treatments. Seedlings were easily transferred to pots.

NRS have been successful in propagating *F. neowawraea* from air-layers, however, access limitations and black twig borer damage have restricted the success of this method. Air-layers can dry out during the months between visits to the remote and sometimes restricted areas. The material being air-layered is still vulnerable to the BTB while on the tree. Air-layers are performed and monitored by the NRS Horticulturist and trained NRS staff. The air-layers are checked within two months to re-wet or recut and check callus status, and then are rechecked at a similar frequency for collection. One air-layer was successfully harvested over one year after being installed, while another had enough root development to harvest after about two months. To date, eight of the 62 installed air-layers have been successfully established as greenhouse stock (13%). A few air-layers which died soon after collection in the greenhouse had extensive BTB damage and would have likely died in the field.

Typically, only one or two trees can be visited per day and air-layers may take several trips to maintain and monitor. In contrast, many cuttings can be collected on a single trip. Cuttings also take a long time to produce roots, and many fail. They are treated with 3% Dip-n-Grow® and placed in a mixture of vermiculite and perlite in small pots on the mist bench at the Army Nursery. They can take weeks to months to produce roots. Once established, the cuttings are transferred to sterile media. All successful cuttings are currently thriving. Four percent of the cuttings taken from the field have become established in the Army Nursery. This percentage, however, is actually slightly lower, for the number of cuttings actually made by the NRS Horticulturist is much higher than the number of cuttings collected from a tree. In contrast, cuttings made from plants in the Pahole Mid-elevation Nursery root better than wild cuttings. Thirty-six percent of the cuttings taken from greenhouse stock have been successful. The difference between the health of the plants in the wild versus the nursery is likely reflected in the different success rates. When determining the success of cuttings for this taxon, it is important to remember the importance of utilizing all collected material. It is imperative to attempt to root all material. Despite the poor health of the founders, both cuttings and air-layers are accomplishing *ex situ* storage goals (see map below genetic storage summary).

Seed Storage: A small amount of fruit brought to the Seed Conservation Lab in January 2002 was tested. Two-year storage tests indicate seeds stored at -18°C show no decrease in viability (88%). Storage trials on these frozen seeds are ongoing; but refrigeration storage still needs to be tested.

Genetic Storage: There are currently 15 of the 38 O‘ahu founders represented at the Army Nursery. Some plants are being grown *ex situ*, in the Army greenhouse and at botanical gardens. However, greenhouse space is limited, and the BTB still affects trees removed from a forest setting. Also, a large, easily accessible location is necessary to account for this taxon’s large size and allow for frequent monitoring and treatment to protect from the black twig borer. NRS hope to collect fruit from *inter/ex situ* plants for storage and testing in the coming years, as plants mature.

Cuttings collected from the Nānākuli PU in November 2005 and from West Makaleha in February 2006 flowered in April 2006 while on the mist bench even before they developed roots. These plants produced male flowers and pollen was collected and is being stored. Female plants that were at Pahole Mid-elevation Nursery had flowered earlier. When they flower again NRS will attempt to pollinate them with the stored pollen. If pollen stores, this may assist in the production of seed for storage from the greenhouse living collection.

Tissue culture in the Micropropagation Lab has not been very successful; it is not a good storage option for wild material of this taxon but, greenhouse material may be more successful. Cuttings will be taken from greenhouse stock with substantial representation and will be brought to the lab for more testing.

Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Flueggea neowawraea							
Central and East Makaleha	6	0	0	0	0	2	1
Halona	2	0	0	0	0	2	0
Kahanahaiki to Kapuna	7	0	0	0	0	2	0
Kauhiuhi	1	0	0	0	0	0	0
Makaha	10	0	0	0	0	5	0
Mikilua	1	0	0	0	0	0	0
Mt. Kaala NAR	4	0	0	0	0	1	1
Nanakuli, south branch	1	0	0	0	0	1	0
Ohikilolo	1	0	1	0	0	1	1
West Makaleha	6	0	0	0	0	1	1
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				0	0	15	4

Map removed, available upon request

Outplanting Issues

Since there is no natural recruitment, augmentation must be used as a tool to achieve stability once black twig borer controls are in place. Two augmentations have been established in the Kahanahāiki to Kapuna PU. These plants were grown from seed collected from the West Makaleha PU. One of the sites was established in December 2003. Twenty-six plants were planted and only five have died. However, the remaining plants at this site have only grown an average of three centimeters in two and a half years and only 11 of the 21 plants were observed being healthy during the last monitoring in . Because these plants have not grown vigorously NRS will transplant about half of the plants to a new site in the coming year. The new site was chosen because it has the same general habitat qualities as the second augmentation site where plants are performing well as discussed below.

The second augmentation site was established in February 2005. Since this group of about 20 plants was outplanted they have averaged over a meter of growth. This site was supplemented in the last year and all plants are doing very well. These plants have not flowered yet. NRS are documenting the sex of all wild plants when in flower and will balance males and females in all augmentations. Small collections are also established at Leeward Community College (LCC) and the Waimea Audubon Center (WAC).

Research Issues

See Chapter 6 on Research for discussion on the Black Twig Borer.

Surveys

No surveys targeting *F. neowawraea* were conducted in the last year. Additional trees were discovered in Makaha and West Makaleha in the last year. As NRS management expands into new areas, the expectation is that additional trees will be discovered.

Taxon Threats

No additional threats were noted in the last year.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Flueggea neowawraea

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki to Kapuna	Manage for stability	Partial	Partial	No
Ohikilolo	Genetic Storage	No	No	No
West Makaleha	Genetic Storage	No	No	No

Action Area: Out

TaxonName: Flueggea neowawraea

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Central and East Makaleha	Manage for stability	No	No	No
Halona	Genetic Storage	No	No	No
Kauhiuhi	Genetic Storage	No	No	No
Makaha	Manage for stability	No	Partial	No
Mikilua	Genetic Storage	Yes	No	No
Mt. Kaala NAR	Genetic Storage	No	No	No
Nanakuli, south branch	Genetic Storage	No	No	No

Manage for Stability PUs:

Kahanahāiki to Kapuna: This PU contains wild trees known from Kahanahāiki, Pahole and Kapuna gulches, and an augmentation of two outplanting sites both located in Kahanahāiki. The two outplantings in this PU are discussed in the 'Outplanting Issues' section above. Two of the three trees in Kahanahāiki have had cuttings or air-layers established from them and are in a living collection at the Pahole Nursery.

In Pahole Gulch, there are three mature trees and one additional tree is known from Kapuna Gulch. The Pahole trees are within the larger Pahole fenced unit and the Kapuna tree will be inside the last sub-unit of the Kapuna fence. NRS is pursuing a collection permit to be able to collect vegetative material from these trees in the coming year. There has been no collection from trees within the Pahole NAR in the last year as it is currently not approved.

Central and East Makaleha: Two trees are known from Central Makaleha. Cuttings from both trees have been successfully rooted and been established at the Pahole Mid-elevation Nursery. Both trees are in moderate condition and are not fenced. Goat control has been conducted in this area, but there is no large-scale fence planned for Central Makaleha. NRS will consider small scale fencing if necessary.

In East Makaleha, NRS currently knows of four mature trees but there are large unsurveyed areas in the management unit, which very likely harbor additional trees. NRS monitored many of these trees in the last year. In the coming year, NRS will collect for propagation. Goat control has been conducted in this PU, but no other management has been conducted here for *F. neowawraea* in the last year. This area is scheduled to be fenced in year four of the MIP.

Mākaha: NRS currently know of nine *F. neowawraea* in Mākaha Valley. In the last year, NRS worked with the BWS Watershed Planner, Amy Tsuneyoshi, to install air-layers on the trees in Mākaha. In the coming year, NRS will continue to airlayer and collect cuttings from unrepresented trees. In late 2003, hundreds of fruit were seen on the ground around one mature tree. NRS collected approximately 50 fruits and had high hopes that some fruit might be viable, as there are other *F. neowawraea* in the area. However, the fruit appeared immature. The fruit that were collected were sent to the Micropropagation Lab, but no seeds germinated. Four of the trees are within the proposed Mākaha fence exclosure. There are likely more undiscovered trees in Mākaha. Weed control has begun in sites with *F. neowawraea* in the last year.

Other PUs:

West Makaleha: This PU has six mature trees and it includes the only tree that has ever been observed to produce a large amount of viable fruit. Over 600 mature fruit were in December 2001. Plants grown from these collections have been reintroduced and planted, as discussed above. This tree will be collected from in the future and may prove to be the most productive individual on O'ahu. The two trees growing closest to this tree are thought to be male. NRS has been working to secure stock from all of the trees with cuttings and air-layers in the last year and will continue this in the coming year. NRS believes there are more trees yet to be found in West Makaleha, and will conduct surveys in the future during regular management work.

'Ōhikilolo: There is one small fence around the last live tree in this PU that was built to exclude goats that had been browsing the suckers growing at its base. Since then, goats have been removed from the valley. Cuttings have been established from this tree, and are being grown in the Army Nursery. Fruit has been collected, however none were viable. NRS has conducted weed control in this area and will continue this in the coming year.

Hālona: NRS has worked with the Navy to collect cuttings from this PU. The cuttings were rooted from both the trees and are now being grown at the Army Nursery. They will be managed as a living collection and will be cloned. No other management has occurred at this site.

Kauhiuhi: In the last year, NRS worked with Navy staff to monitor the site and collect cuttings. The plant is in poor condition and no collections have been established from this site.

Mikilua: The site is protected by a fence constructed by the Navy in 1998. The tree was monitored by NRS in the last year and cuttings are being propagated at the Army Nursery. This tree is in poor condition and NRS will work with the Navy in the coming year to secure collections.

Mt. Ka'ala NAR: There are currently four living trees in this PU. Three trees are known from one site that is just outside the Mt. Ka'ala NAR boundary in the Mokuleia Forest Reserve and a single tree is known from another gulch that is inside the NAR. NRS collected from two of the three trees that are outside the NAR and there are now plants from one of them at the Pahole Mid-elevation Nursery. One of these three trees has been observed producing viable seed in the past and NRS will continue to monitor this site to collect mature fruit in the coming year. None of these sites will be fenced and NRS does not conduct weed control at any of these sites. The single plant in the second site has not been collected from.

Nānākuli: NRS monitored and collected cuttings from this tree in the past year. It is a very healthy tree and cuttings were established in the Army Nursery.

3.1.12 *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

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have stable structure?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
1/3	0/3	0/3	1/3	0/2

Taxon Level Discussion

This taxon as a whole has not been given high management priority. This is mainly due to the relatively high numbers of individuals of this taxon and the order in which MUs were planned for construction. The Central Makaleha and west branch of East Makaleha PU is the only MFS population without stable numbers. Over the last year, NRS worked to control goat populations in Mokulei‘a Forest Reserve and Mt. Ka‘ala NAR with NARS staff. Additional genetic storage collections were made in the last year

Major Highlights/Issues Year 2

- Seed collections were made from the Ala‘ihe‘ihe and Manuwai PU for storage at the Seed Conservation Lab.
- The Manuwai population saw a decline from 36+ mature plants monitored in 2000 to 9 mature plants this year.

- **Plans for Year 3**
- NRS hope to locate more plants in the Central Makaleha and West Branch of East Makaleha PU via surveys, and thus eliminate the need for reintroductions.
- Genetic storage collections will be made from underrepresented plants.
- Hunting to minimize goat impacts will continue across Mokulei‘a Forest Reserve and Mt. Ka‘ala NAR with NARS staff.

Action Area: In

TaxonName: Hedyotis degeneri var. degeneri **TaxonCode: HedDegDeg**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki to Pahole	Manage for stability	279	8	8	492	16	16	0	0	0	492	16	16	A thorough census of known sites found many more plants
	Total for Taxon:	279	8	8	492	16	16	0	0	0	492	16	16	

Action Area: Out

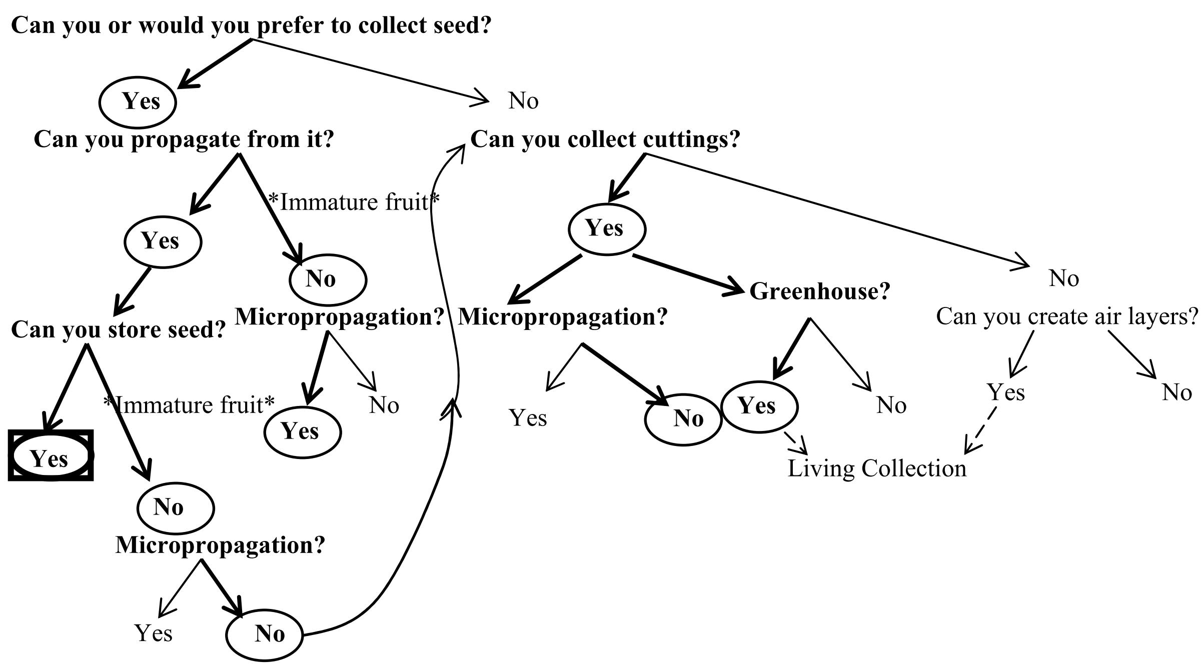
TaxonName: Hedyotis degeneri var. degeneri **TaxonCode: HedDegDeg**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Alaiheihe and Manuwai	Manage for stability	61	0	2	34	0	2	0	0	0	34	0	2	Monitoring in the last year of all known sites showed a significant decline
Central Makaleha and West Branch of East Makaleha	Manage for stability	33	2	7	33	3	7	0	0	0	33	3	7	One additional immature plant observed in the last year
East branch of East Makaleha	Genetic Storage	10	0	0	10	0	0	0	0	0	10	0	0	No monioring in the last year
	Total for Taxon:	104	2	9	77	3	9	0	0	0	77	3	9	

Propagation and Genetic Storage

At this time, what is the best preferred propagation technique?	At this time, what is the preferred genetic storage technique?	Is more genetic storage testing needed?	Are additional steps required for obtaining enough seed?
Seed	Seed	Yes	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: Fruit should be collected when they are just starting to dehisce. Increasing the frequency of visits to better track fruit development would allow for good timing of collections.

There would be enough seed in a couple fruit (~3-6) at this stage to achieve genetic storage goals for a founder. Seeds in green fruit may have lower storage potential. Immature fruit have germinated in micropropagation, but they can not be stored there and would need to be propagated in the greenhouse after germination.

Propagation: Plants can be propagated from cuttings. Approximately 40% of cuttings collected in November 2003 rooted. Only one cutting was brought to the Micropropagation Lab and it failed. This method should be tried again, given that cuttings will root in the greenhouse. Mature and immature fruit have germinated in the Micropropagation Lab. Initial germination rates are variable. Studies this year on seeds of *H. parvula* have indicated that seed size correlates with viability, and seed size had not yet been studied in this taxon. Also, often the only fruit available for collection are mostly dehisced, and the very few seeds remain in the fruit. These seeds are most likely lighter in weight and appear small and flat. Therefore, they may have an increased chance of not being as viable as a heavier seed that already dispersed from the open fruit. If this taxon could be collected just as the fruit start to dehisce, large collections from wild plants could very easily be made. Initial viability ranges from 16-93%.

Seed Storage Research: Seeds are currently banked at 4C and 20% relative humidity. These conditions are based on storage preferences determined for other species of *Hedyotis*. Seeds were tested from a 2002 collection this year and show no decrease in viability. Once genetic storage minimums were met, collections could occur once every four years, but this should only happen for collections were initial viability has been tested. More viability tests can be done on already stored seed to give a better indication of storage viability trends.

Genetic Storage: No seedlings that were germinated in the Micropropagation Lab were able to be subcultured, but more research into different techniques could be conducted if necessary. At this time, micropropagation is not a genetic storage option. Since enough seed can be collected from the wild plants and seed can store, it is the best genetic storage option for this species and NRS will continue to collect, including a collection for storage testing.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Hedyotis degeneri var. degeneri							
Alaiheihe and Manuwai	34	0	0	7	0	0	5
Central Makaleha and West Branch of East Makaleha	33	3	5	18	0	0	15
East branch of East Makaleha	10	0	0	0	0	0	0
Kahanahaiki to Pahole	492	16	4	3	0	1	3
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				28	0	1	23

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 co-exist.

Outplanting Issues

NRS have not outplanted this species, nor have any other natural resource programs on O‘ahu. Reintroductions may be considered in the Central Makaleha and West Branch of East Makaleha PU once the MU fence is constructed.

Research Issues

There are no research issues for this taxon.

Surveys
No surveys were conducted for this species in the last year

Taxon Threats
No new threats have been observed to this taxon.

Population Unit Threat Control Summary

Action Area: In

TaxonName: Hedyotis degeneri var. degeneri

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki to Pahole	Manage for stability	Partial	Partial	No

Action Area: Out

TaxonName: Hedyotis degeneri var. degeneri

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Alaiheihe and Manuwai	Manage for stability	No	No	No
Central Makaleha and West Branch of East Makaleha	Manage for stability	No	No	No
East branch of East Makaleha	Genetic Storage	No	No	No

Manage for Stability PUs:

Kahanahāiki to Pahole: No action was taken in the Pahole portion of this PU in the last year. The monitoring that found many more plants was done in December 2004 but the numbers were not reported until this year. In the coming year, NRS will continue to monitor these sites and attempt to collect for genetic storage. NRS monitored the Kahanahāiki portion of this PU this population this year in September and found a decline in numbers of living plants. Three of the six mature plants appeared to be dead. No ungulate sign was detected and the ungulate snares on the adjacent ridge were untouched. NRS will continue to collect for genetic storage from this PU, monitor the site closely for decline and will continue ungulate control in the area.

Central Makaleha and West Branch of East Makaleha: Seed collections were made from the Central Makaleha populations for genetic storage. Hunting to minimize goat impacts will continue in the coming year, as will genetic storage collections from this PU.

Ala‘ihe‘ihe and Manuwai: In the last year, NRS visited the area and monitored some of the plants. Seed collections were made from the Manuwai population for genetic storage. The Manuwai population saw a marked decline from 36+ mature plants monitored in 2000 to nine mature plants this year. Due to the length of time in between monitoring, it is unclear what the cause of this decline may be, but competition with weeds may have been a factor. *Clidemia hirta* is now a dominant component of the habitat. Ungulate sign was not detected 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:

East Branch of East Makaleha:
No action was taken by NRS in the past year

3.1.13 *Hedyotis parvula*

Requirements for Stability:

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

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have stable structure?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
2/3	2/3	1/2 (only 2 wild PUs)	2/3	0/1

Taxon Level Discussion

This year NRS made significant collections from the Hālona and ʻŌhikilolo PUs, which are the only remaining *in situ* populations of this species. A reintroduction is planned within the East Makaleha Management Unit (MU) fence once it is constructed. Plants tend to grow on steep cliffs where feral ungulates are not a direct threat. Weeds have not been observed to be a direct threat to plants. Fire has increasingly become a threat as recent wild fires (2005) in Nānākuli and Lualualei did come close to the Hālona PU. Thus, NRS have focused on grass control around the PUs to reduce fire threat. NRS acquired significant collections of this taxon in the last year. This species can be grown from seeds or cuttings and seeds can be stored well. In the coming year, NRS will focus on collecting from the remaining unrepresented founders and continue weed control. The East Makaleha fence will be built in year four of the MIP and the reintroduction will begin once that is complete.

Major Highlights/Issues Year 2

- NRS made large collections from both wild PUs this year.
- NRS has began grass control at wild sites to reduce fire threat.

Plans for Year 3

- Continue seed collection efforts for storage and testing.
- Assess fuel control efforts.

Action Area: In

TaxonName: Hedyotis parvula **TaxonCode: HedPar**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ohikilolo	Manage for stability	79	12	17	120	28	40	0	0	0	120	28	40	A thorough census of one site found many more plants and the same is expected from a census of the other site in the next year
	Total for Taxon:	79	12	17	120	28	40	0	0	0	120	28	40	

Action Area: Out

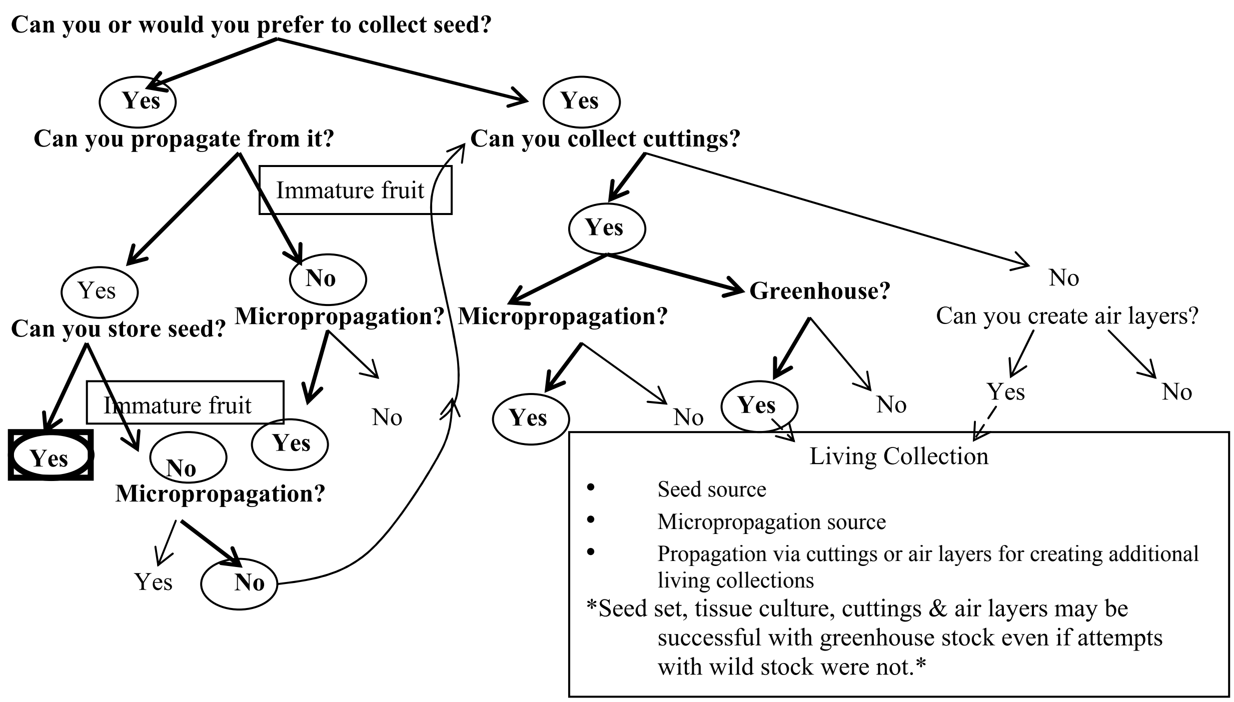
TaxonName: Hedyotis parvula **TaxonCode: HedPar**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
East Makaleha	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Halona	Manage for stability	87	28	19	87	28	19	0	0	0	87	28	19	Observations in the last year showed no change
	Total for Taxon:	87	28	19	87	28	19	0	0	0	87	28	19	

Propagation and Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	Yes, but not extensive – fine-tuning & backup research	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: Studies and observations were made at the Seed Conservation Lab to help develop collection strategies to optimize seed quality for genetic storage purposes. Post-harvest ripening studies were conducted in response to fruit that was collected slightly immature. This would allow NRS to know if fruit could be collected slightly immature without affecting viability. Mature seeds had higher germination rates than seeds that were post-harvest ripened ($P = 0.000$). Based on these results, NRS will no longer collect immature fruit. Seeds also have varying sizes, and some fruit have been observed to have a few large seeds and many small seeds. Other fruit sometimes contain seed much larger than the average seed size. Studies compared seed size to fresh viability. Seeds were placed into either a small, medium, or large category for size, and then were sown. None of the small seeds germinated, and medium and large seeds had similar germination rates. Finally, observations were made on the degree of dehiscence at time of collection. Collection is optimal when fruit are dry and brown with no green anywhere on the capsule either prior to dehiscence or when there is a small fissure across the top of the fruit (see picture below). Fruit with green generally contain immature seeds and fruit that are fully opened tend to contain no seeds or a few seeds with a higher likelihood of low viability.

Mature fruit of *Hedyotis parvula*: undehisced or just starting to dehisce

Propagation: Cuttings were previously rooted in the Army Nursery but a large trial has not been tested to determine success rate or optimal technique. In 2005, NRS collected cuttings from the nursery stock to be tested in the Micropropagation Lab. They were established in tissue culture. Seeds, mature and immature, have been brought to the Micropropagation Lab, successfully established in tissue culture, and later moved to the lab's greenhouse. For mature collections, initial viability from multiple plants from multiple populations averaged 70%. Seeds from herbarium specimens from the National Tropical Botanical Garden were taken to the Seed Conservation Lab for germination testing, but none of the seeds were viable.

Seed Storage: Seeds are being stored at the Seed Conservation Lab. No formal seed storage testing has been done and all seeds are banked at 4C and 20% relative humidity. These conditions are based on storage preferences determined for other species of *Hedyotis*. Since several plant from the ʻŌhikilolo PU are very close to the genetic storage requirement, NRS plans to collect from these individuals nest year. At this time, a bulk collection can be made from individuals already sufficiently represented in seed storage. Since some of the 2000 / 2001 ʻŌhikilolo collections have slightly surpassed the genetic storage minimum, 25 seeds from 2 plants were sown for viability testing. Testing banked seeds helps to determine; 1) whether seed storage is a feasible option, 2) storage potential at the banked storage condition, 3) collection schedule for maintaining adequate counts for storage goals, and 4) provide valuable information on seedling quality and propagation of stored seed. One collection, stored for six years, had high germination (76%) but was never tested initially. The other, stored for five years, had lower germination (20%) but seeds were small and possibly underdeveloped. Based on the success of this year's collections, eight older collections can be removed from storage and a small subsample tested. Although testing is not complete, NRS recommend a collection interval of five years, if individual collections are determined to have either high initial viability or documented as mature and an appropriate size for this taxon. If the eight collections at the Seed Conservation Lab that are to be tested this year do not support the data collected from this year's tests, the collection interval will be modified.

Genetic Storage: Seed banking is the primary genetic storage method. NRS focused on collecting seeds from the Hālona PU this year, and over 22,000 seeds from 60 plants in the Hālona PU were collected and placed into storage. Additional collections were also made from the ʻŌhikilolo PU and there are now over 78,000 seeds in storage from 100 plants. As the MIP requires collection of 50 seeds from 50 plants from each PU, storage requirements for the ʻŌhikilolo PU have been met.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Hedyotis parvula							
Halona	87	28	0	54	0	2	47
Ohikilolo	120	28	2	96	0	0	90
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				150	0	2	137

Outplanting Issues

The East Makaleha PU will be established via reintroduction once the MU fence is complete. No outplantings of this species have been done. Plants grow on very steep cliffs, so outplantings will have to take place on rappel. Plants have been grown to sufficient size to be planted in the Army greenhouse many times. NRS are building experience planting onto cliffs; *Tetramolopium filiforme* was successfully outplanted on a cliff at Puʻu Kumakaliʻi.

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. *Melinis minutiflora, Rubus argutus,* and *Erigeron karvinskianus* all threaten the habitat of *H. parvula* and NRS have initiated some control of these species at the ‘Ōhikilolo PU and at Halona. A large fire, like the Nanakuli fire of 2005, would likely threaten the Hālona PU again and NRS have begun controlling grass there in the last year.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Hedyotis parvula

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Ohikilolo	Manage for stability	Yes	Partial	No

Action Area: Out

TaxonName: Hedyotis parvula

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
East Makaleha	Manage reintroduction for stability	No	No	No
Halona	Manage for stability	Partial	Partial	No

Manage for Stability PUs:

‘Ōhikilolo: The ‘Ōhikilolo PU includes two sites and has stable numbers of individuals. Goats have been removed from ‘Ōhikilolo and pigs do not threaten this PU. Both sites have been monitored by NRS for several years, however a complete census of the areas while on rappel had not been done. During regular monitoring and collection at the makai site in the last few years, the observed number of plants had been increasing with the increasing observer hours. In the last year, NRS spent a considerable amount of time there and the number of plants observed is higher than ever. In addition, the habitat has been improving since the removal of goats. NRS has been conducting grass control in the area and has begun to remove the alien trees on the cliff where the plants are. Genetic storage has begun from this PU and many founders are represented by large collections in the Seed Conservation Lab. Storage testing is being conducted on collections from the last few years. In the coming year, NRS will focus monitoring the second site to better determine population size, collect from unrepresented individuals for seed storage and continue to test seed collections for storage potential. Grass control will continue and NRS will begin to remove alien trees such as *Schinus terebinthifolius* and *Grevelia robusta.*

Hālona: This PU has a stable number in individuals in two different sites; one large population on State land (75 mature) and another small population (12 mature) on the Lualualei Naval Magazine. The portion on State land will be fully managed. The plants on Lualualei Naval Magazine will be monitored and collected for seed storage. There are no observed ungulate threats to this PU, however NRS will be working with the State and Navy in the next year to address goat control nearby to prevent a larger herd from becoming established and moving south to the PU. The 2005 fire in Nānākuli and Lualualei came close to this site. NRS worked with TNC on containing that fire and will continue to support fighting fires which threaten this site. Management of grass in the area has begun and NRS will expand this effort in the coming year. NRS must develop a more comprehensive weed control plan this year as some noteworthy weeds (*Ageratina riperia, Melinis minutiflora*) impact habitat for this taxon. Seed has been collected from many founders and is being stored. This PU has no other known threats and if seed storage potential is good full genetic representation will occur soon.

Central and East Makaleha: This MU fence is slated for construction in year four of the MIP. In the coming year, NRS will spend a significant amount of time monitoring the historic site in this PU, and are hopeful that plants will be found. A reintroduction may also be conducted within the proposed East Makaleha fence when it is complete.

3.1.14 *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

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have stable structure?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
0/3	0/3	0/3	1/3	0/3

Taxon-Level Discussion

Despite the continued decline in the wild and the numerous challenges in the conservation of this species, some progress has been made in propagation and *in situ* conservation over the past year. There are still four known extant populations, two of which are now fenced (Pālāwai and Waiʻanae Kai). And a third population, Mākaha, will be fenced by the end of 2006. Previously micropropagation of this species had been marginally successful as most plants *in vitro* had not developed roots. Recently though, *in vitro* plants placed in cooler conditions have produced roots (Nellie Sugii Pers. Comm. 2006). There are currently 19 plants in the greenhouse, the larger plants have been air layered in hopes of increasing the numbers of propagules. However, there are just 21 individuals now known in the wild and seed collection efforts were not successful this year.

In anticipation of the change in the Army's Mākua Action Area, and the subsequent removal of this species from the Army's stabilization list, the Army has been working closely with the Plant Extinction Prevention program (PEP) so that the management of this species will be continuous when the Army's management goals are changed. Additionally, the Army continues to work cooperatively with all pertinent landowners and land managers on both the *in situ* and *ex situ* conservation of this species. In this light, NRS initiated a propagation workshop that included Horticulturists, Agriculture Extension Agents, Natural Resource Managers and Researchers. One concern with keeping the plants in cultivation was the risk of becoming root bound or rooting into the ground through the pot. Both points were legitimate concerns and most agreed that they could be mitigated by various horticultural methods. This working group was in consensus with the goal of using the collection as a stock plant propagule source with the possibility of growing plants to maturity to be able to perform pollination trials and achieve viable seed collection. There remain many unanswered questions as to how to best go about doing this.

Major Highlights/Issues Year 2

- A total of 19 plants in the greenhouse, representing 2 of the 4 extant populations.
- Airlayering of greenhouse stock has been successful
- Waianae Kai PU was fenced this year
- Waianae Kai PU continues to be threatened from flower picking
- Propagation workshop to explore *Hesperomannia* specific issues was successful

Plans for Year 3

- Work with PEP program, State, and TNC for continuous management for this species when the Army's Mākua consultation is complete.

Action Area: In

TaxonName: Hesperomannia arbuscula **TaxonCode: HesArbu**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kapuna	Manage for stability	1	0	0	1	0	0	0	0	0	1	0	0	This single plant has been monitored in the last year
	Total for Taxon:	1	0	0	1	0	0	0	0	0	1	0	0	

Action Area: Out

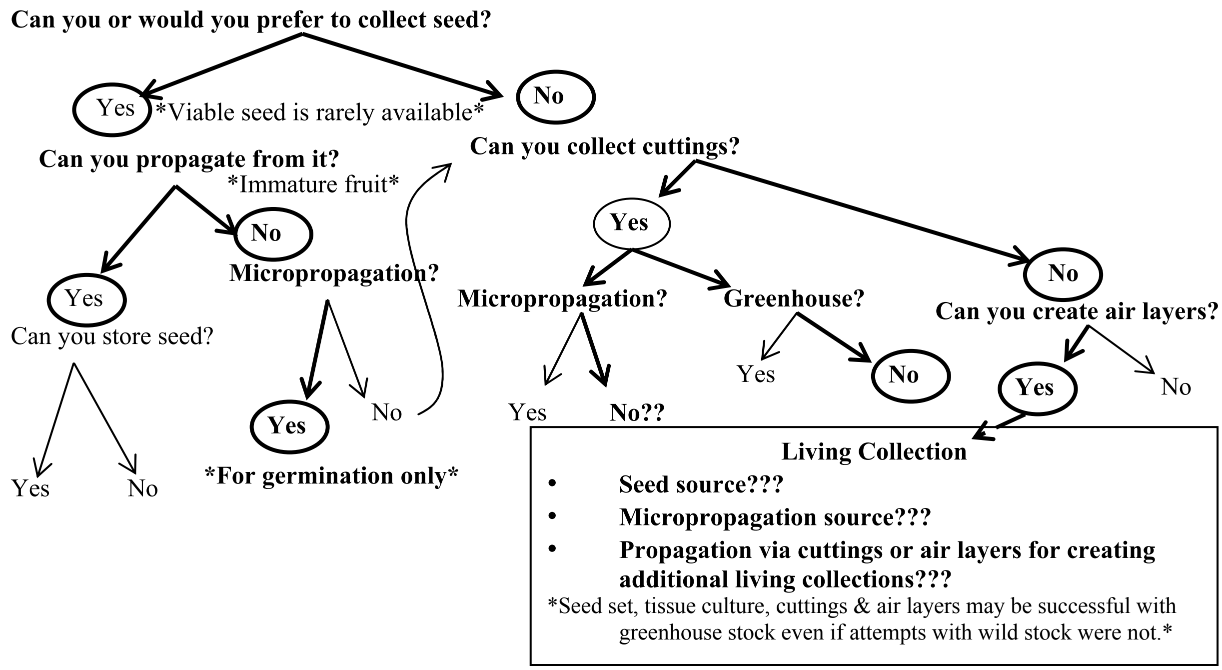
TaxonName: Hesperomannia arbuscula **TaxonCode: HesArbu**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha	Manage for stability	6	12	0	5	8	1	0	0	0	5	8	1	One mature and a few immature plants died in the last year and one seedling was found
North Palawai	Manage for stability	4	0	2	3	0	1	0	0	0	3	0	1	One mature plant and one seedling died in the last year
Waianae Kai	Genetic Storage	4	0	1	2	1	0	0	0	0	2	1	0	Two mature plants died in the last year
	Total for Taxon:	14	12	3	10	9	2	0	0	0	10	9	2	

Propagation and Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Seed (if available) & air-layers	Living collection	Yes	Yes; living collection

Prioritizing Genetic Storage & Propagation Techniques



Collection: Collections are attempted when the base of the inflorescence has begun to swell and the top has begun to loosen and open. NRS, PEP, and BWS were unable to collect viable fruiting heads of this species this year. Collections made from both Mākaha and Pālāwai contained no viable seeds.

Propagation: In previous years, seeds were collected from North-north Pālāwai, Mākaha and Wai‘anae Kai and put into micropropagation where many of them germinated. This year, Micropropagation Lab staff relocated this taxon’s inventory to the coolest location in the lab and began frequent subculturing. The plants have responded positively. Most look healthier and two began to produce roots. Until this point, only one of the 28 plants in micropropagation had ever produced roots, even though many different treatment methods have been tested. The seedling that originally did form roots was accidentally placed upside-down in the test tube. That plant was moved to the Army nursery in 2001 but died two years later. Air-layers were attempted this year on plants in Mākaha but were not successful. The Seed Conservation Lab received only one collection with viable seed, and since viability is known to be very low for this taxon, all viable seed was germinated for propagation. In July 2005, 156 seeds from one plant from North Pālāwai were collected. Seeds were sorted by size, color and appearance and all sown on 1% water agar. Of the 30 seeds that appeared to not be empty, 19 germinated (63%).

As mentioned, this year NRS initiated a propagation workshop to discuss the difficulties associated with this species *ex situ*. Propagation by air layer was discussed due to the inconsistent success of this technique. It appears that *H. arbuscula* wounds may be sensitive to moist conditions and it was suggested that air layering be done during the dry season to aid in the success. An individual propagated via airlayer is shown here.

Seed Storage Research: No seeds are yet available for storage testing.

Genetic Storage: Genetic storage for this species has been difficult. Seed storage has not yet been attempted because there has not been enough seed to test. Though plants have shown improvements in their condition in the Micropropagation Lab this year, additional material should not be collected for tissue culture until more root establishment is documented. There are currently four plants from air-layers; three from North Pālāwai and one from Wai‘anae Kai, growing in the nursery at Pahole. Seedlings that were not doing well in the wild in Pālāwai were removed and taken to the nursery and most of them have survived and are growing. Nine plants from the seeds germinated at the Seed Conservation Lab are also at the nursery. The Pahole Mid-Elevation Nursery has proven to be the best growing environment for this species. NRS will use this living collection for air-layers and seed production when they flower.

Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Hesperomannia arbuscula							
Kapuna	1	0	0	0	0	0	0
Makaha	5	8	0	0	1	0	0
North Palawai	3	0	13	0	2	8	3
Waianae Kai	2	1	8	0	1	1	1
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				0	4	9	4

Unique Species Observations

Flowers from Wai‘anae Kai were taken from the trees for the 3rd year in a row. The Kapuna plant did not flower this year. Just one individual in Mākaha flowered this year and it appears that the flowering heads aborted and fell off the plant.

Outplanting Issues

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

Research Issues

This species may benefit from cross pollination within and among populations. Pollination studies would be easily tested on the greenhouse plants once they flower. Pollination crosses were attempted by the PEP program between the Wai‘anae Kai and Mākaha populations this year however these were unsuccessful due to the removal of flowers from Wai‘anae Kai and the early abortion of flowers in Mākaha.

Individuals within the North Pālāwai PU were fertilized in 2005. This PU has produced several seedlings in the past, and one individual within this population has produced the only seed mature enough to be propagated by the Seed Conservation Lab. However, over the past two years this PU has drastically declined in numbers. It is unlikely that fertilization caused this decline however the seedlings observed in the field here were also present prior to the fertilization treatment. Therefore, the addition of fertilizer to natural PUs should be studied to determine the potential benefits to this species *in situ*.

Air layers appear to be one of the most successful ways to increase the number of propagules (viable seeds are preferred as they may provide more individuals and have more genetic variability but are rarely available). This coming year it is hoped that a reliable air layer technique for this species will be developed utilizing the greenhouse individuals.

Taxon Threats

The Wai‘anae Kai PU is threatened by people, as the flowers have been picked repeatedly preventing any seed collection from this population. This species appears to be fragile and trees within fenced areas have died after extensive monitoring and weeding. Feral pigs continue to be a threat to the Mākaha and Kapuna PUs. And weeds continue to threaten this species in all known PUs. Bird predation on flowers is suspected for the Palawai plants as several flower heads previously seen could not be found during a monitoring trip in July 2006.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Hesperomannia arbuscula

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kapuna	Manage for stability	No	Yes	No

Action Area: Out

TaxonName: Hesperomannia arbuscula

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Makaha	Manage for stability	No	No	No
North Palawai	Manage for stability	Yes	Yes	No
Waianae Kai	Genetic Storage	Yes	No	No

Manage for Stability PUs:

Kapuna: There is just one individual in this PU. The PEP program has visited this plant and determined it is too weak for air layer attempts at this time. This individual did not flower this year. This is the only population for which no *ex situ* material exists. Therefore, high priorities in the conservation of this species would be to obtain propagation material from this individual, protect this PU from ungulates. It may also be helpful to fertilize this plant to try to get it to flower in the coming years.

North Pālāwai: Although this PU was fenced in 2003 this PU has continued to decline each year. Two mature plants and one seedling remain within the fenced area and one more mature plant occurs outside the fence. Some mature plants have died within the fence, perhaps due to trampling during weeding and over monitoring. Nevertheless, this area contains the most intact habitat for this species with an entirely native canopy and few weeds to control. This PU is also the best represented in *ex situ* propagation; there are 9 seedlings from one fruit collection in 2005, 5 individuals that were rescued seedlings, and 2 plants represented via collected air layers.

NRS have been treating *E. stipoides* along the ridge leading to this PU. This grass is incipient in the area and NRS feel it is beneficial to prevent it from becoming well established in the area. See Chapter 2.1 MIP Weed Management for a more detailed discussion.

Mākaha: A few plants have died since last year. However, this PU is still the largest with 14 individuals. The Mākaha fence will enclose this population and will hopefully be completed by the end of 2006. Currently, feral pigs and weeds threaten this PU. Just one individual flowered this year and the flowers either aborted and fell off the plant at anthesis or remained on the plant but failed to produce any viable seed. Several air layers were also attempted this past spring on one individual however none were successful and this individual died shortly afterwards. It is thought that the air layers were unsuccessful and that the plant died due to these stresses. This PU is not represented in greenhouse stock though some individuals grown from seed exist in micropropagation.

Other PUs:

Wai'anae Kai: NRS assisted the PEP program in fencing this population this year. Two mature and one immature individual were enclosed in this fence. As mentioned this PU has had all the flowers removed for the past 3 years. Given the short flowering season and the fact that these plants are not directly on the trail, NRS believe the removal of these flowers is deliberate. The PEP program is trying to address this concern at the community level. One of the remaining individuals in this PU is represented via a collected air layer. The State's horticulturalist has air layered this greenhouse individual to increase the propagules from this PU.

3.1.15 *Hibiscus brackenridgei* subsp. *mokuleianus*

Requirements for Stability:

- 4 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

4 MFS PUs with stable numbers of mature individuals?	4 MFS PUs with stable structure?	4 MFS PUs with full genetic storage?	4 PUs with fences?	Reintroductions complete?
0/4	0/4	1/4	1/4	0/4

Taxon Level Discussion

The major threats to *H. brackenridgei* are weeds, ungulates, and fire. *Panicum maximum* and *Leucaena leucocephala* both alter habitat and greatly increase fuel loads, and comprise the dominant vegetation at all PUs. At the pre-IT and IT meetings last year NRS and the IT decided to add a fourth Manage for stability population at Keaʻau. This was justified by the extreme fire threat faced by this species as well as the reliance on reintroduction as a management tool for this species. The Keaʻau population will be establish by reintroduction. However, it will take significant efforts including fencing and extensive alien grass control before the site is ready for reintroduction. The three other manage for stability populations were selected to encompass the plasticity present in this species and include the Mākua Valley PU in the Action Area, the Kaimuhole to Palikea Gulch PU on Dole lands, and the Hāʻili to Kawaiu PU on State of Hawaii lands. NRS has worked extensively with weed management and at the same time with fuels modification in the Mākua PU. NRS will rely on reintroduction into more manageable areas for the other PUs as threat control is not feasible at the wild sites. NRS has begun this for the Hāʻili to Kawaiu PU but has struggled to find a manageable site with a willing landowner for the Kaimuhole to Palikea Gulch PU. This year NRS is proposing to pursue a fencing site in Kaʻawa gulch that can be used for reintroduction (see Outplanting Issues section for details). NRS has collected from all wild PUs to fully represent the morphological and genetic variability of this taxon. An arthropod seed predator was identified last year and NRS are still in the process of determining the impacts of this threat. Stock from three of the five wild PUs has been established in *inter situ* sites around the island by NRS for safe keeping. Although none of the PUs currently have stable numbers, NRS are optimistic about the probability of success for stabilization of this taxon, but the weed and fire threats which must be overcome are very significant. Reintroduction of this taxon into more manageable areas will play a major role in overcoming these threats.

Major Highlights/Issues Year 2

- Numbers in the Mākua population are at an all time low. NRS is considering Augmentation.
- NRS began reintroduction at Dillingham Military Reservation (DMR).

- Dole indicated to NRS that they are not interested in allowing large scale conservation actions on their lands in the Lower Ka‘ala NAR area.

Plans for Year 3

- Begin propagation for augmentation if numbers do not increase after the winter of 2006-2007.
- Continue expansion of the DMR reintroduction.
- Balance founders at the Mākua Range Control Living collection.
- NRS are proposing to pursue an exclosure at Ka‘awa gulch for managing the Kaimuhole to Palikea stock

Action Area: In

TaxonName: Hibiscus brackenridgei subsp. mokuleianus TaxonCode: HibBraMok

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makua	Manage for stability	18	8	11	16	4	0	0	0	0	16	4	0	A few plants died in the last year and no seedlings were observed
	Total for Taxon:	18	8	11	16	4	0	0	0	0	16	4	0	

Action Area: Out

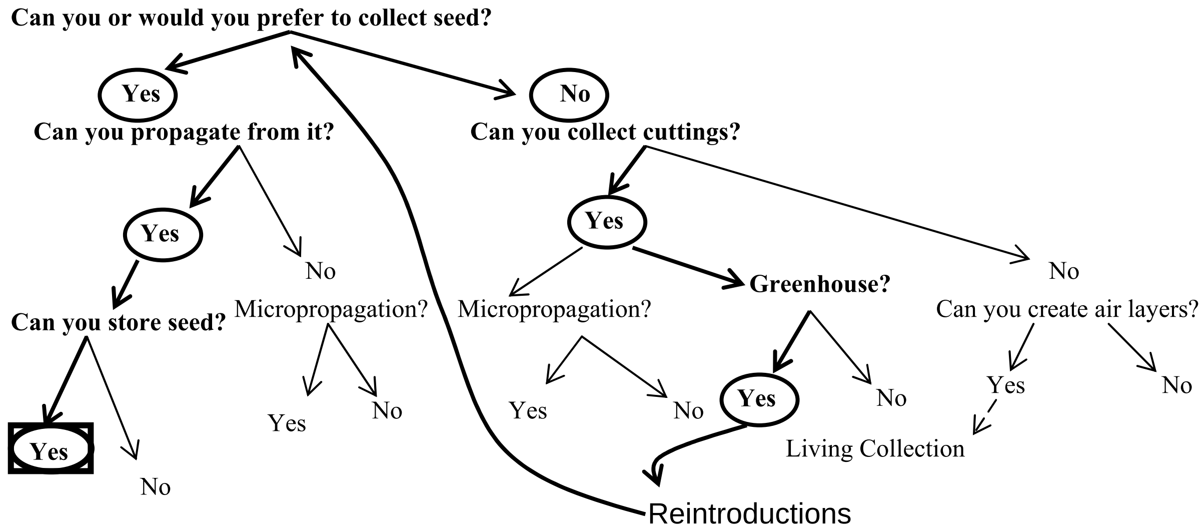
TaxonName: Hibiscus brackenridgei subsp. mokuleianus TaxonCode: HibBraMok

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Haili to Kawaiu	Manage for stability	3	5	5	5	6	0	0	0	0	5	6	0	Immature plants have matured and seedlings survived to become established in the last year
Kaimuhole and Palikea Gulch	Manage for stability	4	230	0	7	230	8	0	0	0	7	230	8	Seedings and more mature plants were observed in known sites in the last year
Kaumoku Nui	Genetic Storage	2	750	0	14	0	0	0	0	0	14	0	0	Mature plants were observed in the best habitat in the last year and most immature plans seen in the past have died
Kihakapu	Genetic Storage	6	316	57	6	316	57	0	0	0	6	316	57	No monitoring in the last year
	Total for Taxon:	15	1301	62	32	552	65	0	0	0	32	552	65	

Propagation and Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Cuttings	Seed	No	Insecticide treatments may help boast viability

Prioritizing Genetic Storage & Propagation Techniques



Collection: Cuttings are easily collected from this species. Cuttings only need to be taken once from the wild plants and then additional cuttings can be made from Army Nursery stock or living collections and many plants can be produced quickly.

Mature plants can produce hundreds of flowers in a season and several hundred seeds in a season. In order to reduce NRS impact at wild sites, few seeds have been collected. Instead, more than 12,000 mature seeds were collected for storage testing from clones of the Mākua plants at Mākua Range Control. Unfortunately, much of the seed collected was not viable. It was observed that all seeds that were not viable had slits through their seedcoat and were rotten inside. NRS and the Seed Conservation Lab investigated the seed collected from other living collections at Koko Head and Ka‘ala Learning Center and found similar results. While monitoring the plants at Range control last year, NRS found an introduced insect, *Niesthrea lousianica Sailer* (Rhopalidae), covering the inside of the opened fruit. The insect was identified by Hawaii Department of Agriculture (HDOA) and has been studied as a biocontrol agent for *Abutilon theophrasti* because it reduces seed viability by 98% (Patterson *et al* 1987). NRS will work next year during collection to determine if this insect is the source of the predation on seeds and develop techniques to control the insect if necessary to improve seed viability. 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 and insecticide was applied to address the insect pests in the area.

Propagation: Clones are easily grown 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. Cutting success is usually 100%. 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 too early in the year or they may become root-bound before planting season. No air-layers have been attempted on this species, but it is likely they would be successful. Only seeds that sink are used for viability tests. Of these seeds, initial germination is

96-100% when sown on paper after scarification. In many cases gibberellic acid (GA3) increases the germination rate. Many scarification techniques have been tested and sanding is the most effective. However, as mentioned before, few viable seeds are produced considering the volume of seed a single plant produces. Cuttings are the preferred method for propagating this species.

Seed Storage Research: Seeds have been stored at -18˚C and 20% relative humidity for four years with a slight drop in viability (initial viability 96%). Seeds have also been stored at room temperature for two years and germination rates had increased. Many collections are currently being stored under a variety of treatments. Seeds of this taxon probably have a high storage potential, and within a couple years the ideal storage conditions will be known.

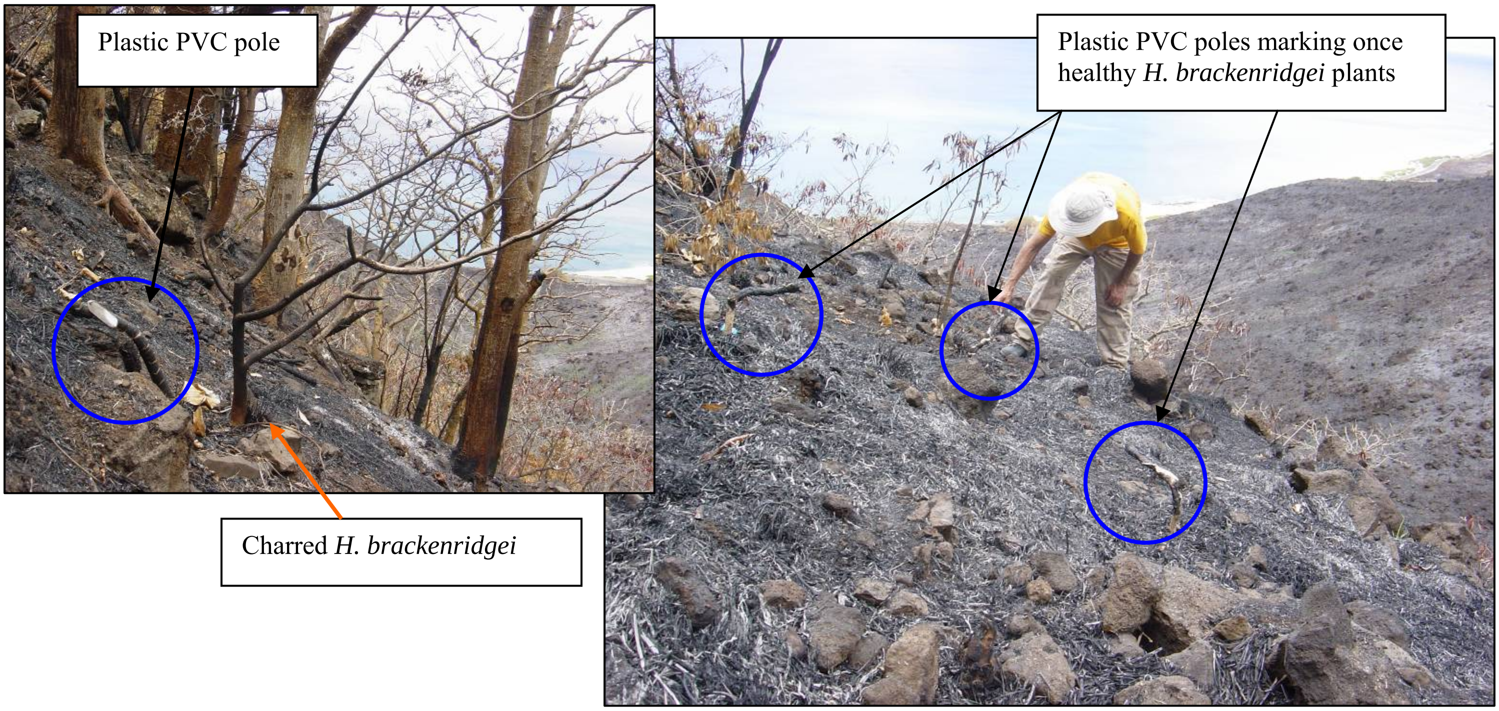
Genetic Storage: Last year 36 founders were represented at the Army Nursery and this year 45 founders are represented. This species appears to do well in cultivation, both in large pots and in the ground. Twenty of the 29 Mākua PU founders are currently represented in botanical gardens and at Mākua Range Control, and 27 will be represented after this year's outplantings. The last two founders are in propagation and will be added next year.

Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Hibiscus brackenridgei subsp. mokuleianus							
Haili to Kawaiu	5	6	3	0	0	6	5
Kaimuhole and Palikea Gulch	7	230	0	1	0	11	11
Kaumoku Nui	14	0	0	0	0	0	0
Kihakapu	6	316	0	2	0	10	11
Makua	16	4	9	10	0	26	19
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				13	0	53	46

Outplanting Issues

Plants grown from cuttings from the Mākua plants have been planted into secure landscaped environments outside of the action area (Status report 2005). NRS will continue to plant at Mākua Range control and will have all but two of the founders represented at this site in the next year (see Genetic Storage section above). NRS does not plan to augment at the other sites this year. The Kaluakauila MU is the only remote reintroduction location with Mākua stock to date. NRS began reintroduction in this MU in December of 2002 in a site at the lower end of the MU in good dry forest habitat. However in 2003, NRS abandoned this site because of fire impacts and impractically fire threat control options. Unfortunately, this area burned again this August all but two of the remaining plants where killed. The remaining individuals were in poor condition and it is likely that they will not survive. The pictures below illustrate the impacts of the fire. Previously healthy and robust plants where killed. It is important to note that the plants had been vigorous and most had reached reproductive age even though NRS had not done any management on the site in the past three years. Unfortunately, fire destroyed almost all of what remained.



NRS has also conducted experimental outplantings in more forested portions of the MU. These are not approved IT restoration sites and NRS has only reintroduced a small number of plants by combining them with other reintroduction efforts in the area. The goal has been to judge performance in this habitat and work out reintroduction techniques that will be applied to larger IT sanctioned reintroductions once habitat is secured. In this effort NRS introduced eight plants to the upper patch in 2004 and another eight in 2005. Of these sixteen, fifteen are still alive and most are healthy. In January 2006 NRS introduced 20 plants to the lower patch. Thus far these plants are performing well. In the next year NRS may add a few additional plants if there are extra plants available after other planting goals are met. No plants are being specifically propagated for this purpose. NRS plan to reintroduce Mākua stock in Kea‘au once habitat is secured.

Twenty-one plants from the Hā‘ili to Kaiwaiu PU where grown from cuttings and reintroduced to Dillingham Military Reservation in November of 2005. In March of this year all plant where alive and most appeared healthy and many where reproductive.

For the Kaimuhole to Palikea PU, NRS is proposing to pursue an exclosure in Ka‘awa gulch. The area is included in the Mokuleia Forest Reserve and is one of the few areas were state land comes down to an elevation that is suitable for *H. brackenridgei*. In the next year NRS will explore the area and determine suitable sites for reintroduction and propose fencing to the State. NRS has approximated the area presented below as the first proposal to stimulate discussion.

Map removed, available upon request

Founders Represented in Outplantings

TaxonName: Hibiscus brackenridgei subsp. mokuleianus **TaxonCode: HibBraMok**

Total Num Plants based upon Plants that have been numbered

PopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Haili to Kawaiu	Manage for stability	14	8
Kaimuhole and Palikea Gulch	Manage for stability	237	1
Kaumoku Nui	Genetic Storage	14	6
Kihakapu	Genetic Storage	322	0
Makua	Manage for stability	29	20
	Total for Taxon:	616	35

Number of Founders = Number of Mature, Immature, and Dead founder plants.
Number of Founders Represented = Number of founder plants represented in reintroductions.

Research Issues

The highest research priority for *H. brackenridgei* is to determine factors impacting seed viability (see Genetic Storage section above).

Taxon Threats

There is no change in the general status of threats to the taxa. (See Status update 2005 for a full discussion.) NRS observed one new potential threat this year, competition with the native species *Sicyos pachycarpus* at the Dillingham reintroduction. This past winter was extremely wet ands this species exploded and grew over many of the H. *brackenridgei*. NRS will be aware of this threat and monitor if the conditions seen this year reoccur. If they do NRS will hand clear plants.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Hibiscus brackenridgei subsp. mokuleianus

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Makua	Manage for stability	Yes	Yes	No

Action Area: Out

TaxonName: Hibiscus brackenridgei subsp. mokuleianus

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Haili to Kawaiu	Manage for stability	Partial	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

Manage for Stability PUs:

Mākua: Individual counts for Mākua are down from last year's counts and seedlings were not seen this year despite monitoring efforts during the wet season. NRS are considering whether augmentation of the site is an appropriate strategy in the next year. This issue should be discussed by the IT and recommendations made. In previous years, it appeared that numbers where steadily rising and that stability could be achieve through germination from the existing seed bank. Recruitment from the wild seed bank would likely increase genetic variation present as seeds germinated in areas without mature plants and likely represented stock that had been extirpated from the site. Unfortunately, in 2005 the upward trend plateaued and this year NRS has documented a decline. The causes for this decline are not clear. Management at the site has not changed and overall the environment is similar to previous years. While the early winter was dry the early spring was very wet and if anything seedlings could have been delayed. One possible explanation is that the germination that was documented in 2001-2003 represents the majority of the seed that is going to grow from the historical seed bank. Perhaps management in these early years has already stimulated and recovered what was present on the site. If this is the case then NRS may not expected continued germination from a historical seed bank. This coupled with present seed predation impacts by *Niesthrea lousianica sailer* and the continued natural senescence of mature plants may be the cause of the decline. The question remains, when should NRS begin augmentation. Perhaps it is worth waiting one additional year and expending and extra effort to survey for seedlings and at the same time work to quantified *Niesthrea lousianica sailer* impacts.

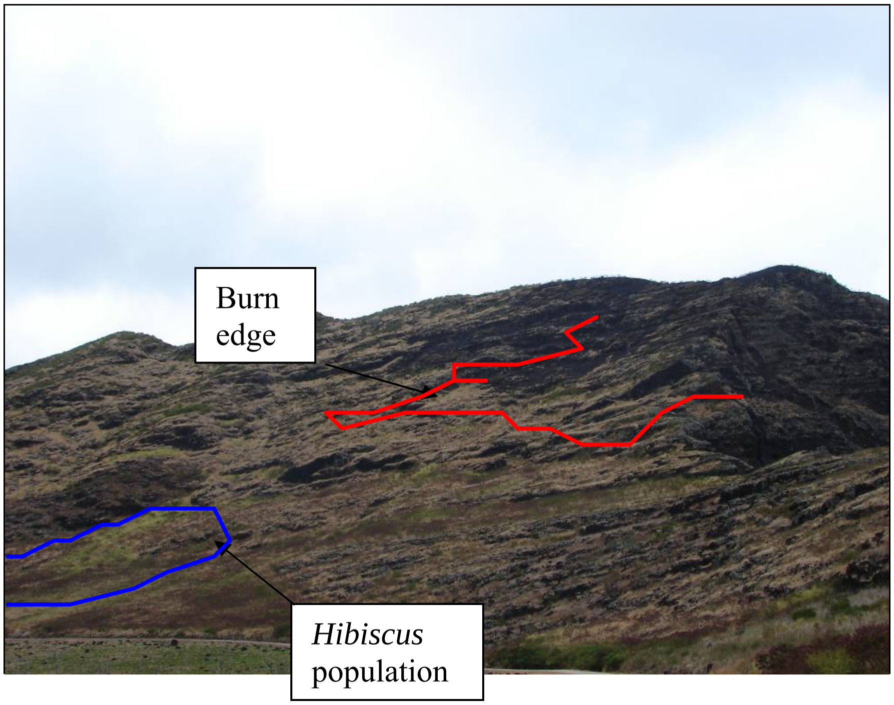
Mākua PU Population Structure

Monitoring Date	Nov 2000	Mar 2001	Jan 2002	June 2003	March 2004	Aug 2005	July 2006
Mature/Juvenile/Seedling	4/2/2	4/2/3	8/5/2	13/6/2	18/8/11	18/8/11	16/4/0

NRS collected cuttings from additional plants to supplement the living collection at Mākua Range Control and will represent all but two founders this year. This year goats did breach the Ohikilolo ridge fence above the population in July. However, goats have not been detected in the area of the *H. brackenridgei*. Unfortunately due to range restrictions on firearm use in the area, it has been difficult to remove these animals. In September NRS resorted to using snares and are confident that this effort will be effective and circumvent the restrictions.

Weed and fuel control by NRS is ongoing and is discussed in the Weed Management chapter. NRS has begun to work with the new Wildland Fire Crew and hope to expand their involvement in the next year. The fire crew plan to double the boundaries of the firebreaks around the patch and extend the 30 m fire break within the road as well as the 10 m break above the road. These breaks were discussed in last year report as they are not installed around the road below the *H. brackenridgei*. The contractor that cleans the road in other areas is not interested in working in this area because of the sloped terrain. NRS hope that the fire crew can clear this area. However, most recently the crew has struggled to get UXO clearance to begin these actions.

On July 3rd 2006 an arsen fire ignited in the vicinity for Kaneana cave. This fire burned up over Ohikilolo and back down toward the *H. brackenridgei* population. It was stopped by helicopter water drops but burned within about 150m of the *H. brackenridgei* plants. This once again illustrates the precarious nature of habitat occupied by this species. For more information see the Memorandum for Record (MFR) included as Appendix III. The picture below illustrates the proximity.



Hāʻili to Kawaiū: NRS monitored both of these PUs this year and collected for reintroduction at a site established this year at Dillingham Military Reservation. As discussed in last years report NRS does not plan any management actions at these wild sites and instead will intensively manage the reintroduction site. Plants appear to be performing well at the site and NRS will continue to augment in the next year. For details seed Outplanting Issues section above.

Kaimuhole and Palikea Gulch: As reported last year much of the area in this PU is unmanageable due to steep terrain and *P. maximum* cover. In addition, Dole is not interested in allowing management of this taxon on their lands. NRS is proposing to pursue an exclosure in Kaʻawa gulch for the management of this stock. See Outplanting Issues Section for details. Presently NRS maintains a small living collection.

Keaau: Currently the Army is in consultation with USFWS concerning the MMR action area and inclusion of the *Gouania vitifolia* population in Keaau. If Keaau is included in the action area the site will be used as a *H. brackenridgei* reintroduction site and will be the fourth Manage for Stability PU, as approved by Mr. Joel Lau. No data concerning Keaau has been entered into the tables since the conclusion of the consultation is still pending.

Other PUs:

Kaumoku Nui: NRS monitored this PU in the last year and found increasing numbers of plants as compared to previous years. These plants are fortunately growing in the best possible habitat in the area. They occur along the top margin of a rocky cliff with sparse grass. The living collection that is housed at the Army baseyard well represents the PU and is available for stock should it ever be needed.

Kihakapu: No updates.

3.1.16 *Melanthera 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 identical adjacent plants. Genetic studies suggest that plant material separated by >2 m is genetically distinct.

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have stable structure?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
3/3	3/3	0/3	2/3	0/0

Taxon Level Discussion

The three largest populations in the best habitat are designated as ‘Managed for Stability’. One PU is in the Action Area (AA) and the other two are located off-site. These three PUs already have stable numbers of individuals, but all threats are not controlled and genetic storage research is still ongoing. Ungulates have been controlled at the ‘Ōhikilolo and Mt. Ka‘ala NAR PUs. The population estimates for this taxon are being revised and are not yet reliable in determining a trend. Many of the estimates are based on observations made many years ago and these sites are still being re-located and monitored more closely by NRS on rappel. In general, this taxon occurs in many locations and where it is found in large numbers appears to be very stable.

Major Highlights/Issues Year 2
- Fire has burned habitat and plants in the ‘Ōhikilolo and Keawa‘ula PUs in the last year. Both were started by arson along Farrington Highway.
- Studies by Dr. Carol Baskin using seeds collected from greenhouse plants have shown that seeds at temperatures of 20C and 15C had significantly more germination than seeds kept at 24C or higher. Testing at Lyon Arboretum has showed that propagation from stored seed may be more successful than propagation of freshly-collected seeds. Both of these preliminary results demonstrate aspects of complex dormancy.

Plans for Year 3
- Conduct a post-fire assessment of the Keawa‘ula PU.
- Continue seed propagation studies to determine the best germination method. Once established, the storage potential can be tested.
- Complete the fence in Mākaha to begin management of that portion of the Kamaile‘unu and Wai‘anae Kai PU.

Action Area: In

TaxonName: Melanthera tenuifolia **TaxonCode: MelTen**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki	Genetic Storage	54	23	4	54	23	4	0	0	0	54	23	4	No monitoring in the last year
Kaluakauila	Genetic Storage	64	20	40	64	20	40	0	0	0	64	20	40	No monitoring in the last year
Keawaula	Genetic Storage	45	15	0	45	15	0	0	0	0	45	15	0	No monitoring in the last year
Ohikilolo	Manage for stability	1242	1	0	1242	1	0	0	0	0	1242	1	0	No monitoring in the last year
	Total for Taxon:	1405	59	44	1405	59	44	0	0	0	1405	59	44	

Action Area: Out

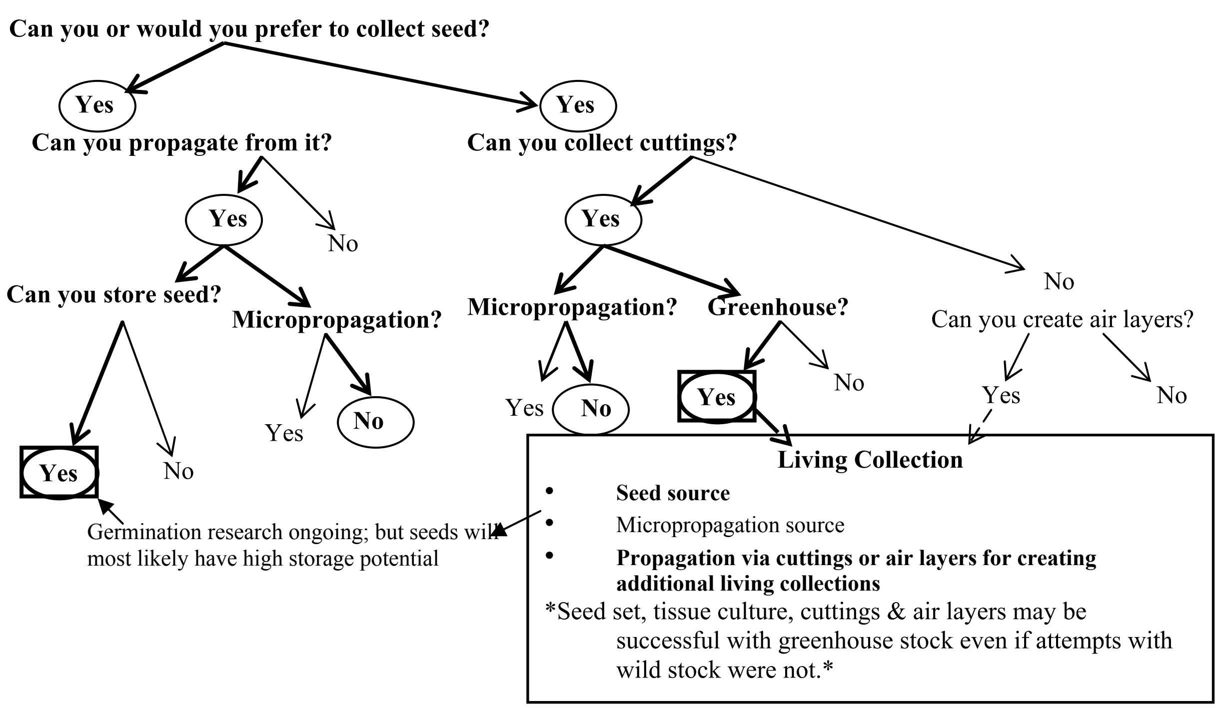
TaxonName: Melanthera tenuifolia **TaxonCode: MelTen**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kamaileunu and Waianae Kai	Manage for stability	831	269	297	880	269	297	0	0	0	880	269	297	Estimates were revised based on observations of the known sites in the last year
Mt. Kaala NAR	Manage for stability	300	0	0	300	0	0	0	0	0	300	0	0	No monitoring in the last year
	Total for Taxon:	1131	269	297	1180	269	297	0	0	0	1180	269	297	

Propagation and Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Cuttings	Living Collection	Yes	Yes, living collections

Prioritizing Genetic Storage & Propagation Techniques



Collection: NRS have had difficulty collecting substantial amounts of seed from wild populations because seeds tend to fall off the peduncle easily and 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 challenging. This year, NRS experimented with collection techniques with plants in the Army Nursery. It was found that a larger number of seeds can be obtained by collecting slightly before maturity and allowing seeds to air-dry and finish ripening post-harvest. Inflorescences at this stage have already had petals dry up and fall off and seeds are swollen, but seed color ranges from yellow-green to yellow and browning. Completely dried flower heads usually contain very little seed because most seed has already fallen out of the inflorescence. Collecting slightly immature seeds allows for a larger number of seed to be collected as well as a larger window of opportunity to collect.

Propagation: *Melanthera tenuifolia* cuttings root easily with a success rate of 50-75%.

Seed Storage: The other challenge with seed from this taxon is overcoming dormancy to allow for substantial germination. Seeds appear viable during germination testing for at least two years, but little or none germinate. The greenhouse living collection has served as an excellent seed source for dormancy, germination, and storage tests. Last year, a collection of seed was sent to Dr. Carol Baskin at the University of Kentucky for dormancy tests. She determined that seeds at temperatures of 20C and 15C had significantly more germination than seeds kept at 24C or higher. Seeds previously tested at the Seed Conservation Lab were kept at 24C. All growth chambers are currently set above 20C as they are mimicking seasonal temperatures. This year, NRS acquired temporary use of three growth chambers at the University of Hawaiʻi for germination studies. One was calibrated to the seasonal low for the average elevation from where the majority of wild plants are located. Another was calibrated to the average year-round temperature and the third chamber was set at the average seasonal high. Though germination was still low, fresh seeds only germinated at the low-temperature growth chamber (20C/14C) two months after sowing (test ongoing). Seeds collected in 2001 from plants grown at the Harold L. Lyon Arboretum greenhouse were also tested in these chambers. Germination of seeds stored dry at 24C was significantly more than seeds stored dry at -18C ($P=0.001$) and seeds tested initially prior to storage ($P = 0.001$). Therefore, due to this complex level of dormancy, propagation from stored seed may be more successful than propagation of freshly-collected seeds. Steps to determine the type of dormancy are underway and will help determine the best way to stimulate germination. Another greenhouse collection was recently collected and split between population sites because they are at different elevations. These tests started in August 2006.

Genetic Storage: NRS has been using clones of wild plants as a living collection 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 nursery space and care. Thus far, NRS have focused clonal nursery storage on fire-threatened sites from within the Action Area. Ongoing seed studies will determine whether or not seed can be stored from this living collection. NRS also brought cuttings in April 2004, August 2004, and July 2005 to the Micropropagation Lab to determine if it is possible to store these clones *in vitro* rather than in a nursery, but all attempts failed. Seeds were also previously brought to the Micropropagation Lab and the few that did germinate did not survive in test tubes.

Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Melanthera tenuifolia							
Kahanahaiki	54	23	4	11	0	38	7
Kaluakauila	64	20	0	8	0	9	1
Kamaileunu and Waianae Kai	880	269	0	0	0	0	0
Keawaula	45	15	0	0	0	0	0
Mt. Kaala NAR	300	0	0	0	0	0	0
Ohikilolo	1242	1	11	16	0	17	13
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				35	0	64	21

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.

Research Issues

Research is being conducted as stated above to determine a reliable germination technique for this taxon.

In the next year NRS will consider the application of high-resolution imagery as a monitoring tool. Such a technique, if successful, would allow NRS to detect population trends without needing to conduct an on-the-ground census of the population.

Taxon Threats

Other than fire, no additional threats have been noted in the last year.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Melanthera tenuifolia

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki	Genetic Storage	No	No	No
Kaluakauila	Genetic Storage	Yes	Yes	No
Keawaula	Genetic Storage	No	No	No
Ohikilolo	Manage for stability	Yes	No	No

Action Area: Out

TaxonName: Melanthera tenuifolia

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kamaileunu and Waianae Kai	Manage for stability	No	No	No
Mt. Kaala NAR	Manage for stability	Partial	No	No

Manage for Stability PUs:

ʻŌhikilolo: Although most plants occur along the 1000 foot tall cliff faces in the middle of ʻŌhikilolo Ridge, the ʻŌhikilolo Makai site is part of the same PU. It is at 400 ft. in elevation and less than 300 meters from the ocean. This site faces distinct challenges from fire, small population and habitat size and has extremely harsh conditions relative to the rest of the PU. NRS have committed significant resources to the *in situ* protection of this site and to capturing it in storage. In the last year, a fire that started from the arson along the highway burned into MMR and likely damaged many of the plants (Appendix II). NRS have excellent *ex situ* representation from this site and are comfortable that the genetic make-up of these plants has been captured. NRS spent many hours on rappel collecting cuttings from plants at this site. Over time, many cuttings have been established from founders that have since died so that currently there are more founders being grown at the Army Nursery than have ever been observed in a single monitoring of the site. In the past year, NRS has begun weed control of along the crest of ʻŌhikilolo Ridge. The target species are primarily *Schinus terebinthifolious* and *Grevelia robusta*.

Kamaileʻunu and Waiʻanae Kai: The managed portion of this PU will be within the first Mākaha fence that will be built in the coming year. In 2004, a total of 63 mature individuals were observed within the proposed fence perimeter and NRS has not monitored the site since. The *M. tenuifolia* habitat to be included in the Mākaha fence is very native and has few weeds of concern. Genetic storage of this PU will begin once a seed storage technique is developed.

Mt. Ka‘ala NAR: There is one site with plants in this PU and when it was monitored in the last year the estimate of the number of plants was not revised. Genetic storage will begin when a seed storage technique can be determined.

Other PUs:

Kahanahāiki: There have been no additional actions in the last year.

Kaluakauila: The fire in the Keawa‘ula area in the last year did not reach any known plants in this PU. A living collection from more than ten founders is being kept in the Army Nursery to produce seed for storage research. There have been no additional actions in the last year.

Keawa‘ula: This PU was burned in the July 2006 Keawa‘ula fire (Appendix IV). On a subsequent visit, NRS noted that several plants and habitat were in fact burned, but given the sprawling habit of the taxon, it was difficult to say for sure how many died as a result of the fire. NRS monitored this PU in September 2004 and estimated that there were more than 45 mature plants. In the coming year, NRS will monitor this PU to determine how many plants are left at this site. There are no collections from this PU in storage.

3.1.17 *Neraudia angulata*

Requirements for Stability:

- 4 Population Units (PUs)
- 100 reproducing individuals in each PU (short-lived perennial, mostly dioecious, prone to large declines or fluctuations in population size)
- Threats controlled
- Complete genetic representation of all PUs in storage

How many of the 4 MFS PUs have stable numbers of mature individuals?	How many of the 4 MFS PUs have a stable structure?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many of the reintroductions are complete?
0/4	0/4	0/4	2/4	0/4

Taxon Level Discussion
There are four PUs designated ‘Manage for Stability’ that represent the full geographic and morphological scope of this taxon. Known locations of the two *Neraudia* varieties show significant morphological differences. See the MIP Stabilization Plan for a more detailed discussion of morphological distinctions between the two varieties, locations of varieties and intermediate plants, and results from genetic analyses. Also the MFS PUs section below further details actions at those PUs. Briefly, most PUs contain plants that trend toward var. *angulata* or an intermediate form. For example, the Mākua and Wai‘anae Kai Makai sites have plants that are considered var. *angulata*. The Wai‘anae Kai Mauka site has intermediate plants. The PUs with var. *dentata* plants are the most imperiled. The PUs with the var. *dentata* are Punapōhaku, Manuwai, and Kapuna. These var. *dentata* sites have low numbers of plants and the heavily degraded habitat continues to be severely impacted by ungulates. Stock from these three sites will be represented in two reintroductions in the much less degraded Kaluakauila MU.

Both Wai‘anae and the Mākua PUs have a relatively large total number of plants (see table below), but also contain many small PUs that require genetic storage. Collections have focused on establishing cuttings from the smallest PUs for living collections in the greenhouse and botanical gardens. In the last year, NRS completed collections from every site except the two large Wai‘anae Kai PUs. All collections are in genetic storage or maintained as living collections. These collections will produce seed stock for further genetic storage as well as storage research.

Neraudia has been outplanted with initial high survivorship at two sites (Mākua and Kaluakauila) and natural recruitment occurred in one of the two sites. Ungulate and weed control is ongoing at most sites and no other significant threats are known at the large PUs.

Major Highlights/Issues Year 2

- A single F_1 mature plant was observed at one augmentation site in the Mākua PU.
- Collections have been established from all but the two large Waiʻanae PUs in the last year for a living collection in the greenhouse.
- Cuttings were established from the newly discovered Punapōhaku plant.
- Seed storage data showed high germination rates after being kept in the dark for two years. This raises NRS hopes that seed banks may assist in the recovery of populations at extirpated sites.
- One additional wild plant was observed in Kapuna gulch.

Plans for Year 3

- Continue monitoring wild and outplanted plants to guide reintroduction plans and gather further information about life histories and reproductive strategies.
- Continue to supplement the Kaluakauila PU with var. *dentata* stock from Punapōhaku Manuwai, and Kapuna PUs at two separate sites.
- Augment the Mākua PU with stock established with cuttings.
- Pursue the ungulate control plans proposed to the State for the Waiʻanae Kai Mauka PU.
- Monitor and collect from the new plant in the Kapuna PU.
- Continue pursuing discussions with the State for fencing at the Manuwai MFS PU in order to manage a reintroduction for stability at that site or decide on another MFS PU elsewhere.

Population Unit Status

Action Area: In

TaxonName: Neraudia angulata **TaxonCode: NerAng**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kapuna	Genetic Storage	1	0	0	2	0	0	0	0	0	2	0	0	One additional plant was observed in the known site
Makua	Manage for stability	29	60	26	40	6	0	4	0	0	44	6	0	Many additional plants were observed in the known sites
Punapohaku	Genetic Storage	1	0	0	1	0	0	0	0	0	1	0	0	The single plant has been observed many times in the last year
	Total for Taxon:	31	60	26	43	6	0	4	0	0	47	6	0	

Action Area: Out

TaxonName: Neraudia angulata **TaxonCode: NerAng**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Halona	Genetic Storage	8	0	0	30	4	0	0	0	0	30	4	0	Many more plants were observed in the known sites
Leeward Puu Kaua	Genetic Storage	3	0	0	4	0	0	0	0	0	4	0	0	One additional plant was observed in the known site
Makaha	Genetic Storage	16	1	0	16	1	0	0	0	0	16	1	0	No monitoring in the last year
Manuwai	Manage for stability	1	0	0	0	0	0	0	0	0	0	0	0	The last plant at this site died in the last year
Waianae Kai Makai	Genetic Storage	46	35	0	46	35	25	0	0	0	46	35	25	Monitoring in the last year found seedlings amoungst the known plants
Waianae Kai Mauka	Manage for stability	49	4	50	57	28	54	0	0	0	57	28	54	Additional plants were observed within the known site in the last year
	Total for Taxon:	123	40	50	153	68	79	0	0	0	153	68	79	

Action Area: Reintro

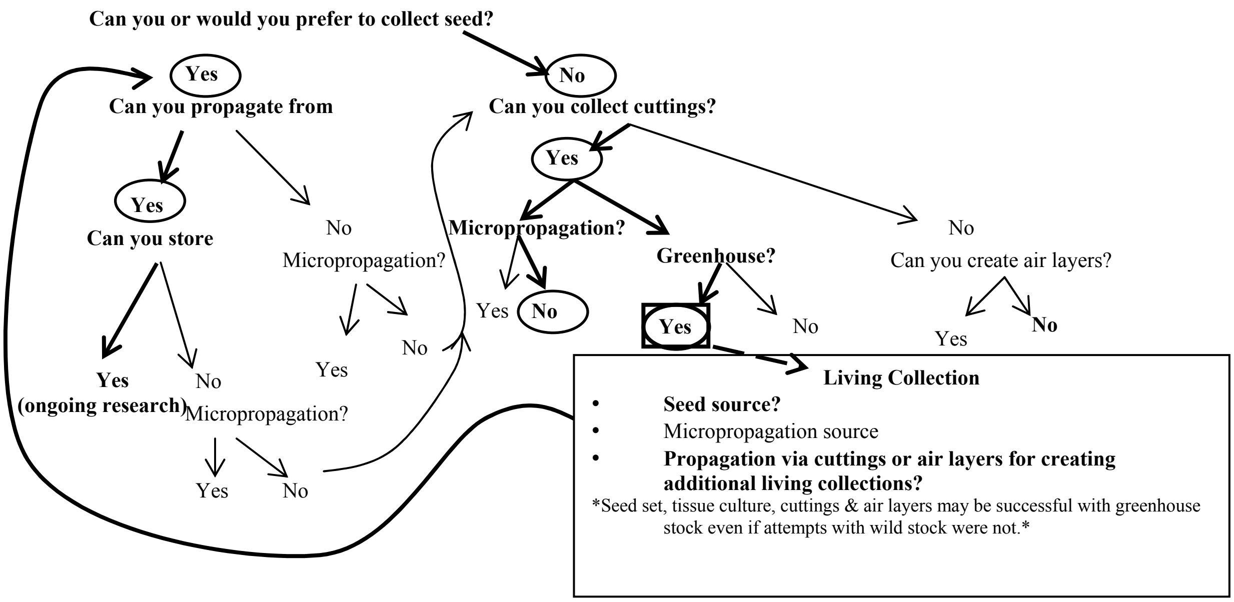
TaxonName: Neraudia angulata **TaxonCode: NerAng**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaluakauila	Manage reintroduction for stability	13	0	0	0	0	0	27	0	0	27	0	0	Additional plants were reintroduced into the existing site
	Total for Taxon:	13	0	0	0	0	0	27	0	0	27	0	0	

Propagation & Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Cuttings	Living Collections & Seed	No	Yes, living collections, possibly including cross pollinations

Prioritizing Genetic Storage & Propagation Techniques



Collection: This taxon produces very few mature fruit at one time. Fruit can ripen slowly and take over a month to reach maturity. Because of this, it has been difficult to obtain large enough collections from wild plants to run seed storage trials or obtain genetic storage goals. Instead, cuttings are taken to meet propagation and storage goals.

Propagation: 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. Less than 50% of cuttings made from wild plants in 2005 were successful. Cutting success is highly variable for both wild and greenhouse stock, but cuttings from greenhouse stock (typically > 50%) do have a higher success rate than cuttings from wild stock (typically < 50%). NRS observed that many of these initial cuttings will flower and set fruit within one year, producing much more seed than the wild plants. In the coming year, NRS will attempt to establish clones in micro-propagation from greenhouse stock to see if this is more successful than wild material. Tissue culture attempts for both seed and cuttings from wild plants have failed.

Seeds have a specific degree of physiological dormancy that can only be broken with a very long period of warm, moist conditions. Fresh seeds, therefore, germinate very slowly over a year. Most germination occurs four to seven months after sowing. There has been over 50% germination from two different seed lots collected in 2003 and 2004, but many other collections have lower viability. Seedlings, however, are vigorous and easily propagated.

Seed Storage Research: Eight large seed collections have been made from the greenhouse stock from 2004 to the present. Each consecutive collection has been tailored to results from tests on previous collections and focused on overcoming dormancy and storage issues.

Preliminary tests on this taxon for the three tested temperatures (-18C, 4C, 24C) from 8% - 33% relative humidity (RH) show a significant decrease in viability after only one year. Seeds may be desiccation-sensitive and are likely not able to be dried for storage purposes. Seeds retained the highest viability after two years of dry storage (20% relative humidity) when frozen, but germination dropped from 56% to 11%. Soil seedbank potential tests were also initiated for two of the earlier collections. Seeds were stored in the dark at 24C and 100% RH for six months, one year, and two years, at which time seeds were placed in the light. Eighty-five to 90% of those seeds germinated within two weeks for all three time intervals. Further dark tests at different temperatures and for different lengths of time were consequently conducted. Seeds did not germinate when stored dark at 100% RH at 4C or 24C for one, two, or three months. Since all fresh germination tests are conducted in a growth chamber reflecting monthly average day and night temperatures to reflect field conditions; dark tests are also being conducted at these temperatures instead of a consistent 24C. Results support the taxon’s inability to withstand desiccation. Seeds can be stored imbibed, however, for at least two years, while maintaining high viability. Trials have been set up to test these conditions up to 20 years.

Genetic Storage: NRS now have established material propagated from collections made in 2003-2004 from the Mākua, Manuwai, Kapuna, Hālona , and Leeward Pu‘u Kaua PUs that currently serve as nursery stock plants. Eight large seed collections have been made for research purposes from this living collection. Living collections will continue to be maintained and propagated for reintroductions. Due to morphological differences within the var. *dentata* and the questionable breeding system of the taxon, pollen from the Punapōhaku founder, which has repeatedly been observed to have only male flowers, was collected multiple times this year and is being stored. Several greenhouse clones from one of the Kapuna founders have been isolated at the Army greenhouse. These plants have been observed to only have female flowers, though there is potential for this stock to produce male flowers (see below: Unique Species Observations). One of these Kapuna plants was pollinated with fresh-collected pollen from the Punapōhaku founder and 47 seeds were collected (4 are currently being germinated under the dark conditions described above). After 3 months of storage, some of the pollen was removed from storage and the isolated Kapuna stock was pollinated again. One mature fruit developed and eight immature fruit are currently developing. These attempts have been made in order to make certain that these founders will cross prior to mixing at the reintroduction site and to study the progeny, particularly in morphology and vigor. Stored pollen will continue to be tested to determine success of the storage technique.

Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Neraudia angulata							
Halona	30	4	0	0	0	12	4
Kapuna	2	0	0	1	0	1	1
Leeward Puu Kaua	4	0	0	0	0	2	0
Makaha	16	1	0	2	0	8	2
Makua	40	6	26	0	0	17	1
Manuwai	0	0	4	0	0	2	2
Punapohaku	1	0	0	0	0	1	0
Waianae Kai Makai	46	35	0	0	0	0	0
Waianae Kai Mauka	57	28	1	0	0	0	0
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				3	0	43	10

Unique Species Observations

More research is necessary on the reproductive biology of this taxon as most plants appear to be dioecious. NRS have observed fruit production or evidence of recruitment in nearly all of the PUs, including the Kapuna PU which contained only a single plant for many years until a new plant was observed this year. The wild Kapuna plant was observed with immature fruit in 2002, suggesting it is possible for a plant to simultaneously have both male and female flowers (and be monecious). It remains unclear whether this is a common occurrence given the low number of extant plants and the difficulty of regularly monitoring wild populations. It is possible that the Kapuna plant with immature fruit did not contain viable seed. Notably though, NRS have never observed a mature fruit without a seed.

In the last year, NRS closely monitored a few outplanted individuals that were grown from cuttings from the original Kapuna founder. These plants were previously observed to be fruiting, but it remains unclear if the fruit was produced from male and female flowers on the same plant or from different individuals. Monitoring this past year unfortunately failed to resolve this question of whether this species is functionally dioecious given an asynchrous flowering strategy or whether nearly all plants are strictly dioecious with unisexual flowers.

The Punapōhaku site also contains only one wild plant, only male flowers and no fruit have been observed since its discovery in April of 2005. NRS will continue to monitor all PUs to determine if larger populations are necessary to increase chances of pollination between functionally dioecious plants. It may be that single plants or clones from a single plant like the Kapuna and Punapōhaku PUs are not strictly unisexual and are able to produce male and female flowers on a single plant at the same time, but that this is not a frequent occurrence. If this is the case, NRS will revisit the number of plants necessary for a stable population to ensure adequate seed production. If plants are found to be unisexual (like the Punapōhaku plant), NRS staff will adjust management efforts accordingly. NRS continue to record the sex of all monitored plants over time.

Outplanting Issues

In the last year, NRS planted a single plant from the Manuwai stock into the Upper Kaluakauila reintroduction that had only Kapuna stock. At the time, the Kapuna plants had only female flowers and the Manuwai plant had only male flowers. At the MIP meeting in January of 2005, botanist Joel Lau with the HBMP, suggested that we remove the Manuwai stock to keep it separate as it is morphologically distinct. The Manuwai plant was removed from the site and all the immature fruit was removed from the Kapuna stock around it to prevent recruitment from a mixed Kapuna/Manuwai propagule. During this time, only female flowers were observed on the Kapuna stock and no male flowers have been observed since.

For further outplanting issues, see the Kaluakauila and Mākua MFS PUs discussion later in this section.

Founders Represented in Outplantings

TaxonName: Neraudia angulata **TaxonCode: NerAng**

Total Num Plants based upon Plants that have been numbered

PopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Halona	Genetic Storage	34	0
Kaluakauila	Manage reintroduction for stability	0	0
Kapuna	Genetic Storage	2	1
Leeward Puu Kaua	Genetic Storage	4	0
Makaha	Genetic Storage	17	0
Makua	Manage for stability	72	4
Manuwai	Manage for stability	4	0
Punapohaku	Genetic Storage	1	0
Waianae Kai Makai	Genetic Storage	81	0
Waianae Kai Mauka	Manage for stability	86	0
	Total for Taxon:	**301**	**5**

Number of Founders = Number of Mature, Immature, and Dead founder plants.
Number of Founders Represented = Number of founder plants represented in reintroductions.

Research Issues

NRS will continue to monitor the reproductive biology of this taxon in order to determine the appropriate number of plants for stable, naturally recruiting reintroduction sites.

Surveys

No surveys have been proposed for this taxon in the coming year. However, NRS will continue to survey around known populations for additional plants during regular monitoring.

Taxon Threats

There are no additional threats to report from the last year.

Population Unit Level Discussion

Action Area: In

TaxonName: Neraudia angulata

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kapuna	Genetic Storage	Yes	No	No
Makua	Manage for stability	Yes	Partial	No
Punapohaku	Genetic Storage	No	No	No

Action Area: Out

TaxonName: Neraudia angulata

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Halona	Genetic Storage	No	No	No
Leeward Puu Kaua	Genetic Storage	No	No	No
Makaha	Genetic Storage	Partial	No	No
Manuwai	Manage for stability	No	No	No
Waianae Kai Makai	Genetic Storage	Partial	Partial	No
Waianae Kai Mauka	Manage for stability	Partial	No	No

Action Area: Reintro

TaxonName: Neraudia angulata

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kaluakauila	Manage reintroduction for stability	Yes	Yes	Yes

Manage for Stability PUs:

Mākua: In March 2005, two strategic fences were erected protecting the area with the largest amount of plants from pigs. NRS hope that this effort will allow *N. angulata* to colonize the area previously disturbed by pigs. At the time of fence construction, about 65 mature and 27 immature plants were present. In the coming year, NRS will monitor the wild sites and inspect the fence.

There are three *in-situ* sites in Lower Mākua and one augmentation site. NRS augmented the Mākua PU with 26 mature plants in April 2003. Cuttings from the Mākua PU were used as source material for this augmentation. Survivorship was 100% in December of 2003 and the site was supplemented with an additional 21 plants (all juvenile) at that time for a total of 47 plants on site. In August of 2005, survivorship for the entire site was ~75%. Most of the plants that died were from the first, April 2003 planting cohort. In January of 2006, only 10 out of 47 reintroduced plants remained. Notably, one large mature plant had also recruited naturally. This is the first instance of a naturally recruiting plant within a reintroduction site. As of June 2006, only four plants remain including the F_1 plant. While the outplants unfortunately were fairly short lived, this experimental outplanting demonstrated that natural recruitment from outplants is possible. Since most of the 47 outplants had about a 3 year life span, establishing larger outplanted populations and multiple plantings will likely be necessary to get obtain recruitment. Additionally, planting younger (but still hardy enough) plants may also be required to ensure the longest reproductive period possible at outplanting sites.

Kaluakauila:

The Kaluakauila MU currently contains one reintroduction site that is a MFS PU and was founded with stock from the Kapuna PU as discussed above. In the coming year, NRS will begin to supplement this Upper Kaluakauila site with stock from the Punapōhaku founder. The goal for this site is 105 plants with equal founder and gender representation. This coming year, NRS will establish a new site within Kaluakauila using founders from the Manuwai PU. This new site called Lower Kaluakauila will eventually also contain 100 plants. Rugged terrain between the first site and the new second site effectively separates these two reintroductions. Reproductive isolation between the two sites is intended to keep the Manuwai var. *dentata* stock but to keep separate as it is morphologically distinct.

Since the first outplantings in 2003, survivorship of outplants has been high at Kaluakauila. (90% as of August 2006). 27 mature plants currently remain on site out of a total of 30 plants. Last year 17 plants were added to this site using Kapuna stock. Plants have been observed with mature fruit, but no recruitment has been noted. NRS will continue to observe plants to determine the sex of individual plants and how often viable seed is produced.

Reintroduction Plan for Kaluakauila PU

Site	Founding PU	# of founders in each PU	Target # of plants from each founder	Target # of outplants	Existing # of plants from founders	Type of stock used for outplantings
Upper Kaluakauila	Kapuna Punapōhaku	2 1	35,35 35	105	27 N/A	Cuttings Cuttings
Lower Kaluakauila	Manuwai	4	25	100	N/A	Cuttings

Wai‘anae Kai Mauka: There have been no additional actions in the last year. A fence will be built pending approval of a proposal submitted to the State in 2004.

Manuwai: In just 3 years the number of plants at this site went from 11 mature individuals and one juvenile to zero because of ungulates. Plants were first found in March of 2003 during surveys of the Mokulē‘ia Forest Reserve. NRS submitted a proposal to the DLNR to build a fence around the plants in 2003 but have still not received a response to the proposal. No plants were found as of July 2006. Fortunately, propagules were collected during a monitoring visit and are being grown at the Army Nursery. These Manuwai plants will be cloned and planted into the Lower Kaluakauila site when ready (see Kaluakauila PU discussion above.) NRS will continue to monitor for regeneration at the extirpated Manuwai wild site in the coming year.

Given the extirpation of all plants at the Manuwai site, NRS question whether this PU should remain a MFS PU given the reluctance of State officials to agree to fencing in this area. For the coming year, NRS will secure the Manuwai stock at Kaluakauila (as well as in living collections) and continue pursuing fencing at Manuwai for the eventual reintroduction of this taxon to the area. Unless more plants are found at Manuwai, this will be the second site where this taxon will be managed as a reintroduced population. This is a far more uncertain process of managing this taxon for stability than augmenting or stabilizing an existing population.

Other PUs:

Punapōhaku : Discovered in 2005, this site has only one plant (var. *dentata)*. Stock has been secured from this plant and will be used in the Kaluakauila reintroduction as discussed above. No other management is planned for this site other than weeding around the plant and regular monitoring.

Kapuna: Discovered in 2000, this site currently has two plants, both var. *dentata*.. The site was severely degraded and dominated by weeds when first found and only one plant known at that time. Cuttings of this plant were taken to the Army Nursery and cloned. Significantly, another plant was found at this site in the last year. This second founder will be monitored and collected from and both founders will be used to supplement the Kaluakauila reintroduction. The goal is to represent this PU in a reintroduction site that is equally mixed with the newly discovered Punapōhaku PU (see Kaluakauila PU discussion above).

Mākaha: There have been no additional actions in the last year. Cuttings from 8 founders are now growing in the Army Nursery.

Leeward Pu‘u Kaua: In the last year, NRS monitored and collected from one of the two historical locations in this PU. Collections were made from three mature founders, but cuttings from only two were founders were successfully established in the greenhouse. This site has the only population of feral goats in the southern leeward Wai‘anae Mountains and NRS will be working with the Navy and State agencies to control this growing goat population in the coming year. NRS will continue to maintain the living collection and monitor the second remaining historical site in the PU.

Hālona: All three sites in this PU have been monitored and collected from in the past year. The number of founders at this site increased from 8 mature individuals in 2005 to 34 individuals in 2006 (including 4 immatures). These revised population estimates are the result of additional surveys at the same sites and not the result of discovering new population locations. Only two observations of all three sites were made in the last five years. Collections were made from 15 of 34 total founders across the three sites. NRS expect that these most recent collections will be successful in the greenhouse and maintained as living collections to meet genetic storage goals.

Wai'anae Kai Makai: This PU was monitored in January 2006 and no change in population size or distribution was noted. A fenceline was scoped to protect the MFS PU of *Nototrichium humile* that also occurs in the same area. Fencing plans to exclude pigs and goats were submitted to the DLNR and NRS is awaiting the DLNR's response. A few large *Casuarina equisitifolia* and *Grevillea robusta* trees were removed from this area in the last year. NRS will continue to monitor these sites, control a few large invasive trees and work with DLNR to fence this gulch. Genetic storage collections will begin in the next year in order to establish a small living collection. Hopefully seeds can also be obtained from either the wild plants or from living collection plants for storage.

3.1.18 *Nototrichium humile*

Requirements for Stability:

- 4 Population Units (PUs)
- 25 reproducing individuals in each PU (long-lived perennial)
- Threats controlled
- Complete genetic representation in storage of all PUs

How many of the 4 MFS PUs have stable numbers of mature individuals?	How many of the 4 MFS PUs have stable structure?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
4/4	0/4	0/4	2/4	0/2

Taxon Level Discussion

There are a total of 13 *Nototrichium humile* PUs known with plants. Four PUs are designated as ‘Manage for Stability’ because this taxon is highly threatened by fire from Army training in Mākua. Two MFS populations are off-site and two are within the Action Area (AA). Each of these four PUs has stable population numbers of mature plants, but ungulates are not excluded from two of the four PUs yet. At this time genetic storage is done by establishing collections from cuttings of wild plants. Most of these collections are currently kept in the greenhouse, however a more long-term *inter-situ* or *ex-situ* site must be determined.

Major Highlights/Issues Year 2

- Collections of plants grown from cuttings have been established in the greenhouse from seven of the thirteen known PUs.
- Living collections of two PUs have been established at Waimea Botanical Garden.

Plans for Year 3

- Conduct a post-fire assessment of the Keawa‘ula PU.
- Conduct a thorough census of the population structure in the four MFS PUs.
- Continue to establish plants from small and fire threatened PUs in living collections at Botanical Gardens and other similar sites. These will be used to observe flowering and fruit production in order to guide future collection and storage plans.
- Pursue the ungulate control plans submitted to the State for the Wai‘anae Kai PU.
- NRS will strive to visit the remaining small PUs that have not been monitored recently and take cuttings to establish a living collection.
- Determine feasibility of seed collection and storage using living collections.

Action Area: In

TaxonName: Nototrichium humile **TaxonCode: NotHum**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki	Genetic Storage	34	0	0	70	4	0	0	0	0	70	4	0	No monitoring in the last year
Kaluakauila	Manage for stability	198	35	0	198	35	0	0	0	0	198	35	0	Monitoring found no change
Keaau	Genetic Storage	21	31	0	21	31	0	0	0	0	21	31	0	No monitoring in the last year
Keawaula	Genetic Storage	138	5	0	138	5	0	0	0	0	138	5	0	No monitoring in the last year
Makua (East rim)	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Makua (south side)	Manage for stability	56	19	0	56	1	0	16	0	0	72	1	0	Plants in the augmentation have beome mature
Pahole Gulch	N/A	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Punapohaku	Genetic Storage	302	14	7	302	14	7	0	0	0	302	14	7	No monitoring in the last year
	Total for Taxon:	749	104	7	785	90	7	16	0	0	801	90	7	

Action Area: Out

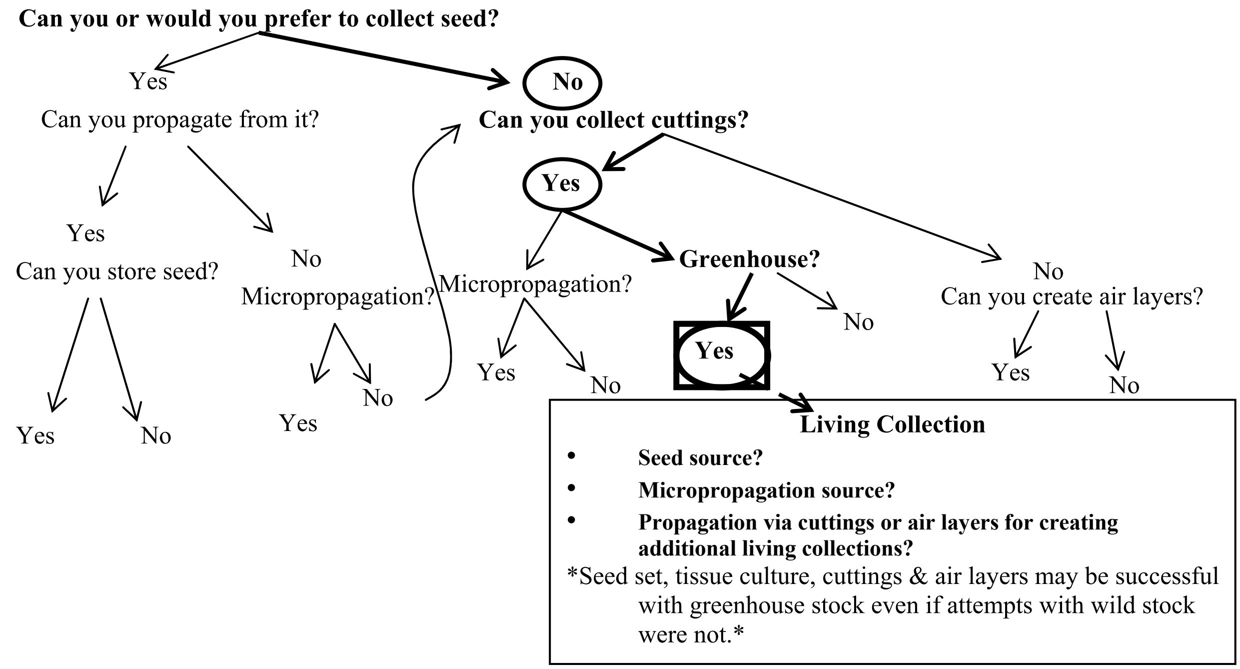
TaxonName: Nototrichium humile **TaxonCode: NotHum**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaimuhole and Palikea Gulch (Kihakapu)	Manage for stability	58	7	0	58	7	0	0	0	0	58	7	0	No monitoring in the last year
Kealia	Genetic Storage	3	0	0	0	0	0	0	0	0	0	0	0	Plants not observed during surveys in the last year
Keawapilau	Genetic Storage	5	0	0	5	0	0	0	0	0	5	0	0	No monitoring in the last year
Kolekole (east side)	Genetic Storage	12	0	0	12	0	0	0	0	0	12	0	0	No monitoring in the last year
Makaha	Genetic Storage	16	3	0	16	3	0	0	0	0	16	3	0	No monitoring in the last year
Nanakuli	Genetic Storage	5	0	0	5	0	0	0	0	0	5	0	0	No monitoring in the last year
Puu Kaua (Leeward side)	Genetic Storage	12	0	0	12	0	0	0	0	0	12	0	0	No monitoring in the last year
Waianae Kai	Manage for stability	224	5	0	224	5	0	0	0	0	224	5	0	Monitoring found no change
	Total for Taxon:	335	15	0	332	15	0	0	0	0	332	15	0	

Propagation and Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Cuttings	Living Collection	Yes	Yes, further pollination studies needed

Prioritizing Genetic Storage & Propagation Techniques



Collection: Seed collection has been difficult and germination very low. *Nototrichium 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 50 fruits submitted to the Seed Conservation Lab had viable seed that germinated. NRS will use living collections in the next year to investigate the dynamics of fruiting and collection possibilities.

Propagation: This taxon is propagated via cuttings. NRS have had an 80% success rate in propagating cuttings of this taxon.

Seed Storage Research: This is not able to happen until NRS studies why there is low to no seed set. NRS will use living collections to research the issue and design a strategy to approach this question using living collections.

Genetic Storage: Genetic storage is currently being achieved via the use of cuttings, but this approach consumes space and labor. See Genetic Storage Summary Table below for current numbers of plants stored. There are somewhat low numbers from each population, however NRS feel at this point in time it is more important to collect a small sample of representatives from across several populations to use for seed-set/storage research at an *ex-situ* site. Fire threatened populations are however priority populations to collect from. This year, NRS will focus on obtaining genetic representation from Kea‘au and Nānākuli PUs, as both are fire threatened, both have very low numbers of plants, and both without active management by NRS. These plants will be kept in the Army Nursery until an *ex-situ* is established. Once seed collection information is better understood, NRS will then begin comprehensive genetic storage via seed collection, again prioritizing collection from fire-threatened populations. NRS have already established an ex-situ site at Waimea Botanical Gardens where representatives from the fire threatened "C-Ridge" in the Kahanahāiki PU, as well as plants from elsewhere in Mākua are established. NRS will also bring more cuttings to the Micropropagation Lab for testing.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Nototrichium humile							
Kahanahaiki	70	4	1	5	0	9	5
Kaimuhole and Palikea Gulch (Kihakapu)	58	7	0	0	0	13	12
Kaluakauila	198	35	0	5	0	0	4
Keaau	21	31	0	0	0	0	0
Kealia	0	0	0	0	0	0	0
Keawapilau	5	0	0	0	0	5	4
Keawaula	138	5	0	0	0	9	9
Kolekole (east side)	12	0	0	0	0	9	8
Makaha	16	3	0	0	0	0	0
Makua (south side)	56	1	0	0	0	0	0
Nanakuli	5	0	0	0	0	0	0
Pahole Gulch	0	0	0	0	0	0	0
Punapohaku	302	14	0	0	0	12	7
Puu Kaua (Leeward side)	12	0	0	0	0	0	0
Waianae Kai	224	5	0	0	0	5	4
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				10	0	62	53

Outplanting Issues

There have been no new outplanting issues in the last year. NRS has only conducted one outplanting with this species, in Lower Mākua. NRS visited this site this year and the plants are extremely vigorous. Should outplanting ever be needed, it appears it will be successful with this species.

Research Issues

This year NRS will use the living collections to research seed set to determine more effective seed collection methods.

Taxon Threats

No additional threats have been noted in the last year.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Nototrichium humile

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki	Genetic Storage	Partial	No	No
Kaluakauila	Manage for stability	Yes	Partial	Partial
Keaau	Genetic Storage	No	No	No
Keawaula	Genetic Storage	No	No	No
Makua (south side)	Manage for stability	Partial	Partial	No
Pahole Gulch	N/A	Yes	No	No
Punapohaku	Genetic Storage	No	No	No

Action Area: Out

TaxonName: Nototrichium humile

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kaimuhole and Palikea Gulch (Kihakapu)	Manage for stability	No	No	No
Kealia	Genetic Storage	No	No	No
Keawapilau	Genetic Storage	No	No	No
Kolekole (east side)	Genetic Storage	Partial	No	No
Makaha	Genetic Storage	No	No	No
Nanakuli	Genetic Storage	No	No	No
Puu Kaua (Leeward side)	Genetic Storage	No	No	No
Waianae Kai	Manage for stability	No	No	No

Manage for Stability PUs:

Kaimuhole and Palikea Gulch: No additional monitoring of this PU occurred in the last year. Plants from 13 founders in this PU are established in the Army greenhouse. There is no ungulate control in this PU. A proposed fencing project was not approved by the land manager, Dole Food Co.

Kaluakauila: There was no additional monitoring of this PU in the last year. The population estimate is likely still too low and NRS will strive to amend this in the coming year. Because this PU is so large, it has not yet been a priority to establish a living collection of this stock. All known threats are currently controlled in this PU. A fire did however threaten this management unit and burned just meters within the fence (see Appendix IV for more details).

Mākua (South Side): A comprehensive monitoring of all the gulches encompassed by this PU has never been conducted and the population estimate may be too low. Three strategic fences have been built to restrict pigs by blocking the openings to very deep and steep gulches. These fences protect at least 50 individuals. At one site, 17 of the 18 plants that were outplanted in 2003 to augment the site remain and are growing vigorously.

Wai‘anae Kai: There has been no revision of the population estimates for this PU after the largest site was monitored last year. There are likely many more small groups of plants in this PU that have not been observed. Collections have been secured from plants in this PU in the greenhouse. NRS has proposed to the State to build strategic fences in this PU and this is pending approval.

Other PUs:

Kea‘au: No additional actions have been taken for this PU in the last year. Collection from this PU is scheduled for this coming year.

Keawa‘ula: NRS visited this site in September 2004 and observed 138 mature and five immature trees. The forest patch around this population is almost completely surrounded by *Panicum maximum* and is shrinking with each successive fire. A fire in July, 2006, again surrounded the forest patch. On a subsequent visit, NRS did not note any further reduction in habitat for this taxon (see Appendix IV for more fire details). NRS have some genetic representation from this population. Fuel loading of *P. maximum* is the biggest threat to this site.

Mākua (East Rim): No additional actions have been taken for this PU in the last year.

Kahanahāiki: NRS currently have 28 representatives from the unmanaged portion of this PU planted at Waimea Botanical Gardens. This year, NRS collected from unrepresented plants from this site to increase the number of individuals at this *ex-situ* site.

Punapōhaku: No additional actions have been taken for this PU in the last year. NRS have a small number of representatives from this population.

Ke‘ālia: HBMP botanist, Joel Lau visited this site recently and reported that no plants were observed.

Keawapilau: NRS have established a living collection from all five plants at this site. No monitoring has been done in the last year.

Kolekole (East Side): NRS visited both the southern and northern sites in this PU this year and collected from plants at both sites. There is an exclosure around the northern site that the Navy built several years ago.

Mākaha: No monitoring of this PU was done in the last year. A strategic fencing project is currently under construction to protect a site for other taxa. This fence does not include any *N. humile,* however it would be a likely site for augmentation or genetic representation of this PU, should an outplanting of this population be necessary.

Nānākuli: No additional actions have been taken for this PU in the last year. Collection from this PU is scheduled for this coming year.

Pu‘u Kaua (Leeward side): No additional actions have been taken for this PU in the last year.

3.1.19 *Phyllostegia kaalaensis*

Requirements for Stability:

- 4 Population Units (PUs)
- 50 genetically unique, reproducing individuals in each PU (short-lived perennial, seems to be primarily a vegetative reproducing taxon)
- Threats controlled
- Complete genetic representation of all PUs in storage

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have stable structure?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
0/3	0/3	0/3	0/3	0/3

Taxon Level Discussion

There are currently no known wild populations of this species. NRS and DLNR are maintaining the remaining stock from Palikea Gulch, Wai‘anae Kai, and Keawapilau to Pahole PUs as stock plants and living collections. NRS is currently focusing on conserving the *ex situ* stocks and trying to ensure that the stock is represented in as many plant propagation facilities as possible. The plants do not easily produce seeds in the greenhouse and cuttings are used to maintain the stock and produce propagules for reintroduction. There are two reintroduction sites within the Keawapilau to Pahole PU which have not been very successful. NRS are looking into possible microsite differences and greenhouse stock age to explain the low success rate.

Major Highlights/Issues Year 2

- DLNR and NRS attempted to collect seed from greenhouse stock for germination studies.
- NRS and HBMP conducted several surveys for wild populations, none were found.

Plans for Year 3

- NRS plan to work with the NARS horticulturist to obtain additional seed collections from greenhouse stock plants.
- Additional surveys of historical locations will be conducted.
- NRS plan to study microsite differences in order to improve the outplanting success rate for this species.
- NRS plan to attempt more reintroductions at locations to be determined.

Action Area: In

TaxonName: Phyllostegia kaalaensis **TaxonCode: PhyKaa**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Keawapilau to Pahole	Manage for stability	0	19	0	0	0	0	0	2	0	0	2	0	No wild plants and the outplanting continues to decline
Palikea Gulch	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No plants were observed when this site was monitored in the last year
	Total for Taxon:	0	19	0	0	0	0	0	2	0	0	2	0	

Action Area: Out

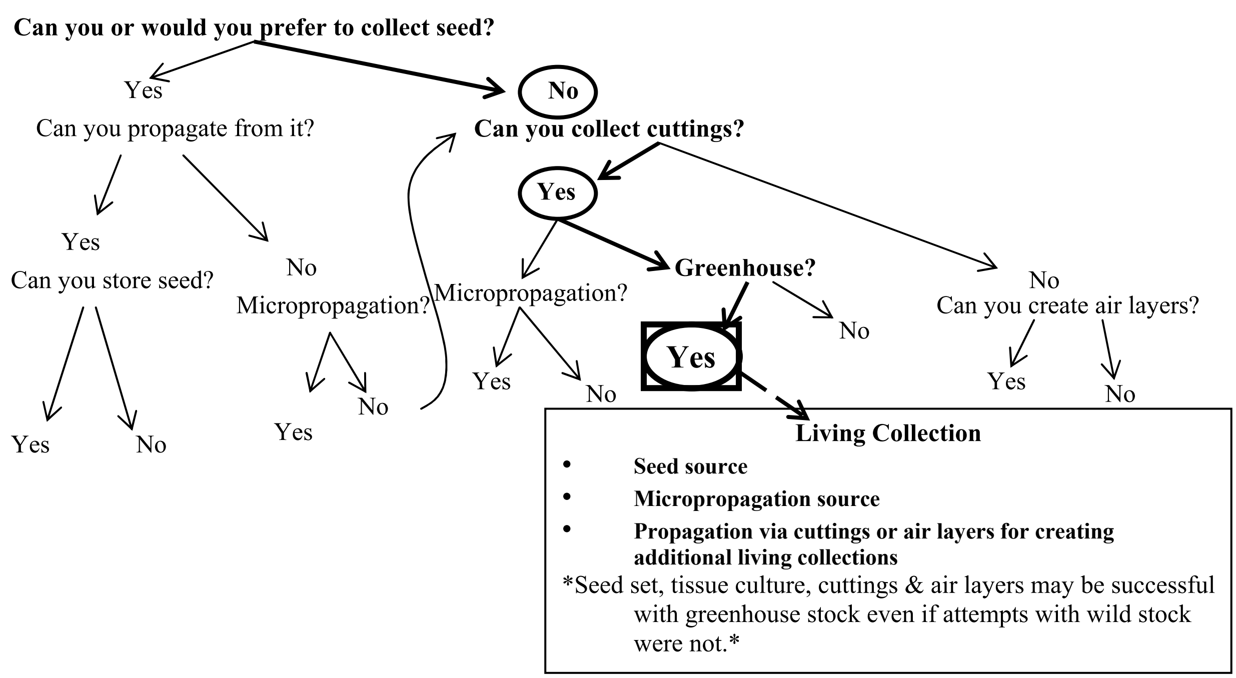
TaxonName: Phyllostegia kaalaensis **TaxonCode: PhyKaa**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	0	0	0	Reintroductions will begin when the MU fence is complete
Manuwai	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	0	0	0	Reintroductions will begin when the MU fence is complete
Waianae Kai	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
	Total for Taxon:	0	0	0	0	0	0	0	0	0	0	0	0	

Propagation and Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Cuttings	Tissue culture & Living collection	Yes	Yes, from Living collection

Prioritizing Genetic Storage & Propagation Techniques



Collection: Very little *P. kaalaensis* seed has ever been collected. Some of the plants in the greenhouse were hand-pollinated by the NARS Horticulturist this spring and 162 seeds were collected for germination and storage testing. Cuttings have been taken from the wild plants and successfully rooted in the greenhouse and tissue culture.

Propagation: *Phyllostegia kaalaensis* can be successfully grown from cuttings. NRS has very successfully transferred clones out of test tubes from the Micropropagation Lab into the greenhouse many times. In the greenhouse, this taxon is susceptible to insect pests and pathogens and can be 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.

Seed Storage: The Seed Conservation Lab initiated germination and storage trials this year from the seed produced from the greenhouse pollinations. The majority of fruit collected from these plants did not contain viable seeds. Germination was stimulated by gibberellic acid (GA3), which could be attributed to either the collection of slightly immature fruit or a certain degree of physiological dormancy. Since most fruit were received fully mature and only one out of 74 seeds have germinated without GA3, seeds of this taxon may have physiological dormancy and seeds may not germinate immediately after maturity and dispersal. NRS will work with NARS Horticulturist next year to collect a larger collection for more tests.

Genetic Storage: Next flowering season, the NARS Horticulturist plans to isolate plants from different population sites and perform a variety of specific pollinations for fruit production. Plants will be self-pollinated and crossed within population sites to determine what pollinations yield the most viable seed set. This year, many cuttings were made from unrepresented greenhouse plants and brought to the Micropropagation Lab in order to have all greenhouse stock represented in tissue culture. NRS will continue to work with the Micropropagation Lab to continue propagating and maintaining stock in both facilities.

Status of Genetic Storage

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Phyllostegia kaalaensis							
Keawapilau to Pahole	0	0	5	1	2	3	3
Palikea Gulch	0	0	5	0	3	3	3
Waianae Kai	0	0	4	1	2	2	2
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				2	7	8	8

Outplanting Issues

Two plantings of this taxon have been conducted in the last three years. They have had the lowest survivorship for any taxa planted by NRS. Both sites are in the Keawapilau to Pahole PU, one in Keawapilau Gulch and the other in Pahole Gulch. Details of the outplantings are described in the PU section.

Other reintroductions will be conducted to test a variety of planting site characteristics, plant status pre-planting, variations in planting densities and variations of stocks. In the coming year, NRS will outplant plants that are young, growing vigorously, and kept in shallower pots to prevent root rot. More intensive monitoring of these sites will also be done to refine site selection criteria and outplanting strategies.

Reintroductions will occur in the coming year only at the Keawapilau and Pahole PUs. Stock for these reintroductions will come only from their respective PUs. In the future, a Kapuna reintroduction will include a mix of stock from various PUs. Also, following completion of the larger ‘Ēkahanui fence in 2007, a reintroduction at that PU will be done using Palikea Gulch stock. See also the MFS PU section for further discussion on outplanting plans at the three MFS PUs.

Currently, only 3 MFS PUs are designated. The fourth MFS PU will be designated once outplanting techniques are refined and proven to be successful at establishing stable, reintroduced populations.

Founders Represented in Outplantings

TaxonName: Phyllostegia kaalaensis **TaxonCode: PhyKaa**

Total Num Plants based upon Plants that have been numbered

PopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Keawapilau to Pahole	Manage for stability	5	1
Makaha	Manage reintroduction for stability	0	0
Manuwai	Manage reintroduction for stability	0	0
Palikea Gulch	Genetic Storage	5	0
Waianae Kai	Genetic Storage	4	0
	Total for Taxon:	**14**	**1**

Number of Founders = Number of Mature, Immature, and Dead founder plants.
Number of Founders Represented = Number of founder plants represented in reintroductions.

Research Issues

Outplanting techniques, as stated above, require further research. When stock is available, research is also needed for seed storage techniques.

Surveys

Due to its recent extinction from the wild, NRS and the HBMP Botanist recently conducted surveys for *P. kaalaensis*. No additional populations were 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 ʻĒkahanui were surveyed. New areas to survey will be identified and more surveys conducted over the next year with the HBMP Botanist.

Taxon Threats

In addition to threats mentioned in previous reports (see NRS 2005) *P. kaalaensis* is prone to seasonal infestations of white fly and powdery mildew both in reintroductions and *ex situ*. It is unclear if these pathogens have a significant long-term effect on individual plant survival. Healthy plants kept in the greenhouse do not produce much seed and NRS will be investigating this in the coming year.

Population Unit Level Discussion

No wild populations are extant. NRS will not report on these PUs next year unless their status changes and will instead discuss the three reintroductions planned to capture all available stock. NRS will periodically monitor the extirpated sites for regeneration.

Population Unit Threat Control Summary

Action Area: In

TaxonName: Phyllostegia kaalaensis

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Keawapilau to Pahole	Manage for stability	Yes	Partial	No
Palikea Gulch	Genetic Storage	No	No	No

Action Area: Out

TaxonName: Phyllostegia kaalaensis

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Makaha	Manage reintroduction for stability	No	No	No
Manuwai	Manage reintroduction for stability	No	No	No
Waianae Kai	Genetic Storage	No	No	No

Manage for Stability PUs:

Pahole to Keawapilau:

Pahole: The Pahole reintroduction was established in November 2004. Currently, there are only 2 plants left of the original 47 planted. In the coming year, NRS will use more Pahole stock to plant into this site with outplants that are younger (see discussion in Outplanting sections). NRS will use the microsites that were most successful to guide this years planting sites.

Kapuna: In the coming year NRS will work with the NARS Specialist to determine if there are any appropriate outplanting sites within the new Kapuna fence. Stock from the Pahole site will be mixed with the Keawapilau stock to establish an outplanting here. The site where the wild plant recently occurred will be fenced in the last sub-unit of the Kapuna fence. Weed control is conducted there regularly for other taxa.

Keawapilau: NARS staff collected cuttings from a single plant at this site in 2000. This stock is represented at the Pahole Mid-elevation Nursery. NARS selected a site to reintroduce these plants, and in February 2004, 35 plants were reintroduced into Keawapilau. By July 2004, 15 plants were dead, and at last monitoring in June 2006 all had died (see NRS 2005 for more discussion). In the coming year, NRS will work to get stock established *ex situ* at the Lyon Micropropagation Lab and will work to find a suitable site in the Kapuna fence to establish another outplanting as discussed in the Kapuna section above.

Manuwai Reintroduction: Palikea gulch stock will be used to establish this reintroduction when Manuwai gulch is be fenced in year seven of the MIP. Until this time, stock from Palikea gulch will be maintained in the greenhouse, Micropropagation Lab, and at a future ʻĒkahanui reintroduction.

Mākaha Introduction: Waiʻanae Kai stock will be used to establish this introduction. 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 Waiʻanae Kai will be maintained in the Greenhouse and Micropropagation Lab.

Other PUs:

ʻĒkahanui: This site will be used to plant stock from Palikea Gulch in the coming year. This will give NRS valuable experience outplanting this taxon and may serve as a back-up storage site for this stock. Palikea Gulch stock was chosen as this is the closest PU to ʻĒkahanui.

Palikea Gulch: NRS monitored this site in August of 2006 and no plants were found. Collections were made from these plants in March of 2003 and are now being kept at the Army Nursery. Stock will be cloned and established in test tubes at the Lyon Micropropagation Lab in the next year.

Waiʻanae Kai: There is stock from this PU at the Lyon Micropropagation Lab and the Army Nursery. It will be used in the coming year to establish a Mākaha introduction.

3.1.20 Plantago princeps var. princeps

Requirements for Stability:
4 Population Units (PUs)
50 reproducing individuals in each PU (short-lived perennial)
Threats controlled
Complete genetic representation of all PUs in storage

How many of the 4 MFS PUs have stable numbers of mature individuals?	How many of the 4 MFS PUs have stable structure?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
0/4	1/4	0/4	1/4	0/4

Taxon Level Discussion

The distribution of *Plantago princeps* var. *princeps* is widespread and a number of PUs are known. Some PUs contain a number of plants and some PUs have only very small numbers of plants. *P. princeps* var. *princeps* is currently found on mesic cliffs sprinkled throughout the Wai‘anae mountains and from three sites on wet cliffs in the Ko‘olau mountains. Since this taxon is found in the AA for Mākua and Schofield Barracks West Range (SBWR), four PUs were chosen to ‘Manage for Stability.’ In order to capture this ecotype, these sites include:
1) The threatened PU in the Mākua AA (‘Ōhikilolo),
2) The PU in the SBMR AA (Kalena),
3) An off-site in a managed area in the Wai‘anae mountains (‘Ekahanui), and
4) An off-site area in the Ko‘olau mountains (Waiawa).

Current preliminary genetic research indicates that the Waiawa PU may be more closely related to *P. pachyphylla* (see research issues below). NRS will wait for more genetic analyses before changing the management plan for this species. NRS has not monitored all of the PUs and in the next year will visit the Konahuanui PU to help determine if this is a better site than the Waiawa PU for a MFS PU. There have been difficulties with the cultivation of this species in the nursery therefore, a “Think Tank” group was initiated by NRS to discuss these challenges. The participants were made up of Horticulturists, Agriculture Extension Agents, Natural Resource Managers and Researchers. Many of the participants were familiar with the challenges involved in the cultivation of this species. The goal of this meeting was to exchange past experiences and share information to try and improve the success of long term cultivation. The primary limiting factor appeared to be caused by the plant pathogen *Peronospora* sp., a type of Downey mildew (see propagation discussion below).

Major Highlights/Issues Year 2

- Preliminary genetic research indicates the Waiawa PU may be more closely related to *P. pachyphylla* than *P. princeps* var. *princeps*.
- NRS observed morphological variation between two subpopulations in the ‘Ēkahanui PU.

- NRS observed this species to be susceptible to downy mildew in propagation.
- NRS staff held a meeting with propagators to develop and test better propagation methods.

Plans for Year 3

- NRS will conduct the first outplanting of this species in an augmentation to the ‘Ēkahanui PU.
- NRS will continue to refine propagation techniques.
- NRS will monitor and collect from Nu‘uanu and Kōnāhuanui PUs.

Action Area: In

TaxonName: Plantago princeps var. princeps **TaxonCode: PlaPriPri**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
North Mohiakea	Genetic Storage	15	5	0	10	2	11	0	0	0	10	2	11	Small changes were observed in the known site in the last year
Ohikilolo	Manage for stability	22	0	12	12	14	0	0	0	0	12	14	0	The older plants had died in this site and many new younger plants were observed
Pahole	Genetic Storage	3	4	9	2	10	4	0	0	0	2	10	4	Small changes were observed in the known site in the last year
	Total for Taxon:	40	9	21	24	26	15	0	0	0	24	26	15	

Action Area: Out

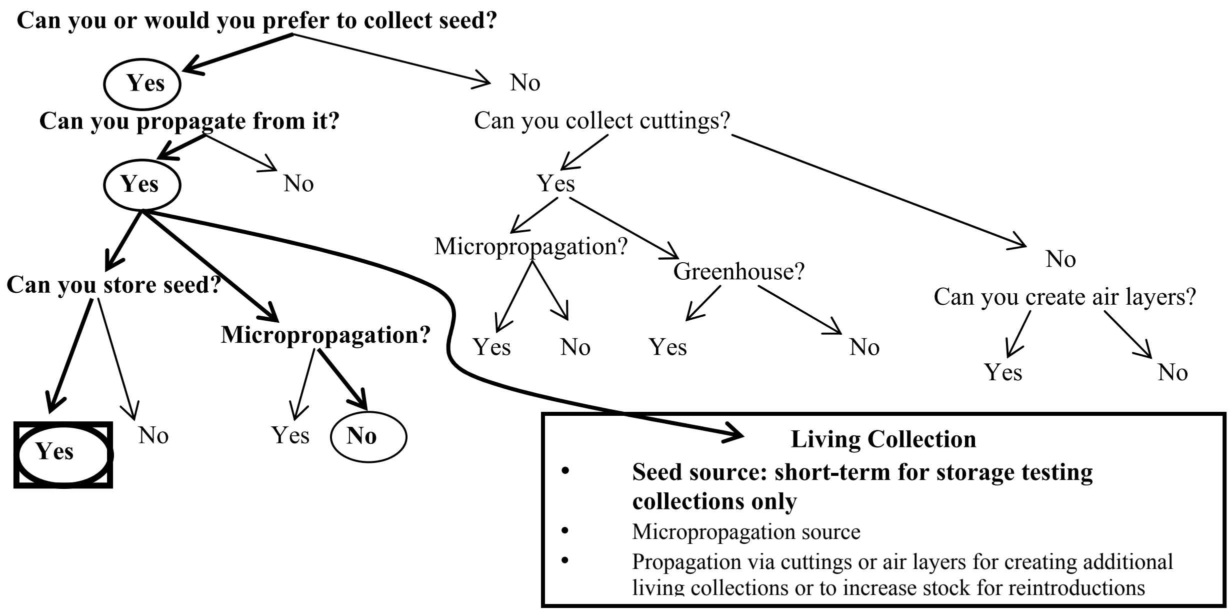
TaxonName: Plantago princeps var. princeps **TaxonCode: PlaPriPri**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ekahanui	Manage for stability	34	52	36	34	50	36	0	0	0	34	50	36	Small changes were observed in the known site in the last year
Halona	Genetic Storage	10	17	11	10	17	11	0	0	0	10	17	11	No changes were found when this site was observed
Konahuanui	Manage for stability	40	5	0	40	5	0	0	0	0	40	5	0	No monitoring in the last year
North Palawai	Genetic Storage	1	0	1	1	0	1	0	0	0	1	0	1	No changes were found when this site was observed
Nuuanu	Genetic Storage	1	0	0	1	0	0	0	0	0	1	0	0	No monitoring in the last year
Waiawa (Koolaus)	Manage for stability	16	17	50	16	17	50	0	0	0	16	17	50	No monitoring in the last year
	Total for Taxon:	102	91	98	102	89	98	0	0	0	102	89	98	

Propagation and Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	Yes	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: Infructescences are collected when brown and contain mature seeds (see picture below).

Propagation: Cuttings have been moderately successful but only a few have been collected. Germination of fresh seeds of P. princeps is high, and the majority of collections have over 75% germination. Fresh or stored seeds can sometimes take over one month to start to germinate, and germination can last for over two months. Seeds that have not germinated have been observed to quickly germinate after replating on fresh media (1% water agar). Gibberellic acid (GA3) has been applied to sown seeds in attempt to speed up and increase germination but has been determined to have no effect. Seedlings are easily transferred from agar to perlite/vermiculite with no mortality when two healthy cotyledons are present.

NRS have had challenges growing this species in the greenhouse primarily because of the plant pathogen *Peronospora* sp., a type of Downey Mildew. Past experience has shown this pathogen can quickly move through the nursery infecting 100% of the plants shortly after detection. Certain fungicides have been slightly effective in the suppression of the pathogen. Cultural modifications such as prompt removal of infected leaves, a reduction in fertilizer applications, and increasing plant spacing to facilitate air circulation were employed after detection. In spite of these measures there was still a high level of plant mortality.

Stephanie Dunbar, PhD candidate at the University of Hawaii at Mānoa is conducting research on Hawaiian *Plantago*, set up data loggers within our Army baseyard nursery, at 860 ft., and found levels of relative humidity as high as 98.75%. This creates favorable conditions for Downey Mildew to thrive. Trials were conducted using various media compositions to test the plants response to the pathogen. Plants were also moved to the Pahole Mid-elevation Nursery, at 2000 ft., to test different environmental conditions. All the plants moved to the higher elevation responded favorably to the different environmental conditions making the various media trials inconclusive. This year is the first time that we have been able to grow many plants to maturity and harvest seeds. NRS will continue to grow this species at the Pahole Mid-elevation Nursery for future outplanting and for genetic storage collections.

Seed Storage: Very limited genetic storage testing has been conducted with this taxon. Fourteen of the seventeen seed collections received by the Seed Conservation Lab were made in 2004-2005. Seeds are kept both at 4C and -18C at 20% relative humidity. Seeds germinated for reintroductions after 15 months of storage show no decrease in viability.

Genetic Storage: Because seed from the wild plants is too valuable, NRS will attempt to collect seed from greenhouse plants before they are reintroduced in order to obtain substantial amounts of seed for testing. Five seed collections have been brought to the Micropropagation Lab and though most germinated, all died after transferring to test tubes. NRS will try to establish cuttings in tissue culture this year. If successful, this may provide another genetic storage option for plants from which seed could not be collected as well as a sterile location for these propagules that would not be susceptible to downy mildew.

Mature *Plantago* at the Pahole Mid-elevation Nursery

Mature fruit of *Plantago princeps* var. *princeps*

Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Plantago princeps var. princeps							
Ekahanui	34	50	2	32	0	29	32
Halona	10	17	0	2	0	0	2
Konahuanui	40	5	0	0	0	0	0
North Mohiakea	10	2	1	9	0	5	9
North Palawai	1	0	0	0	0	0	0
Nuuanu	1	0	0	0	0	0	0
Ohikilolo	12	14	10	14	0	0	9
Pahole	2	10	0	1	0	0	0
Waiawa (Koolaus)	16	17	0	6	0	0	1
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				64	0	34	53

Unique Species Observations

Seedlings grown in the growth chamber last year for propagation have shown variation in leaf morphology between plants from two different populations within the ‘Ēkahanui PU. All seedlings from one population (EKA-A) of 30 plants have leaves that are longer and thinner than seedlings (from 4 wild plants) from another population (EKA-C). These plants are now flowering in the greenhouse and still show this variation in their leaves. The two populations are located on the same cliff area but separated by a distance of about 300 meters.

Outplanting Issues

NRS have not yet conducted an outplanting with this taxon, nor have any other agencies attempted to reintroduce this variety. However, *Plantago princeps* var. *laxiflora* is being successfully propagated in field nurseries and outplanted at Kipahulu Gap on Maui by the National Park Service. To reach stable numbers, NRS will need to conduct augmentations. This cliff-dwelling species poses many difficulties for outplanting. At wild sites, ropes are typically used to access plants for monitoring. NRS will plant the upper edges and lower ends of cliffs to limit the amount of rope work required for planting. So far, plants have been grown from cuttings and seeds but are difficult to keep alive in the greenhouse. NRS is refining propagation techniques to grow plants until they are large enough to plant. Outplanting techniques will first be tested at the ‘Ēkahanui PU in the next year. This PU hosts many wild plants clustered in groups along a long, broken, contouring cliff face. NRS hope to conduct an augmentation on an unpopulated part of this cliff face. The cliff is approximately 30ft tall, secure from ungulates, and can be accessed from above and below, making it an ideal trial location

Research Issues

Preliminary results from research conducted by Ms. Dunbar indicates that plants at the Waiawa site are more closely aligned with *Plantago pachyphylla*. Hybridization is also known between *P. princeps* and *P. pachyphylla*. This preliminary finding potentially reduces the number of PUs available for the var. princeps. If this is indeed the case and only the Wai‘anae PUs are grouped as variety princeps, NRS may have to amend the current MFS designations. In the coming year, NRS will collect from the Kōnāhuanui and Nu‘uanu PUs in order to get material to Ms. Dunbar for genetic analysis.

Surveys

No additional surveys were conducted in the last year for this taxon and none are planned for the coming year. TNC staff may contract the HBMP Botanist to survey for a recently observed plant in Nāpepeiao‘ōlelo Gulch.

Taxon Threats

No additional threats were noted in the last year however, rats, weeds, fire, pigs, fungi, and slugs threaten P. princeps.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Plantago princeps var. princeps

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
North Mohiakea	Genetic Storage	Partial	No	No
Ohikilolo	Manage for stability	Yes	No	No
Pahole	Genetic Storage	Yes	No	No

Action Area: Out

TaxonName: Plantago princeps var. princeps

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Ekahanui	Manage for stability	Yes	Partial	Yes
Halona	Genetic Storage	No	No	No
Konahuanui	Manage for stability	Yes	No	No
North Palawai	Genetic Storage	No	No	No
Nuuanu	Genetic Storage	Yes	No	No
Waiawa (Koolaus)	Manage for stability	Yes	No	No

Manage for Stability PUs:

‘Ōhikilolo: Significantly, 10 mature plants died over the past summer presumably due to water stress as the area was observed to be extremely dry and the remaining live plants were all wilted. Plants were observed in early September 2006. NRS have been controlling ungulate threats to this population since 1995, beginning with the construction of a perimeter goat fence along ‘Ōhikilolo ridge. Once propagation and reintroduction techniques are refined, this PU will be augmented within the next few years at sites yet to be determined. NRS will continue to monitor and collect for genetic storage from this PU in the coming year.

‘Ēkahanui: P. princeps is clustered in three groups along a long, broken, contouring cliff face in South ‘Ēkahanui Gulch. Significant genetic storage collections have been made from this PU. Currently, all three groups of plants are protected from ungulates by fencing, cliffs, and steep terrain. All the plants will be included in the l70 acre ‘Ēkahanui subunit II fence planned for the coming year which will provide complete ungulate protection once all ungulates are removed. Rat damage has been observed in this PU and rat control is ongoing at these sites. No predation has been seen since May 2004. Additionally, native snails found in the Māmane ridge area further encourage the need for rat control. Rat control data is shown in the table below. Bait take has dropped from 88% to an average of about 66% of available bait. *Schinus terebinthifolius* and *Psidium cattlelianum* trees at the base of the C site were also controlled by TNC staff.

‘Ēkahanui Plantago princeps Rat Control Data

Plapripri C	# of Stations	Bait Available	Bait Taken	%Take	Rats Snapped	# of Snap Traps	# of Site Visits
2004	2	64	22	34%	0	0	4
2004-2005	2	160	140	88%	0	0	5
2005-2006	4	352	231	66%	8	8	6
Mamane Ridge	# of Stations	Bait Available	Bait Taken	%Take	Rats Snapped	# of Snap Traps	# of Site Visits
2004-2005	11	832	342	41%	7	22	6
2005-2006	11	1026	519	51%	19	22	7

NRS has conducted weed control in these sites and will continue to monitor and control weeds in this PU in the coming year. Grass control remains the priority along with reducing the alien canopy of *S. terebinthifolious* on the cliff. In the coming year, NRS will select an augmentation site within the fence, probably along the same cliff. About 50 plants will be outplanted at the chosen site. NRS also withdrew and germinated seeds for planting into Kalua‘ā by TNC in the coming year in order to also refine outplanting methods at another site.

Rat baiting to protect rare snails and ‘Elepaio in the area will continue. This baiting will also have the overlapping benefit of protecting all *P. princeps* plants in this PU.

Waiawa: NRS did not visit this PU in the past year and management plans currently remain the same. In the coming year NRS will monitor and collect from unrepresented plants and continue planning the proposed fence pending more conclusive results from genetic analysis work.

North Mohiākea: The North Mohiākea PU is located within Schofield Barracks West Range and was designated a MFS PU because it is within the SBWR AA. The *P. princeps* plants at this site are restricted to a steep cliff. Although pigs are present at the site, they only affect the plants at the bottom of the cliff. The weed threats are significant at this site. The most abundant ecosystem-altering weeds present at this PU are *R. argutus* and *Erigeron karvinskianus*. NRS acquired some genetic storage collections from this PU. Access to this population requires a helicopter and is infrequently done because of the proximity to the live fire range. In the coming year as access times permit, NRS will continue to monitor the site and will collect mature seeds from unrepresented plants. This PU will be augmented once techniques are proven to be successful at ‘Ēkahanui or at other sites. This will be accomplished with the seed that is currently stored at Lyon.

Other PUs:

Pahole: NRS monitored the PU last year, and observed more plants in the immature size class. Rat predation has never been observed at the site, the cliff habitat is very intact and native, and the area is fenced. NRS will continue to monitor the area and collect propagules for storage in the coming year. Additional surveys may be needed to find additional plants in order to meet storage goals. Also, augmentation may also be needed at this site in the future to collect enough seed material if collection from nursery stock is unfeasible and production from wild plants cannot meet seed storage goals.

Hālona: This area has not been completely surveyed and more plants may be found. Some genetic storage collections have been made. NRS will re-visit the site to make more collections in the next year. The Nānākuli/Lualualei fire of 2005 burned close to this PU. NRS feel that in the event of another such catastrophic fire, there would be significant fire threat to this PU. In the last year, NRS conducted grass control for mostly *M. minutiflora* on the ridge near the plants. The area where the plants are located is inaccessible to pigs, but there are goats nearby. The goats are known from gulches to the north of Hālona, and don't pose an immediate threat to the plants. NRS are planning proactive goat consultation meetings with the Navy and DOFAW to prevent the ungulates from becoming a problem. Genetic collections will continue from this PU in the coming year.

North Pālāwai and South Branch of North Pālāwai: TNC and NRS monitored both these sites in the last year. One site was extirpated by rats, and only two mature were observed at the other site. In the last year, NRS collected from one mature plant; however these seeds may not be viable as seeds have not germinated. NRS will try to collect mature seed from both plants in the coming year.

Nu‘uanu: NRS have not monitored this site. NRS will work with relevant State staff to visit it in the next year to monitor the plant, obtain collections for genetic analysis and assess threats.

Kōnāhuanui: NRS have not monitored this PU. In the coming year, NRS will go with the HBMP Botanist to monitor, collect, and assess the threats to this PU.

3.1.21 *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

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have stable structure?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
2/3	0/3	0/3	2/3	0/3

Taxon Level Discussion
The goal for *Pritchardia kaalae* is to manage for stability at three PUs located across the historical *P. kaalae* habitat belt, which stretches from ‘Ōhikilolo ridge in Makua to the Kalena-Ka‘ala ridge between SBW and Waianae Kai. Two of the PUs (‘Ōhikilolo and Makaleha to Manuwai) contain and will be centered on managing sites that currently have more than 25 mature plants. The third PU (East ‘Ōhikilolo and West Makaleha) will be reintroduced using with stock mixed from as many of the accessible trees as possible from the rest of the PUs. The goal for the genetic storage PUs is to collect mature seed to represent the founders in living collections in botanical gardens.

While there are stable numbers of mature trees in the two wild PUs, very few juveniles or seedlings have been observed in any of the known sites. The trees produce flowers but rats are thought to consume most or all of the fruit before it can germinate and goats are known to browse the seedlings. *Pritchardia kaalae* is easy to grow from seed and outplantings have been extremely successful. Successful management of all the PUs will require large scale ungulate fences and rat control. Another major challenge for *P. kaalae* management is that outplanted and naturally recruiting young plants may not mature for decades. These plants will need a long-term commitment of ungulate and rat control to create stable and sustaining populations. Genetic storage for this taxon requires more research as seeds may not be easily stored using conventional and locally available facilities. Many collections have been made for testing and research. Most other collections have been used to establish large outplantings and widespread collection for storage will occur once the best techniques are determined.

Major Highlights/Issues Year 2

- Rat control continues to be successful in allowing the development of mature fruit and the establishment of seedlings within natural populations.
- Rat control baiting grids were expanded within the East Makaleha portion of the Makaleha to Manuwai PU.

- 50 additional plants were outplanted in the ‘Ōhikilolo and ‘Ōhikilolo East and West Makaleha PUs and a fence was completed to protect the site from ungulates.

Plans for Year 3

- NRS plan to continue seed collection from unrepresented individuals.
- Outplanting plans for year 3?

Action Area: In

TaxonName: Pritchardia kaalae **TaxonCode: PriKaa**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ohikilolo	Manage for stability	75	277	218	75	3	407	0	284	0	75	287	407	Additional plants were added to the existing outplantings
Ohikilolo East and West Makaleha	Manage reintroduction for stability	0	32	0	0	0	0	0	72	0	0	72	0	Additional plants were added to the existing outplanting
	Total for Taxon:	75	309	218	75	3	407	0	356	0	75	359	407	

Action Area: Out

TaxonName: Pritchardia kaalae **TaxonCode: PriKaa**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha	Genetic Storage	4	0	0	4	0	0	0	0	0	4	0	0	No monitoring in the last year
Makaleha to Manuwai	Manage for stability	50	2	0	54	3	0	0	0	0	54	3	0	A few more trees were found close to known sites
Waianae Kai	Genetic Storage	4	5	0	4	5	0	0	0	0	4	5	0	No monitoring in the last year
	Total for Taxon:	58	7	0	62	8	0	0	0	0	62	8	0	

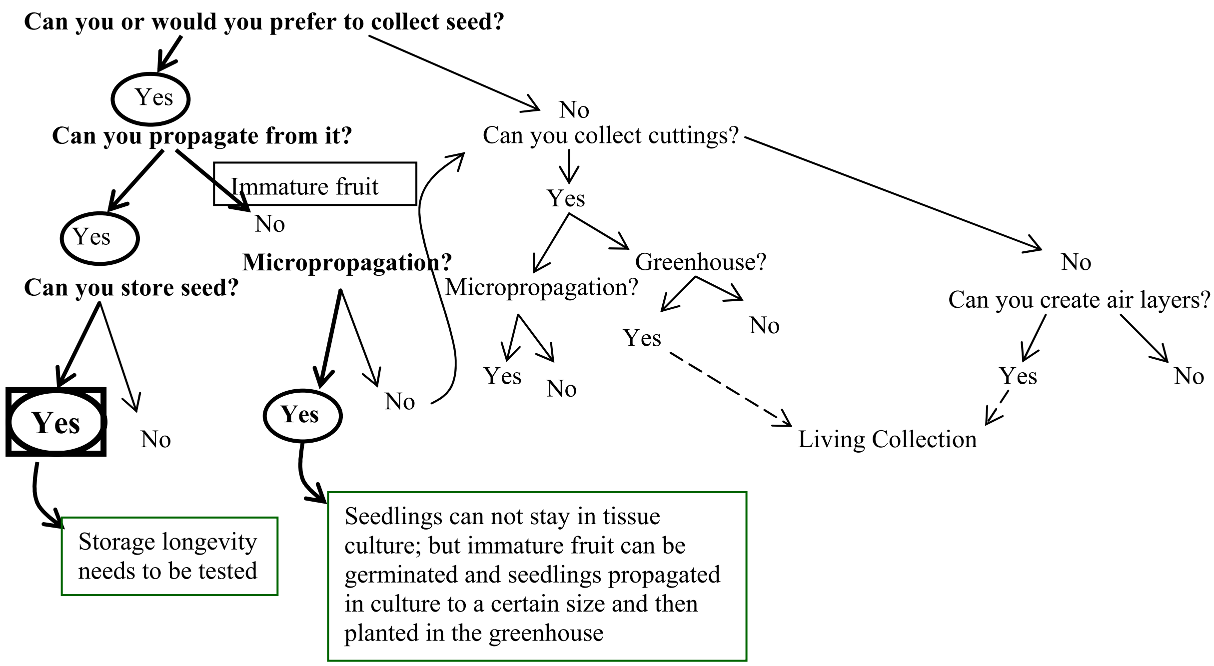
Map removed,
available upon request

***Pritchardia kaalae* Distribution**

Propagation and Genetic Storage

At this time, what is the best preferred propagation technique?	At this time, what is the preferred genetic storage technique?	Is more genetic storage testing needed?	Are additional steps required for obtaining enough seed?
Seed	Seeds?	Yes	No, just more research.

Prioritizing Genetic Storage & Propagation Techniques



Collection: For propagation purposes, fruit can be collected either immature (green) or mature (brown). For genetic storage purposes, seeds should be completely mature prior to collection.

Propagation: The exocarp and mesocarp are removed from mature seeds. Seeds are sown in moss in Ziploc bags, sealed, and kept at a warm temperature and excluded from light until germination. Seedlings are transplanted into pots of vermiculite and perlite. *Pritchardia kaalae* seedlings grow very slowly, plants that are two years old can have only 2-3 small leaves. Embryos in immature fruit can be excised and germinated in tissue culture. These seedlings can only stay in culture for a short period of time. When they reach the size of the test tube they can be successfully transplanted into pots in the greenhouse.

Seed Storage: Dr. Hector Pérez conducted seedling establishment studies with *P. remota*. Based on anecdotal observations, seeds buried in the soil can survive for a significant period of time. Although these species grow in different habitats, the results apply to *P. kaalae* (H. Pérez pers. comm. 2004). Seed is the most feasible method of genetic storage, and Dr. Pérez determined that seeds of *P. remota* have an intermediate storage classification. This may suggest that they may not have long-term storage potential, but that cryo-preservation techniques may increase its storage potential (Pérez 2006). The National Center for Germplasm Research and Preservation (NCGRP) and Dr. Pérez both recommended attempting cryo-preservation for *P. kaalae* embryos. NRS collected seed for testing at NCGRP in 2003. NCGRP reported that excised embryos accept drying well. *P. kaalae* is a good candidate for embryonic storage at –80ºC or in liquid nitrogen at –150ºC (Lisa Hill, pers. comm. 2004). They also recommend removing the exocarp and mesocarp and drying seeds to a relative humidity of 20% at 4C for storage. NRS will collect seeds to test seed storage longevity at 4C and 20% relative humidity and begin to build the seed bank at the Seed Conservation Lab.

Genetic Storage: Current collections are primarily conducted to establish reintroductions for this taxon. NRS will continue to collect from individuals that need to be represented at the reintroductions, and also make one bulk collection from individuals already represented at the outplantings for storage testing at the Seed Conservation Lab (based on NCGRP recommendations).

Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Pritchardia kaalae							
Makaha	4	0	0	0	0	0	0
Makaleha to Manuwai	54	3	0	0	0	0	0
Ohikilolo	75	3	0	4	19	30	25
Waianae Kai	4	5	0	0	1	0	0
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				4	20	30	25

Outplanting Issues

Stock Source to be used for the augmentation of the ‘Ōhikilolo PU	# of Founders that can be collected from	Number of Founders currently represented in the outplanting sites by at least one plant	Goal for the number of plants to be outplanted for each founder	Current Survivorship at each of these two planting sites
‘Ōhikilolo -A,C-K	72	40	6	88%
‘Ōhikilolo -B	3	3	25	94%

Stock Source to be used for the augmentation of the ‘Ōhikilolo East and West Makaleha PU	# of Founders that can be collected from	Number of Founders currently represented in the outplanting sites by at least one plant	Goal for the number of plants to be outplanted for each founder	Current Survivorship at each of these two planting sites
‘Ōhikilolo -A,C-K	72	33	3	69%
Makaleha-A, B, C	57	0	3	N/A

In order to augment the ‘Ōhikilolo PU, NRS have been focusing on establishing several large outplanting sites. Overall, outplanted individuals have high survivorship; however, they are not expected to mature for many years. The goal for the augmentation of the ‘Ōhikilolo PU is to have two sites where three juvenile individuals grown from each of about 72 founders are planted totaling in over 450 juvenile plants for this PU. In addition another outplanting site has begun that will represent a separate group of three plants with thirty outplanted juveniles each for a total of 90 plants. This should bring the totals for this PU to about 75 Matures, 545 juveniles and several hundred seedlings within the next few years.

The plan to create the ‘Ōhikilolo East and West Makaleha PU is to use three plants grown from each of 72 founders from ‘Ōhikilolo and three plants from each of 50 founders from Makaleha to Manuwai to establish a reintroduction of at least 350 juvenile plants in the next several years. Collection is just beginning from the Makaleha sites as rat control is beginning to make lots of fruit available. The numbers for the ‘Ōhikilolo East and West Makaleha PU in the table below are not shown. NRS will work with in the coming year to display the correct numbers for this PU.

Founders Represented in Outplantings

TaxonName: Pritchardia kaalae **TaxonCode: PriKaa**

Total Num Plants based upon Plants that have been numbered

PopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Makaha	Genetic Storage	4	0
Makaleha to Manuwai	Manage for stability	57	0
Ohikilolo	Manage for stability	78	43
Ohikilolo East and West Makaleha	Manage reintroduction for stability	0	0
Waianae Kai	Genetic Storage	9	1
	Total for Taxon:	**148**	**44**

Number of Founders = Number of Mature, Immature, and Dead founder plants.
Number of Founders Represented = Number of founder plants represented in reintroductions.

Taxon Threats

This taxon is threatened first by rats that eat all or most of the fruit before the seeds can mature. If seedlings are produced, they would likely be browsed or disturbed in areas where pigs and goats are present. There are threats from weeds in some areas where species that produce thick ground cover such as (*Erigeron karvinskianus* and *Melinus minutiflora*) may hinder seedling survivorship. Besides large scale fences, rat control is the first necessary step towards stability for this taxon. NRS has been able to reliably control rats within small areas with bait stations and snap traps. The ‘Ōhikilolo PU has been baited for over ten years and NRS has begun control in a few Makaleha sites. In the long-term, large-scale rat control is necessary to provide continued protection of these sites.

Population Unit Level Discussion

Population Unit Threat Control Summary

Makua Implementation Plan - Population Unit Threat Control Summary

Action Area: In

TaxonName: Pritchardia kaalae

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Ohikilolo	Manage for stability	Yes	Partial	Partial
Ohikilolo East and West Makaleha	Manage reintroduction for stability	No	No	No

Action Area: Out

TaxonName: Pritchardia kaalae

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Makaha	Genetic Storage	No	No	No
Makaleha to Manuwai	Manage for stability	No	No	Partial
Waianae Kai	Genetic Storage	No	No	No

Manage for Stability PUs:

‘Ōhikilolo: This PU consists of one large cluster of trees, three large outplanting sites (discussed above in the Outplanting Issues) and several outliers. Besides the 75 mature trees, there are three immature plants, and approximately 400 seedlings in this PU. All the sites are protected from ungulates by the ‘Ōhikilolo ridge crest fence, constructed in 1998. Since then, all goats have been removed from Mākua Valley. Once goats were excluded from the main cluster of trees and rat control was ongoing for about five years, many seedlings began to become established within the patch. Since then, it has become hard to walk through and count the seedlings and many have been alive for as many as seven years. NRS conducted weed control in the habitat around the six managed *P. kaalae* populations. Some of the most problematic weed species in *P. kaalae* habitat include, *Blechnum appendiculatum*, *E. karvinskianus,* and various grass species. *Schinus terebinthifolius* has been eradicated from the main patch but continues to threaten much of the ecosystem in the area. Collections have been made from nearly all the trees in this PU.

NRS administers rat bait and deploys snap traps around the three managed wild sites of *P. kaalae* on ‘Ōhikilolo. Baiting began in 1997 in the Prikaa-A patch (see baiting data table below). NRS re-stock 44 rat traps and 15 bait stations quarterly. This year the amount of bait taken has decreased compared to the last four years. The total bait consumed was 63% of the total bait available.

Prikaa-A Patch Baiting Data by from 1997-2006

Year	# of Stations	Bait Available	Bait Taken	%Take	Rats Snapped	# of Snap Traps	# of Site Visits
1997	6	141	134	95%	5	30	1
1997-1998	6	200	125	63%	0	24	3
1998-1999	6	224	166	74%	3	12	4
1999-2000	6	252	249	99%	3	12	4
2000-2001	7	280	280	100%	4	12	3
2001-2002	15	672	577	86%	6	12	5
2002-2003	15	960	591	62%	10	12	4
2003-2004	15	960	874	91%	9	12	4
2004-2005	15	720	661	92%	7	12	3
2005-2006	15	960	603	63%	11	16	4

Makaleha to Manuwai: NRS has been monitoring more of this PU in the last year and has revised the estimates of the numbers of plants. NRS expect this to continue as new areas are searched. The original counts that were based on Joel Lau's estimates of trees observed, many from afar, between 1991 and 2001. There are still substantial numbers of inaccessible plants on the cliffs, which have not been included in this total. NRS plans to manage the portion of this PU that is within the East Branch of East Makaleha by building a large-scale fence in year four of the MIP. NRS has been controlling rats around at least 40-50 trees in order to collect mature fruit and begin management. NRS administers rat bait twice a quarter to protect the fruit of *P. kaalae*. Eighteen bait stations and 27 snap traps are currently deployed in three grids around three groups of accessible trees at this site (see Rat Data for Makaleha table below). NRS has been working with DOFAW and NARS to survey and control goat populations in this area in the last year. There is still a large group of goats in the area and NRS will continue to work of fencing plans and goat control in the coming year. Weed control will begin once the fence is built. Collections from this site will begin in the coming year and be used mostly for propagation for the East ʻŌhikilolo and West Makaleha reintroduction.

Rat data for Makaleha *P. kaalae*

Upper Patch	#of bait stations	Amount of Bait Available	Bait Taken	% Taken	# of Rats Trapped	# of Snap Traps	# of site visits
2004-2005	6	544	225	41%	15	11	6
2005-2006	6	672	490	73%	11	11	6
LowerPatch	**#of bait stations**	**Amount of Bait Available**	**Bait Taken**	**% Taken**	**# of Rats Trapped**	**# of Snap Traps**	**# of site visits**
2004	8	128	89	70%	3	8	2
2004-2005	8	478	478	100%	26	8	6
2005-2006	8	736	515	70%	10	8	6
TT Patch	**#of bait stations**	**Amount of Bait Available**	**Bait Taken**	**% Taken**	**# of Rats Trapped**	**# of Snap Traps**	**# of site visits**
2005	4	64	21	33%	3	8	1
2005-2006	4	256	193	75%	8	8	4

ʻŌhikilolo East to West Makaleha (reintroduction): This PU currently consists of two reintroductions established at sites mid-way between the wild populations. One reintroduction was established in 2002 on state land in West Makaleha. This site has 93% survivorship (43 of 46 plants) from this planting, but has not been supplemented since. There is ongoing management of weeds and rats at this site for this and other taxa but the plants are not growing vigorously. The second reintroduction site was established in exceptional habitat along the eastern portion of ‘Ōhikilolo ridge in 2002. The site is within the ‘Ōhikilolo ridge fence, and is protected from goat predation. The terrain is very steep. However, the reintroduction is on one of the few ridges which connects smoothly to the valley floor, and was not protected from pigs. Plantings were initially successful, but were later decimated by pigs. Many plants were ripped out of the ground. NRS believe the pigs were attracted to the potting soil as the plants were not destroyed just uprooted. In the last year, NRS has built a fence around this sits and supplemented it with many new plants. The primary weed threats are *S. terebinthifolius* and *M. minutiflora*.

Other PUs:

Mākaha: There are four mature plants are known from this PU. They are all in very inaccessible areas and NRS will further scope the area to determine if plants can be reached in the coming year. Surrounded by weeds, these plants are tall and spindly. Goats are known from the area, and NRS assumes that rats are present as well.

Wai‘anae Kai: NRS has not monitored this site in the last year. A juvenile plant grown from this PU was given to LCC in the last year and will serve as the beginning of a small living collection at this site. NRS will monitor the site in the coming year and collect mature fruit to establish the living collection.

3.1.22 *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 in storage of all PUs

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have stable structure?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
0/3	1/3	0/3	1/3	0/3

Taxon Level Discussion

Three of the four known PUs of *S. mariversa* are being managed for stability. However, NRS continue to monitor and collect seed for genetic storage and testing from all PUs each year. The ʻŌhikilolo and Keaʻau PUs will be within the new proposed Mākua Action Area (AA). The Kamaileʻunu PU and the Puʻu Kawīwī genetic storage PU will still be considered off-site PUs. The ʻŌhikilolo PU is the only PU that is fenced and the Keaʻau PU is the only PU that had stable numbers this year. NRS should construct the Kamaileʻunu and Puʻu Kawīwī PU fences in the coming year and are submitting a CDUA to fence the Keaʻau PU this year. NRS hope fencing and outplanting will enable all manage for stability PUs to reach stability goals.

Major Highlights/Issues for Year 2

- NRS made major seed collections from ʻŌhikilolo, Keaʻau, and Kamaileʻunu PUs this year.
- NRS concluded *S. mariversa* is monocarpic.

Plans for Year 3

- NRS will fence the Kamaileʻunu and Puʻu Kawīwī sites in the coming year.
- NRS will begin long-term monitoring of individuals this fall to obtain demographic data.

Makua Implementation Plan - Population Unit Status

Action Area: In

TaxonName: Sanicula mariversa **TaxonCode: SanMar**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Keaau	Manage for stability	14	69	0	14	114	0	0	0	0	14	114	0	The same number of plants became mature last year and this year but many more immature plants were observed
Ohikilolo	Manage for stability	0	51	0	0	52	0	0	0	0	0	52	0	Close to the same number of immature plants were observed this year
	Total for Taxon:	14	120	0	14	166	0	0	0	0	14	166	0	

Action Area: Out

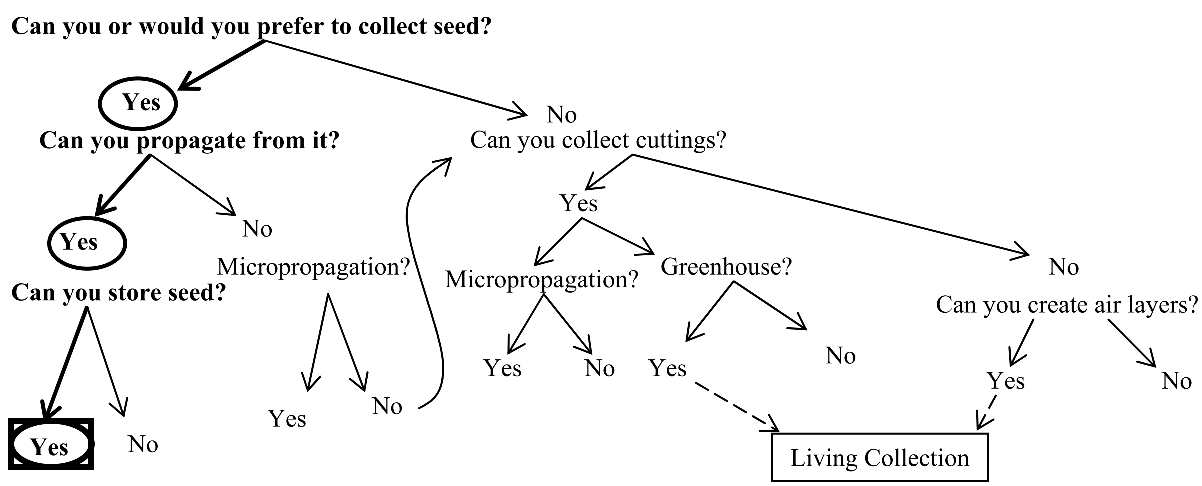
TaxonName: Sanicula mariversa **TaxonCode: SanMar**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kamaileunu	Manage for stability	3	16	0	4	36	0	0	0	0	4	36	0	A few plants became mature this year and many more immature plants were observed
Puu Kawiwi	Genetic Storage	0	4	0	0	4	0	0	0	0	0	4	0	The same number of immature plants was observed but it is not clear if these are the same plants
	Total for Taxon:	3	20	0	4	40	0	0	0	0	4	40	0	

Propagation and Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	Yes, dormancy studies	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: Seeds collected when tan to brown are ideal. Seeds collected this year were yellow and were placed in paper envelopes. A few days later when they were received at the Seed Conservation Lab, all seeds were brown, suggesting that seeds may have further ripened since collection time. It would be interesting to compare fresh germination of yellow seeds to brown seeds. Literature indicates that seeds collected when slightly immature may not have as complex a degree of dormancy as seeds collected when fully dried. NRS will collect this data in the coming year.

Propagation: Cuttings are not a potential method of collection due to this taxon's solitary stem habit. Seeds have a complex level of either physiological or morphophysiological dormancy. Fresh seeds sown in June 2005 germinated in December and January. Seeds from Kamaileʻunu had 96% germination, but seeds from Keaʻau had 0-16% germination.

Seed Storage Research: Stored seeds display variation in germination rates based on PU. A large bulk seed collection from Keaʻau in 1999 has had very low germination. A few of the Keaʻau seeds rot during germination tests and are not viable, but the majority remain viable but have not germinated. Another seed collection from ʻŌhikilolo in 1999 had 50% germination after storing for five years dry at room temperature. A 2002 collection had 60% germination after storage for three years at 20% relative humidity and -18C. This test started in May and seeds did not germinate until December, which is similar to fresh germination results from this year. This suggests that seeds need a period of colder temperatures to break at least one level of dormancy. The optimal storage condition has yet to be determined, but from what data has been collected, seeds of this taxon can tolerate the drying and low temperatures typically necessary for long-term storage. Once dormancy issues are overcome, stored seeds can be tested to give a better indication of the best storage conditions. To address dormancy issues, stored seeds and possibly some fresh seeds (to be collected next year) will be used for a thorough dormancy study. NRS will work with Dr. Carol Baskin, seed biologist at the University of Kentucky, to determine the best approach determining the most efficient germination techniques.

Genetic Storage: NRS has good storage representation of the three *in situ* ʻmanage for stabilityʼ populations. If seed can be collected from plants in the Puʻu Kawīwī PU this next year, NRS will collect for storage. Otherwise, NRS will hold off on seed collections until dormancy and germination issues are addressed, unless fresh seeds are necessary for dormancy studies.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Sanicula mariversa							
Kamaileunu	4	36	41	46	0	0	39
Keaau	14	114	29	53	0	0	40
Ohikilolo	0	52	73	48	0	0	15
Puu Kawiwi	0	4	1	1	0	0	1
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				148	0	0	95

Unique Species Observations

As mentioned, this species appears to be monocarpic. In addition, vegetative immature plants may not emerge every year.

Outplanting Issues

NRS conducted two small reintroductions of this species on ‘Ōhikilolo. In 2001, 30 plants were outplanted, 18 were vegetative in 2002 and 19 were vegetative in 2003. However, no plants have been observed over the last three growing seasons. A seed sowing trial was conducted in 1999 but only one plant was observed the next year. Future outplanting of seedlings may be necessary to reach stability goals. Outplanted individuals may provide useful information on lifecycle and demography of this species.

Research Issues

As mentioned in previous reports (Army NRS 2004, 2005), this species has been challenging to monitor over time. The perennial growth cycle of this species and dynamic fluctuations from year to year in above ground individuals make it difficult to follow individual plants over consecutive years. The portion of the plant that lies dormant in the summer may be several inches below the soil surface and may be fairly undetectable. In addition, *S. mariversa* is monocarpic; plants have not been observed to flower more than once, and tap roots of mature individuals appear to rot after flowering stalks are dried. It also seems that not all immature individuals emerge each year. It is assumed that seedlings take several years to reach maturity. NRS plan to mark a portion of immature plants and monitor them over time to collect demographic data that will lead to development of a minimum viable population size. This will help in projecting needs for reintroductions and genetic storage collections. The NRS Monitoring will work to achieve these goals this coming year (2007). NRS will explore different marking techniques using metal pins or other suitable materials taking care to avoid contact with the plants underground. The pilot will be carried out in at least two sites with different habitats that pose different monitoring challenges, such as the wetter, higher elevation ‘Ōhikilolo PU and the drier, lower elevation Kamaile‘unu PU. Plants in these areas occur in varied depths of soil, and on steeps ranging from cliffs to shelf type habitats offering different levels of accessibility and ease of monitoring. NRS believes that if several more census trips per year are made to each site we may be able to better assess the correct population structure by ensuring that we do not miss a flush of seedlings early in the season, or those individuals that come up for only a brief time and may or may not flower. This method and the resulting information will be evaluated in next years report.

In addition, more seed storage research needs to be conducted to determine the optimal seed storage technique. See Genetic Storage and Propagation/Germination Techniques discussions above.

Surveys

No surveys were conducted for this taxon in the last year.

Taxon Threats

The most prominent threats to this taxon continue to be goats and weeds. NRS plan to have three of the four existing PUs fenced within the coming year and have the fourth PU fenced within the next two years.

Alien grasses such as *Melinus minutiflora*, *Setaria gracilis*, *Andropogon virginicus* and *Rhynchelytrum repens* will be controlled where necessary once ungulate fences have been constructed.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Sanicula mariversa

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Keaau	Manage for stability	No	No	No
Ohikilolo	Manage for stability	Yes	Yes	No

Action Area: Out

TaxonName: Sanicula mariversa

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kamaileunu	Manage for stability	No	No	No
Puu Kawiwi	Genetic Storage	No	No	No

Manage for Stability PUs:

‘Ōhikilolo*:* There are two sites on ‘Ōhikilolo where *S. mariversa* is found. The makai site has been monitored regularly since the inception of the Army program in 1995. The makai site has many more plants than the mauka site. The mauka and reintroduction sites were not monitored this year. This year the makai site contained 52 immature and no mature plants. The table below illustrates monitoring numbers since 1998 for this site.

Monitoring Date	March 1998	May 1999	January 2000	March 2001	March 2002	March 2003	April 2004	February 2005	April 2006
Mature/Immature/ Seedling	0/12/0	27/35/0	15/35/20	80+ total	48/60/30	10/0/0	1/50/0	0/51/0	0/52/0

This table illustrates the sporadic nature of the re-emergence of immature individuals from year to year. In 2002, 60 immature and 30 seedlings were noted. Of that number, 11 matured over the next two years. And from 2004 to 2006, 50 to 52 immature plants were noted. This may mean that of the approximately 90 immature and seedling plants in 2002, potentially 27 plants (or 30%) have not re-emerged. This does not take into account any new plants that may have emerged from the soil seed bank since 2003. NRS plan to compare this data with rainfall data.

Kamaile‘unu: NRS are close to achieving the seed collection goal for this PU. At this time, a total of 5,699 seeds have been collected from 48 individuals. This area is severely impacted by goats. An ungulate fence was scoped this year during seed collection efforts. NRS have observed trampling and significant amounts of goat scat within the *Sanicula* population. However, there does not appear to be any goat browsing on *Sanicula* plants themselves. Once the ungulate fence is constructed, NRS will need to conduct weed control in this area.

Kea‘au: Significant seed collections have been made from this PU. However, this PU is also severely impacted by goats and erosion caused by goat populations. NRS have been pursuing an ungulate fence in this area. It is hoped that this PU will be fenced within the next two years. Although this population is affected by goats, the largest number of emergent plants was noted this year, with 14 mature and 114 immature plants.

Monitoring Date	May 1999	June 2001	June 2002	July 2004	June 2005	May 2006
Mature/Immature/Seedling	16/13/0	1/7/3	21/22/5	7/100/0	3/16/0	14/114/0

Other PUs:

Pu‘u Kawīwī: This PU is designated to be managed for genetic storage. However, due to the lack of mature individuals over the last several years, NRS have not collected seed from this population yet. The only seed collected from this site was from a single plant by Steve Perlman of NTBG in 2000. NRS have been monitoring this site for the past 4 years with varying numbers of individuals observed. However, no mature individuals have been seen since 2003. This PU will be fenced by the end of 2006.

Monitoring Date	Dec 2003	June 2004	June 2005	July 2006
Mature/Immature/Seedling	~15 total	0/32/4	0/4/0	0/4/0

3.1.23 *Schiedea kaalae*

Requirements for Stability:

- 4 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Threats controlled
- Complete genetic representation of all PUs in storage

How many of the 4 MFS PUs have stable numbers of mature individuals?	How many of the 4 MFS PUs have stable structure?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
0/4	0/4	0/4	4/4	0/4

Taxon Level Discussion

There are many small PUs of this taxon across Oʻahu. There are four MFS PUs because this taxon is in the AA for MMR and SBW. Three MFS PUs are in the Waiʻanae Mountains and one is in the Koʻolau Mountains. Two of the three Waiʻanae PUs are wild populations (ʻĒkahanui and Pahole) with Pahole lying inside the Action Area (AA). The third Waiʻanae PU is a reintroduction site using mixed Waiʻanae founders in Central Kaluaʻā. The fourth PU is Maʻakua Gulch in the Koʻolau Mountains that NRS has been monitoring with the Oʻahu PEP program.

There are no juvenile plants known from any of the Waiʻanae PUs. Seedlings have been observed only within reintroduction areas but they do not survive. (pers. comm. Dan Sailer, TNCH) Juvenile plants have been observed in the Koʻolau PUs and some appear to reproduce vegetatively. NRS suspect that there is a significant limiting factor which is not allowing seedlings to grow into juvenile plants especially in the Waiʻanaes. It may be that slugs are limiting the amount of seedlings that survive into larger size classes as slugs have been observed feeding on seedlings and mature plants in Central Kaluaʻā. Currently, NRS is focusing on establishing large reintroductions in the Waiʻanaes and researching slug control techniques (see Chapter 6). Until a slug control technique is available, large reintroductions may that produce a large amount of seed may be able to overcome the limiting factors that is preventing juveniles from becoming established by producing a large seedbank. In addition to large numbers of reintroductions, NRS are focusing on equally representing each available founder for each appropriate PU.

The smaller non-MFS PUs will be kept as living collections and used as sources for mixed founder reintroductions. All Waiʻanae stock will be represented in reintroductions or augmentations and all non-MFS Koʻolau stock will be kept as a living collection and used as a propagule source for storage.

Major Highlights/Issues for Year 2

- NRS have decided to conduct large reintroductions at MFS sites to try to overcome slug pressures.
- NRS are focusing on balancing the founders for reintroductions and augmentations.

Plans for Year 3

- NRS will conclude the first phase of slug control research (see Chapter 6).

Taxon Status

Action Area: In

TaxonName: Schiedea kaalae **TaxonCode: SchKaa**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Mohiakea	Genetic Storage	1	0	0	1	0	0	0	0	0	1	0	0	This plant has been observed in the last year
Pahole	Manage for stability	1	0	0	1	0	0	18	3	0	19	3	0	NARS reports no change to the wild site and an outplanting has begun
	Total for Taxon:	2	0	0	2	0	0	18	3	0	20	3	0	

Action Area: Out

TaxonName: Schiedea kaalae **TaxonCode: SchKaa**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Huliwai	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Kahana	Genetic Storage	5	2	0	5	2	0	0	0	0	5	2	0	PEP reports no change
Kaipapau	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Maakua (Koolaus)	Manage for stability	16	0	0	16	0	0	0	0	0	16	0	0	No monitoring in the last year
Makaua (Koolaus)	Genetic Storage	1	1	0	1	0	0	0	1	0	1	1	0	PEP reported that the wild immature plant has died
North Palawai	Genetic Storage	1	0	0	1	0	0	0	0	0	1	0	0	Monitoring found no change
South Ekahanui	Manage for stability	14	46	0	14	0	0	56	0	0	70	0	0	No change to the wild plants and more plants were added to the TNC augmentation
	Total for Taxon:	37	49	0	37	2	0	56	1	0	93	3	0	

Action Area: Reintro

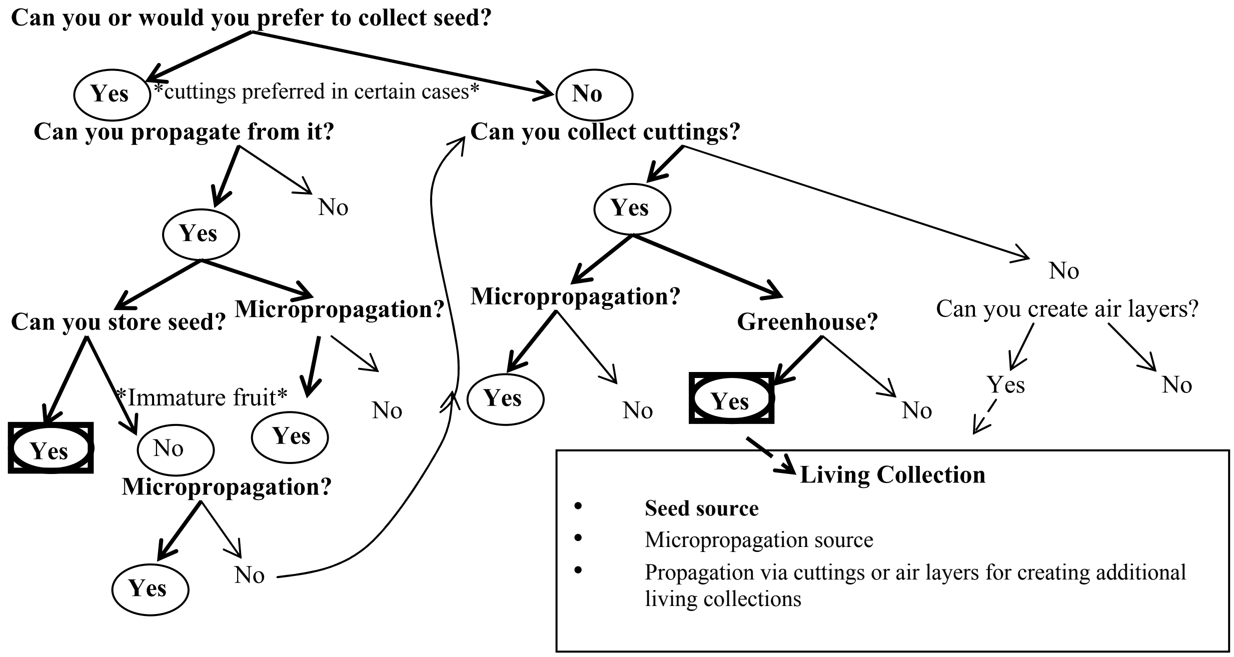
TaxonName: Schiedea kaalae **TaxonCode: SchKaa**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaluaa and Waieli	Manage for stability	40	25	0	0	0	0	72	44	0	72	44	0	The reintroduction has been supplemented
	Total for Taxon:	40	25	0	0	0	0	72	44	0	72	44	0	

Propagation and Genetic Storage

1) At this time, what is the preferred propagation technique?	**2)** At this time, what is the preferred genetic storage technique?	**3)** Is more genetic storage testing needed?	**4)** Are additional steps required for obtaining enough seed?
Cuttings for maintaining wild clones and *in situ* or reintro-produced seed for outplanting.	Seed storage and greenhouse living collections to produce seed.	No	Yes, it is more practical to keep the Ko‘olau PUs as living collections in the greenhouse.

Prioritizing Genetic Storage & Propagation Techniques



Collection: Sufficient collections for genetic storage have been difficult for this taxon. It is difficult to secure a large number of seeds as plants often do not produce high numbers of mature seed at one time. Rather, seeds mature in slow succession over a period of months and frequent visitation is necessary. In addition, many of the Koʻolau PUs are in remote areas that are difficult to access and frequent visitation is impractical. Optimally, seeds should be collected when fruit capsules have dehisced and are dry and brown. However, once the fruit is mature, it tends to quickly dehisce and disperse seeds. NRS staff do not want to run the risk of collecting immature seed, and therefore collect mature fruit, but these are often half empty. This may also contribute to occasional low fresh viability on a collection by collection basis, due to accidental selection for lighter and potentially less viable seeds with less of a chance to disperse.

Propagation: Thorough research has been completed on many propagation techniques and both cuttings and seed are utilized. Both propagule types are successful in tissue culture. Testing of fresh seeds at the Seed Conservation Lab indicates that no special germination requirements are necessary, and seeds sown on agar are easily transferred to perlite/vermiculite. Seedlings are grown in an environment-controlled growth chamber for one to three months before moving to the greenhouse. Germination rates for fresh seeds are typically very high; over 75%. TNC has worked with this species for several years longer than NRS and has successfully collected seed, grown plants in the greenhouse, and reintroduced plants.

Seed Storage Research: A seed lot was designated for testing in 2002 from a TNC reintroduction. Two-year results suggest that seeds store better frozen than at room temperature. However, seeds withdrawn from storage for propagation actually provide a longer viability assessment. Seeds stored refrigerated for three years had 100% germination. Seeds are therefore banked at 4C and 20% relative humidity. Based on these results and storage knowledge for this genus, storage potential for this taxon is probably high, and seeds can be stored for at least three years before re-collection is necessary for maintaining adequate representation.

Genetic Storage: Despite collection challenges, seeds were collected from 19 founders from five PUs. The majority of the stored seeds were either collected from greenhouse stock from one Pahole founder or received from Dr. Steven Weller from first generation greenhouse plants at U.C. Irvine. Weller made these original seed collections from three plants in the late 1980’s to early 1990’s. All had died before NRS was able to collect from them. The majority of the remaining banked seeds are from plants in the South ‘Ēkahanui PU. Cuttings taken from plants in Ko‘olau PUs have been maintained in the greenhouse at Lyon Arboretum and will be used for seed storage due to the inaccessibility of these founders and the inability to make a large seed collection at one visit. Living collections are and will be established for plants that are extirpated *in-situ*, not frequently visited, or only represented *ex situ* in order to collect seed for storage.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Schiedea kaalae							
Huliwai	0	0	1	1	0	1	1
Kahana	5	2	0	0	4	0	4
Kaipapau	0	0	2	0	2	0	0
Maakua (Koolaus)	16	0	0	0	5	0	3
Makaua (Koolaus)	1	0	0	0	2	1	0
Mohiakea	1	0	0	0	0	1	0
North Palawai	1	0	0	1	0	1	1
Pahole	1	0	1	2	0	2	2
South Ekahanui	14	0	2	14	2	13	11
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				18	15	19	22

Outplanting Issues

Besides ungulate fencing and ecosystem scale weed control, outplanting has been the primary focus of field work with this species Mature seed is produced and plants are easily grown to be planted within about a year. Currently, there are four reintroduction sites monitored and maintained by NRS. There are many PUs in the southern Wai‘anaes that have only one wild plant remaining and one (‘Ēkahanui-A) that has many plants remaining. NRS has developed a strategy to mix the separate individual founders from these PUs equally into several reintroduction and augmentation sites. In general, the goal is to maximize the amount of genetic exchange between all the remaining founders in the southern Wai‘anaes in Central Kalua‘ā by planting an equal number of plants from each founder. Equal amounts of plants from the two available Pahole founders will be mixed for the Pahole PU. The following displays the founders used at each reintroduction or augmentation site.

Stock Source for Pahole Augmentation	**# of Founders available**	**# of Founders represented in this site**	**Total outplants per pop ref site**	**Current survivorship**
Pahole-A	1	1	20	81%
Pahole-B	1	1	4	100%
Stock Source for Kalua‘ā-B Reintroduction	**# of Founders available**	**# of Founders represented in this site**	**Total outplants per pop ref site**	**Current survivorship**
‘Ēkahanui-A	15	1	30	33%
‘Ēkahanui-B	3	1	1	0%
Kalua‘ā	1	1	39	88%
Palāwai	1	1	1	100
Stock Source for ‘Ēkahanui Augmentation	**# of Founders available**	**# of Founders represented in this site**	**Total outplants per pop ref site**	**Current survivorship**
‘Ēkahanui-A	15	7	24	79%
‘Ēkahanui-B	3	2	15	80%
Kalua‘ā	1	1	20	45%
Palāwai	1	1	26	50%
Stock Source for Kalua‘ā-C Reintroduction	**# of Founders available**	**# of Founders represented in this site**	**Total outplants per pop ref site**	**Current survivorship**
‘Ēkahanui-A	15	9	63	77%
‘Ēkahanui-B	3	2	12	92%
‘Ēkahanui-C	1	1	7	100%
Huliwai	1	1	11	81%
Kalua‘ā	1	1	9	100%
Mohiakea	1	1	18	66%
Palāwai	1	1	9	61%

Founders Represented in Outplantings

TaxonName: Schiedea kaalae **TaxonCode: SchKaa**

Total Num Plants based upon Plants that have been numbered

PopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Huliwai	Genetic Storage	1	1
Kahana	Genetic Storage	7	0
Kaipapau	Genetic Storage	2	0
Kaluaa and Waieli	Manage for stability	0	0
Maakua (Koolaus)	Manage for stability	16	0
Makaua (Koolaus)	Genetic Storage	1	0
Mohiakea	Genetic Storage	1	1
North Palawai	Genetic Storage	1	1
Pahole	Manage for stability	2	2
South Ekahanui	Manage for stability	16	13
	Total for Taxon:	**47**	**18**

Number of Founders = Number of Mature, Immature, and Dead founder plants.
Number of Founders Represented = Number of founder plants represented in reintroductions.

Research Issues

Slugs are thought to pose the most significant threat to this species. NRS Research Specialist is looking into control techniques (see Chapter 6).

Taxon Threats

It is clear that there is a limiting factor preventing the natural recruitment of this species. Many of the remaining PUs in the Wai‘anae Mountains are known from poor quality habitat consisting of predominately alien forest. However, it is not thought that this affects natural recruitment. It is assumed that slugs consume seedlings of this species and may be the reason that no natural recruitment has been reported in the Wai‘anaes in recent history. Slug predation also was observed on the ‘Ēkahanui -C population, eliminating all above ground growth and causing the plant to re-sprout elsewhere along the root system. Pigs are also considered a significant threat as this species that prefers gulch bottom and lower slope habitats, however most PUs are protected by fences. Nevertheless, plants in the Pahole and ‘Ēkahanui PUs have been fenced for many years and have not begun to recruit naturally. Rat damage has been observed on individuals in the Pahole reintroduction in the last year. This seems to have been a one time event and has not been observed since.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Schiedea kaalae

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Mohiakea	Genetic Storage	Yes	Yes	Partial
Pahole	Manage for stability	Yes	No	Partial

Action Area: Out

TaxonName: Schiedea kaalae

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Huliwai	Genetic Storage	No	No	No
Kahana	Genetic Storage	No	No	No
Kaipapau	Genetic Storage	No	No	No
Maakua (Koolaus)	Manage for stability	Yes	No	No
Makaua (Koolaus)	Genetic Storage	Yes	Partial	No
North Palawai	Genetic Storage	Yes	Yes	No
South Ekahanui	Manage for stability	Yes	Yes	Partial

Action Area: Reintro

TaxonName: Schiedea kaalae

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kaluaa and Waieli	Manage for stability	Yes	Yes	Yes

Manage for Stability PUs:

Pahole: The NARS Specialist monitors the remaining wild plant and collects propagules. In the past year an augmentation was established by NARS in Pahole Gulch.

South ʻĒkahanui: There are still 14 mature wild plants in ʻĒkahanui however no juveniles or seedlings have survived in these sites. All plants are within ungulate fences and NRS and TNC have been monitoring, collecting and controlling weeds around these plants for many years. The augmentations in this site have been established using stock from many different founders. NRS continues to collect mature seed from the wild plants for storage and for use in outplanting. Slug predation also was observed on the ʻĒkahanui -C population, eliminating all above ground growth and causing the plant to re-sprout elsewhere along the root system, significantly reducing seed available for collection. In the coming year, NRS will continue to assist TNC in monitoring the wild plants, collecting mature seed, maintaining the fences, and conducting weed control. A large fence will be built in ʻĒkahanui and will provide many more potential outplanting sites in the coming year.

Central Kaluaʻā: There are no longer any wild plants in this PU. This PU currently consists of two TNC outplanting sites located in the Central Kaluaʻā fence and one NRS reintroduction site. TNC maintains two sites that consist of plant stock from ʻĒkahanui, Kaluaʻā, and Pālāwai. NRS manages another site, higher in the gulch, which contains genetic stock from ʻĒkahanui, Mohiākea, Pālāwai, North Kaluaʻā and Huliwai. In the coming year, NRS will continue to assist TNC in monitoring the plants, collecting mature seed, maintaining the fences, and conducting weed control. In the coming year, NRS plan to supplement the site with more plants to balance the founders.

Maʻakua: NRS has not visited this site in the last year and will work with PEP in the coming year to ensure that the collections are established as a living collection and can be collected from in the greenhouse.

Other PUs:

Huliwai: There are no wild plants left in this PU. Genetic stock from this PU has been kept in the greenhouse and many mature seeds have been collected from it for storage and for use in reintroduction. In addition, many cuttings have been taken from this plant and now serve as a substantial living collection. These seeds have been used to establish the Kaluaʻā planting site and the rest remain in storage. NRS will continue to hold this stock as a living collection and collect seeds for use in reintroduction and storage. In addition, seeds may also be collected from the reintroduced plants and stored.

Kahana: PEP has been monitoring this population in the last year. Cuttings have been collected and are being grown at Lyon Arboretum. These will be used as a propagule source in the future and serve as a living collection of these plants. More potential founders are likely to be found at this site.

Kaipapaʻu: The two mature plants known from this PU have died. The last remaining plants were taken out by a landslide. One plant is represented at Lyon and will serve as a living collection in the greenhouse and a propagules source.

Makaʻua: PEP has been monitoring this PU over the last year. There have been one mature and one immature plant observed here in the past. According to PEP in the last year, the immature plant died. Cuttings have been collected from both plants at this site and they are growing successfully at Lyon Arboretum to serve as a living collection.

Mohiākea: There is still one wild plant in this PU. Seeds have been collected and individuals grown from these collections were outplanted in Kaluaʻā. NRS constructed a small fence around this PU because ungulates are a significant threat in the area. In the coming year, NRS will continue to collect mature seed for storage and to supplement the existing site in Kaluaʻā.

North Pālāwai: There is one mature plant in Pālāwai; it seeded prolifically in past years. On multiple visits, NRS worked with TNC to secure stock for storage. NRS constructed a small exclosure around the plant to protect it from ungulates and small scale weeding was conducted. The site is almost completely dominated by *S. terebithtifolius* and large scale weed control it not feasible. NRS will continue to work with TNC to monitor this site and collect mature seed for storage and propagation for outplanting.

North Kalua'ā: This population has not been observed since 2000, when a single mature plant was observed and collected from. This stock is both in genetic storage and being grown for reintroduction into the Central Kalua'ā outplanting site.

3.1.24 *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

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have stable structure?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
1/3	0/3	0/2 (only 2 wild PUs)	1/3	0/3

Taxon Level Discussion

Schiedea nuttallii is extremely rare; only four extant population sites are known, one consisting of a single plant. The manage for stability PUs are Kahanahāiki to Pahole, Kapuna-Kewapilau Ridge, and an introduction planned for Mākaha. Substantial recruitment of wild plants has only been observed by NRS staff at the Kahanahāiki site. The number of plants at one of the Pahole sites has fluctuated between 10 and 17 since 1996 but NRS have never observed more than a few seedlings. Individual plants of this taxon often show signs of invertebrate damage. Reintroductions are considered somewhat successful although 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.

Major Highlights/Issues Year 2

- Some reintroduced individuals have remained healthy and robust since 1999.
- Kapuna fence construction has begun.

Plans for Year 3

- NRS plan to outplant into the Mākaha fence once it is completed.
- Research will continue on the effects and possible control for slugs and arthropods.

Action Area: In

TaxonName: Schiedea nuttallii **TaxonCode: SchNut**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki to Pahole	Manage for stability	58	17	1	37	4	3	43	4	0	80	8	3	No significant change in the wild sites and more plants were added to the existing augmentations
Kapuna-Keawapilau Ridge	Manage for stability	3	0	0	3	0	0	0	0	0	3	0	0	Monitoring found no change this last year
	Total for Taxon:	61	17	1	40	4	3	43	4	0	83	8	3	

Action Area: Out

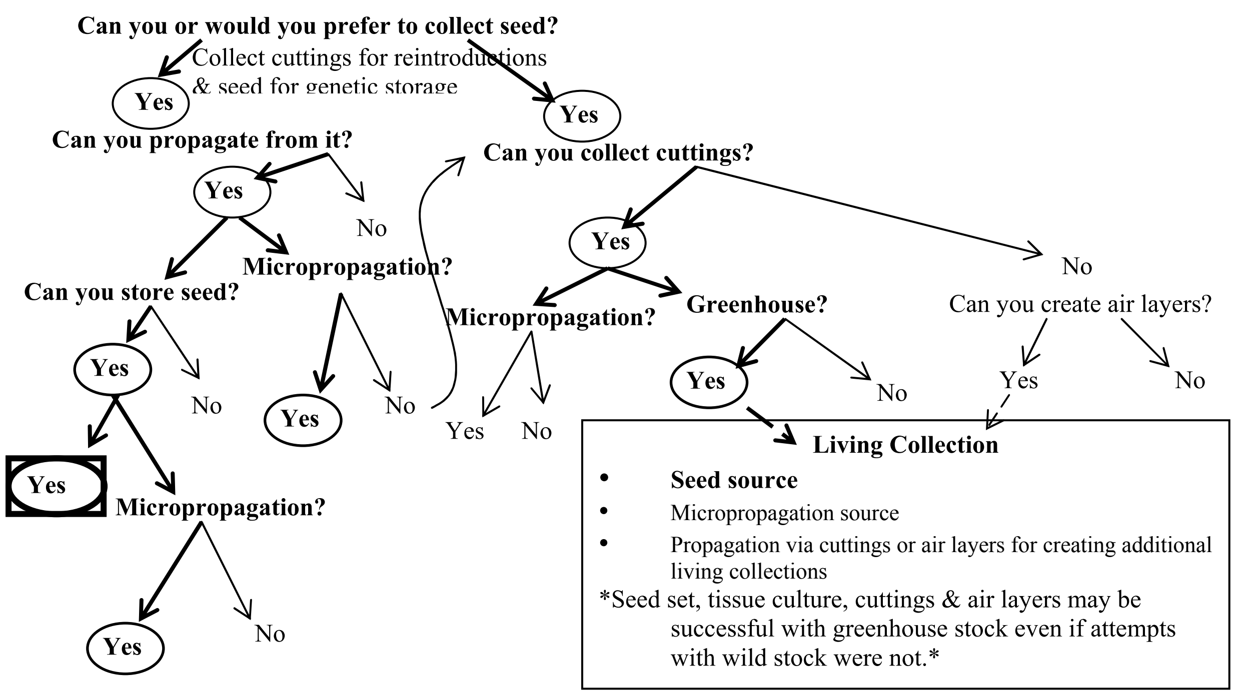
TaxonName: Schiedea nuttallii **TaxonCode: SchNut**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	0	0	0	This reintroduction will begin once the MU fence is complete
	Total for Taxon:	0	0	0	0	0	0	0	0	0	0	0	0	

Propagation and Genetic Storage:

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Cuttings (preferred) and seed (when cuttings are not available or seed is already banked)	Seed	Yes, but not extensive – fine-tuning & backup research	Yes, seeds for storage testing would be from a living collection

Prioritizing Genetic Storage & Propagation Techniques



Collection: Seeds are best collected when capsules are turning tan and drying, but before they have completely dehisced. Many times only one seed remains in a dry capsule, and it is difficult to make sizable collections. This timing is very difficult to achieve. Immature, white seeds are present when capsules are still green and somewhat fleshy.

Propagation: Immature seeds have yet to be tested for propagation and storage potential in the Micropropagation Lab. All seeds received have been mature and brought to the Seed Conservation Lab. The Seed Conservation Lab has not done germination testing of this taxon and has few results for initial germination rates. Of the fresh seed sown on agar, rates are variable, but the majority is over 50% germination. Though most seeds germinate within one month after sowing, some take three months to germinate. Seedlings are easily transferred from agar to perlite/vermiculite. Both seeds and small seedlings have been germinated and grown in an environment-controlled growth chamber. This taxon can also be propagated through the use of cuttings. This year, the majority of cuttings taken from wild plants in the Kahanahāiki to Pahole as well as all greenhouse stock have rooted. This result is much higher than what was recorded in the previous year. Cuttings from greenhouse stock have a higher success rate. Either technique can be used based on propagule availability and destination.

Seed Storage Research: No formal storage tests have been designed for this species because collections are too small and valuable. However, important information has been collected as seeds are removed from storage for propagation. Viability percentages are very hard to calculate for this taxon due to the very low number of seeds received and sown. No decrease in viability had been recorded, and seeds have been stored for over five years. Seeds are stored at -18C and 20% relative humidity. NRS will continue to store seed from natural populations, but will conduct testing on seed collected from greenhouse plants and reintroductions to track changes in viability over time.

Genetic Storage: The Seed Conservation Lab has 21 of the 69 founders represented in storage. An additional founder is represented in tissue culture. This year, NRS continued to withdraw stored seed for propagation for outplanting as well as collect seed for immediate propagation and storage. NRS is working to represent all founders in reintroductions and seed collections are beginning to be made from these sites as plants reach maturity. Many of the reintroduced plants are clones of wild plants, so seed collected from these reintroductions are of the same value as those collected from the wild populations. Collections should be made frequently to achieve genetic storage goals, due to the low number of seeds collected at a given time. Refresher collections do not need to occur more frequently than every five years to maintain genetic storage goals.

Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Micropròp	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Schiedea nuttallii							
Kahanahaiki to Pahole	37	4	22	16	1	25	17
Kapuna-Keawapilau Ridge	3	0	3	0	0	2	0
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				16	1	27	17

Outplanting Issues

Reintroductions have been established at three sites in the Kahanhāiki to Pahole MU; two in Kahanahāiki and one in Pahole. One site within Kahanahāiki has five plants that remain healthy and robust, some of which were planted in 1999. Survivorship at this site is 27%. The ground-covering *Blechnum appendiculatum* may be hindering recruitment, and at the other site, a small landslide covered several plants. Survivorship in the Pahole reintroduction is currently around 62%. NRS believe that natural senescence of plants may have much to do with current survivorship levels at the oldest of the Kahanhāiki sites. This type of declines of mature individuals has been observed in the wild. Of greatest concern is the lack of regeneration at the reintroduction sites. Perhaps there are microhabitat needs that NRS are unaware of which trigger seedling production. NRS will continue to monitor and refine reintroduction methods and will apply this knowledge to future reintroductions.

At all current reintroduction sites, stock was generated from the wild Kahanahāiki plants. NRS will continue to balance founders and maintain representatives from individuals that are currently dead in the wild until the population can sustain itself. In Pahole, stock is being propagated from both wild sites in Pahole (one of which only contains one plant). NRS also hope to augment the Kapuna-Keawapilau Ridge PU using stock from the wild population in this PU. Finally, the Mākaha PU will consist of plants from the Kahanahāiki population.

Founders Represented in Outplantings

TaxonName: Schiedea nuttallii **TaxonCode: SchNut**

Total Num Plants based upon Plants that have been numbered

PopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Kahanahaiki to Pahole	Manage for stability	63	27
Kapuna-Keawapilau Ridge	Manage for stability	6	0
Makaha	Manage reintroduction for stability	0	0
	Total for Taxon:	**69**	**27**

Number of Founders = Number of Mature, Immature, and Dead founder plants.
Number of Founders Represented = Number of founder plants represented in reintroductions.

Research Issues

Both slugs and insects have been observed to frequently attack seedlings of this species. Formal investigation into a related species (see Research Issues Chapter 6), suggests slugs likely impact *S. nuttallii* in a similar manner. Federal biologists consider slugs to be an "immediate and significant threat" to *S. nuttallii* survival (U.S. Fish and Wildlife Service 1998), though these conclusions are based on anecdotal observations. The NRS Research Specialist will investigate slug and insect control options for this species. Research will begin by assessing the abundance and species of slugs present at reintroduction and wild sites (see Chapter 6).

Taxon Threats

Threats to this taxon remain the same (see Army NRS 2005). NRS are researching possible control methods for slugs (see Chapter 6).

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Schiedea nuttallii

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki to Pahole	Manage for stability	Yes	Yes	No
Kapuna-Keawapilau Ridge	Manage for stability	No	Yes	No

Action Area: Out

TaxonName: Schiedea nuttallii

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Makaha	Manage reintroduction for stability	No	No	No

Manage for Stability PUs:

Kahanāhaiki to Pahole: This is by far the largest extant PU and represents about 92 percent of the total wild plants in the taxon. This is the only PU where ecosystem level habitat protection is currently in place. All but one wild *S. nuttallii* site is within a fenced exclosure where habitat quality is good. One of the wild Pahole sites is at low elevation and is entirely weed-dominated and weed control actions are not planned. This year NRS worked with NARS staff to monitor and collect propagule material from Pahole for storage and reintroduction into Pahole for the 2007-2008 reintroduction. If regeneration issues could be overcome, NRS could be close to reaching sustainability goals in this PU. There are no plans to mix plants from Pahole Gulch with plants from Kahanahāiki Gulch in any reintroductions any time soon.

Kapuna-Keawapilau Ridge: This year, NRS assisted the NARS Specialist with monitoring and collecting from this PU. The population is within the area slated for fencing by the Division of Forestry and Wildlife in the coming years. NRS will augment the Kapuna-Keawapilau PU with an outplanting site within one of the Kapuna subunit fences once they are built. There are only 4 founders to augment this population with. The construction of an ungulate fence is the single most important management step for this population.

Mākaha Reintroduction: An ecosystem-sized fence in Mākaha will be completed by the end of 2006. The exclosure contains appropriate *S. nuttallii* habitat for reintroductions, and NRS are currently looking to prepare sites for outplanting. Outplanting this year will depend on finishing the fence and removing all pigs from the exclosure. In the meantime, NRS will maintain clones of all wild Kahanāhaiki plants to ensure that stock is available to conduct a Mākaha reintroduction.

3.1.25 *Schiedea obovata*

Requirements for Stability from MIP:

- 3 Population Units (PUs)
- 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

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have stable structure?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
2/3	1/3	2/2 (only 2 wild PUs)	1/3	0/3

Taxon Level Discussion

Once found in six sites, only two *Schiedea obovata* populations were known last year. In August this year, NRS staff discovered a new population within the only extant PU, Keawapilau to West Makaleha. Prior to the disappearance of *S. obovata* from other known sites, seeds were collected and are being used to augment the Kahanahāiki to Pahole and Keawapilau to West Makaleha PUs. This year NRS worked with the NARS specialist to establish two new reintroduction sites along the Pahole rim. This makes a total of four reintroduction sites within the Kahanahaiki to Pahole PU and one site within the Keawapilau to West Makaleha PU. Slugs have the potential to completely hinder seedling regeneration in several sites. NRS are currently researching a forestry approved slug control bait that may be deployed around mature individuals to enhance recruitment potential (see Chapter 6). Effective slug control is expected to greatly enhance regeneration and stabilization of *S. obovata* populations.

Major Highlights/Issues Year 2

- NRS discovered a new population of *Schiedea obovata* in Keawapilau.
- Two new reintroduction sites were established along the Pahole rim.
- NRS have met seed storage goals for the Keawapilau to West Makaleha PU, and Kahanahāiki to Pahole PU.

Plans for Year 3

- NRS are researching forestry approved slug control bait.
- Continue to balance founders at 2 reintroduction sites in Pahole, and one in Kahanahāiki.

Action Area: In

TaxonName: Schiedea obovata **TaxonCode: SchObo**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki to Pahole	Manage for stability	58	34	149	0	0	0	103	134	56	103	134	56	No wild plants in this PU, but F1 plants in the augmentations are becoming mature and new seedlings are found often
Keawapilau to West Makaleha	Manage for stability	42	1	33	44	16	11	11	14	0	55	30	11	An augmentation began this year and the wild sites are stable and increasing
	Total for Taxon:	100	35	182	44	16	11	114	148	56	158	164	67	

Action Area: Out

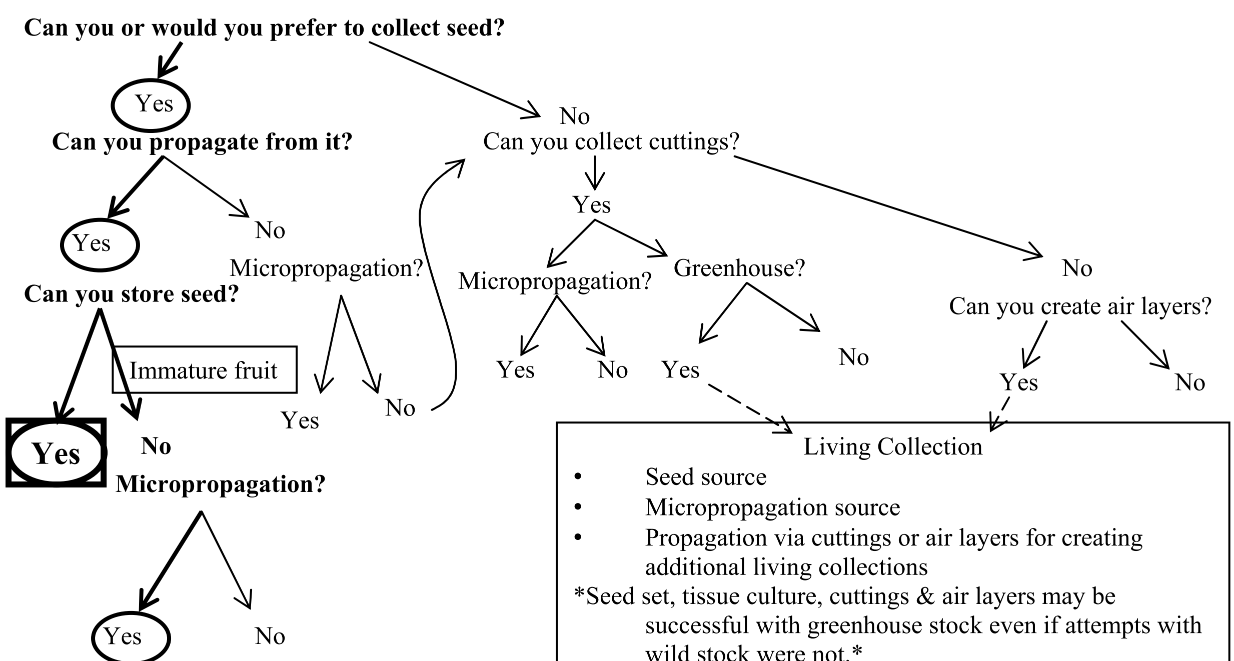
TaxonName: Schiedea obovata **TaxonCode: SchObo**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	0	0	0	The reintroduction will begin once the MU fence is complete
	Total for Taxon:	0	0	0	0	0	0	0	0	0	0	0	0	

Propagation and Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	No	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: The optimal collection time for seed storage purposes is when fruit are not fleshy but beginning to dry out and dehisce. The thin inner capsule that surrounds the seeds should be tan and the seeds should be brown to black. When the capsule is still green, the seeds may not be completely mature. If the fruit is collected for immediate propagation, the fruit can still be fleshy and the inside capsule green. These seeds may actually germinate faster because slightly immature seeds may not be as dormant. Dormancy typically sets in after seeds have fully developed and dropped in moisture content in preparation for dehiscence and dispersal. Populations of *S. obovata* in the wild have been known to disappear for a number of years and then reappear after large rainfall events. Particularly if cooler temperatures were associated with the large rainfall events, this observation is reflective of the physiological dormancy in the seeds of this taxon and allows for at least temporary soil seed banks to be maintained.

Slightly immature (green capsule/tan seeds) **Completely mature (tan capsule/brown seeds)**

Propagation: Fresh germination appears to be stimulated by fluctuations in temperature and seeds can sometimes take six to 10 months, depending on time of year of collection, to begin to germinate. Fresh germination on 1% water agar is typically > 90%, and seedlings can easily be transferred to perlite/vermiculite with very low to no mortality. Stored seeds germinate within a few weeks after sowing. Germination in vermiculite and perlite and on wet paper towels is also very successful (Weller pers. comm., 2004). Immature and mature seeds are also easily germinated at the Micropropagation Lab and maintained in tissue culture via subculturing.

Seed Storage Research: *S. obovata* stores well under refrigeration and freezing. The preferred seed storage technique is refrigeration (4C) or freezing (-18C) at 20% humidity. Seeds tested after five years show 0-4% decrease in viability for each year of storage. Seeds tested after seven and eight years of storage that do not have initial viability results still have good viability.

Genetic Storage: Seed storage is the preferred method of genetic storage due to its success and efficiency. Based on seed storage potential, refresher collections, where applicable, could conservatively occur every eight years to maintain genetic storage goals once they are achieved for a founder. Since 2000, NRS has representation from 64 wild plants from all PUs in seed storage. Reintroduced plants have proven to be an excellent source of seed for storage, and seeds have been collected from sites in the Kahanahāiki to Pahole PU from individuals representing founders that have died. Dr. Weller had collected from a plant in Keawapilau before it died and has it represented in his greenhouse at U.C. Irvine. This stock is currently being propagated for a reintroduction in Kapuna. All five of the original founders from the Kahanahāiki to Pahole PU are represented in the seed bank.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Schiedea obovata							
Kahanahaiki to Pahole	0	0	5	5	1	5	5
Keawapilau to West Makaleha	44	16	8	58	1	11	58
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				63	2	16	63

Unique Species Observations

Within and between populations, there is wide variation in morphological traits such as leaf morphology and branch development. For example, leaf length among similarly-aged cohorts ranged from 2-8 cm. The widest variation in leaf length was observed in a single population (northwest Makaleha). NRS are still unsure as to whether or not this leaf variation is environmental or genetic.

Outplanting Issues

Using seed collected from four wild sites: Kahanahāiki, Pahole (2 sites), and West Makaleha, NRS have been rearing and outplanting *S. obovata* to augment those same wild populations. Stock has only been mixed in the Kahanahāiki PU where plants from a site in West Makaleha were outplanted by a U.H. graduate student for a research project. A joint effort between NARS staff and NRS has led to two different reintroductions of *S. obovata* from two founding populations of Pahole plants into sites just below the Pahole rim, on the Pahole/Kahanahāiki boundary. Notably, seedling recruitment has been extremely high in the first of these outplantings, with hundreds of seedlings seen on multiple occasions. Whether the absence of slugs or some other factor is responsible for the observed recruitment is still unknown. NRS aim to achieve the same success in population structure with the newest of these outplantings established this year using seed stock grown by Dr. Weller from a now extinct population in Pahole Gulch. Dr. Weller isolated his greenhouse plants from other stock in order to collect pure seed from them. He has also grown plants from an extinct Keawapilau site and NRS will consider augmenting the new population in Keawapilau found this August. NRS has seen limited recruitment at the augmentation site in Kahanahāiki. This site will also be investigated for slug impacts.
Quantification of characteristics such as aspect, light cover, and associated species in successful wild and outplanted sites needs further understanding to improve site selection and to create

robust populations that may overcome other threats. This sort of investigation will not only help NRS in site selection, but may also help answer management questions such as how much canopy and understory cover to weed, and whether or not sites could benefit from restoration by outplanting common native species.

Founders Represented in Outplanting

TaxonName: Schiedea obovata **TaxonCode: SchObo**

Total Num Plants based upon Plants that have been numbered

PopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Kahanahaiki to Pahole	Manage for stability	5	5
Keawapilau to West Makaleha	Manage for stability	68	4
Makaha	Manage reintroduction for stability	0	0
	Total for Taxon:	**73**	**9**

Number of Founders = Number of Mature, Immature, and Dead founder plants.
Number of Founders Represented = Number of founder plants represented in reintroductions.

These reintroductions have allowed NRS to compare the performance of offspring reared from *S. obovata* founder populations. Until NRS were able to observe the performance of the Pahole and West Makaleha stocks, reintroduced Kahanahāiki material seemed fairly successful in terms of individual plant vigor. After observing growth in the Pahole and west Makaleha stocks however, NRS found the Kahanahāiki stock has fairly poor vigor. In addition, the Kahanahāiki stock appears less tolerant of herbivory. When exposed to slug herbivory, (see Research Issues, this document) these plants have very few leaves and these leaves are often tattered in comparison with those of Southwest Makaleha plants. Branching development also differs between offspring from different founder populations. For example, the Kahanahāiki stock begins branching right away after outplanting whereas the West Makaleha stock has not begun branching at all. While it is difficult to say what impact early branching may have on plant fitness, greater resistance to slug herbivory would certainly have a positive effect on plant survival. Therefore, it may be advantageous to mix stock prior to outplanting to allow for more genetic exchange. NRS began trying to investigate the impacts of mixing stocks this year (Research Issues below).

Research Issues

Mixed-stock Outplanting:
This year, NRS devised a plan to determine the pros and cons of a mixed-outplanting for this taxon. Prior to outplanting, NRS plans to determine whether or not outbreeding depression for this selfing species can occur. This will be accomplished by documenting and studying vigor and morphology of propagules from hand-crossed pollinations of greenhouse stock.

Though not yet formally concluded, *S. obovata* is at least a facultative selfer, and probably has a very high selfing rate in the wild. Flowers do, however, have a large quantity of black nectar that may attract pollinators. Pollinators, however, have not been observed visiting this species (Weller pers. comm. 2006). Anthers are typically observed to dehisce immediately prior to flower opening, which appears to coincide with stigma receptivity. Essentially, this taxon can bloom and display already pollinated stigmas before nectar can serve as a pollinator attractant. Therefore, the likelihood of this taxon actually crossing is low, but cannot be ruled out. These observations greatly hinder the ability to easily obtain seed from hand crosses.

Pollination of greenhouse stock was initiated in June 2006. Control flowers were tagged, flowers were emasculated but not pollinated, and flowers were emasculated and hand-selfed or hand-crossed with intra- and inter-population site pollen. There was very low seedset after a couple months for even control flowers, as well as very little pollen to harvest from open flowers. Timing of the pollinations was poor, and temperature may have played a role in low pollen availability as well as high flower/fruit abortion. Pollinations will continue in January 2007 at Pahole Mid-elevation Nursery. Pollinations this year occurred at the Army Nursery. A lower elevation, along with timing of study, may have contributed to low pollen availability and low seed set. Plants not in the study that remained at Pahole Mid-elevation Nursery were also observed to have low pollen availability in July 2006 but appeared to have more flowers and seed set by September 2006 than the plants that remained at the Army Nursery.

Slugs:
Slugs are seriously hampering NRS efforts to establish stable, reproducing *S. obovata* populations in the wild. Research concluded in September 2004 by UH graduate student Stephanie Joe, showed seedling mortality doubled when exposed to slug herbivory. Her results demonstrate the need to control slugs in areas surrounding *S. obovata* populations. Stephanie Joe continues her research as an NRS member and is currently investigating control methods for slugs.

This July, NRS staff were integral in conducting the Gastropod forum held at the Hawai‘i Conservation Conference. NRS staff presented preliminary results from experiments, concerns, and ideas about gastropod control methods. The impact of gastropod control on native gastropods is clearly the greatest concern by NRS and other panel members. NRS continue to pursue a control method with limited impact on native gastropods (See Chapter 6).

Surveys

During a visit to another MIP species, another small population of this taxon was found this August. No other surveys were conducted for *S. obovata* this past year.

Taxon Threats

Ungulates, weeds, slugs, and possible rats all threaten the survival of *S. obovata*. Only one PU is completely fenced. The Mākaha fence is currently under construction, and only 3 plants in the Keawapilau to West Makaleha are not protected from ungulates. These plants are on a steep slope and are somewhat geographically protected. Weed control is conducted by NRS at all extant sites but not at historic locations. Additionally, in the Kahanahāiki augmentation, NRS have planted common native species associated with this taxon to keep out encroaching weeds. This year, two months after being outplanted, NRS noted that nearly 40% of individuals had significantly been chewed by rats. As a result, about 6 individuals died from this predation.

NRS will investigate the impacts of rat predation further, and may begin baiting this site if the problem persists.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Schiedea obovata

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki to Pahole	Manage for stability	Yes	Yes	No
Keawapilau to West Makaleha	Manage for stability	Partial	Partial	No

Action Area: Out

TaxonName: Schiedea obovata

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Makaha	Manage reintroduction for stability	No	No	No

Manage for Stability PUs:

Kahanahāiki to Pahole: This PU encompasses three former sites of *S. obovata*; two in Pahole and one in Kahanahāiki. The wild populations in Kahanahāiki and Pahole were gone from the wild by 2001. NRS and the NARS specialist visited all of the former wild populations in the past year to check for new seedlings, but none were found. Reintroduced *S. obovata* in Kahanahāiki have performed poorly compared to those reintroduced to Pahole (see Outplanting Issues section above). NRS outplanted into an existing augmentation site in Kahanahāiki this year, however planting was conducted across a larger area that is actively being restored with common outplantings and frequent weed control. NRS worked with the NARS specialist this year to establish a new reintroduction site on the Pahole side of the Pahole/Kahanahāiki boundary ridge. For this reintroduction, three sites, each about 100 meters apart, were chosen. One of these three sites has seen 100 % survivorship. Successful recruitment continues in the other Pahole reintroduction, and more plants were planted there this year. Hundreds of F1 generation seedlings and juveniles have been seen at this site in the past, and this year six mature F1 generation plants were observed. NRS will work to balance founders at all reintroduction sites in the coming year.

Keawapilau to West Makaleha: This PU encompasses all three known extant populations of *S. obovata*; two in West Makaleha and a new site found in Keawapilau. A population extirpated in Keawapilau in 2000 is also included in this PU. Wild plants alone achieve 50% of stability goals and NRS will continue to augment this PU to fully reach these goals. NRS conduct weed control at all West Makaleha sites and the Northwest Makaleha site is fenced. This year, NRS augmented the smaller West Makaleha population by outplanting into an adjacent exclosure. The source plants occur on a cliff and therefore ungulate impacts are minimized. This year NRS will look for a large manageable site that is similar to the Pahole site where regeneration is so strong (site research mentioned in Outplanting Issues section will be important). This site will likely be a candidate for outplanting stock from both the extinct and newly found Keawapilau sites. NRS will try one more year to determine the impacts of mixing stocks through pollination studies. The results from this investigation will be used to guide decisions about mixing stocks.

Mākaha: Construction of the Mākaha fence is underway and NRS will soon begin selection and preparation of outplanting sites for *S. obovata* in Mākaha. Outplanting this winter is pending on complete construction of the fence, and the removal of feral ungulates. NRS would like to outplant mixed stock from different founding populations in Mākaha, but will wait another year for results from cross pollination studies before doing so.

3.1.26 *Tetramolopium filiforme*

Requirements for Stability:

- 4 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Threats controlled
- Complete genetic representation of all PUs in storage

How many of the 4 MFS PUs have stable numbers of mature individuals?	How many of the 4 MFS PUs have stable structure?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
1/4	1/4	0/4	3/4	0/3

Taxon Level Discussion

Tetramolopium filiforme occurs in five sites in the northern Wai‘anae Mountains. All but one of the PUs are inside either the Mākua AA or Schofield AA (Mohiākea). Since this taxon is found within two AAs there are four PUs that are designated to be managed for stability. The threats for this species are manageable and NRS believe that with reintroductions and the protection and management of additional habitat stability is attainable.

Major Highlights/Issues Year 2

- In the last year NRS has focused collections on the sites with the highest potential threat from fire within the ‘Ōhikilolo PU.
- The Pūhāwai PU has been augmented with plants grown from seed collected off of plants growing in the greenhouse.
- An additional PU was discovered on Pu‘u Kalena in SBW by NRS. This PU is proposed as the forth MFS PU.

- **Plans for Year 3**
- NRS will strive to establish cuttings from the small number of accessible plants in the Kalena and Wai‘anae Kai PUs in the greenhouse. These plants will then serve as the source for seed collections for storage and can be used in outplanting when necessary.
- The Pūhāwai outplanting will be supplemented with more plants.
- Since seed viability is very low and multiple collections from the same plants may be detrimental to the population, collections for genetic storage will be made from more than 50 plants in each PU.

Makua Implementation Plan - Population Unit Status

Action Area: In

TaxonName: Tetramolopium filiforme **TaxonCode: TetFil**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki	Genetic Storage	45	0	0	45	0	0	0	0	0	45	0	0	No monitoring in the last year
Kalena	Manage for stability	0	0	0	9	0	0	0	0	0	9	0	0	New site found
Keaau	Genetic Storage	16	4	0	30	41	17	0	0	0	30	41	17	A thorough census of the known site found more plants
Makaha/Ohikilolo Ridge	Genetic Storage	300	0	0	300	0	0	0	0	0	300	0	0	No monitoring in the last year
Ohikilolo	Manage for stability	2442	552	0	2442	552	1	0	0	0	2442	552	1	Monitoring found no change in the last year
	Total for Taxon:	2803	556	0	2826	593	18	0	0	0	2826	593	18	

Action Area: Out

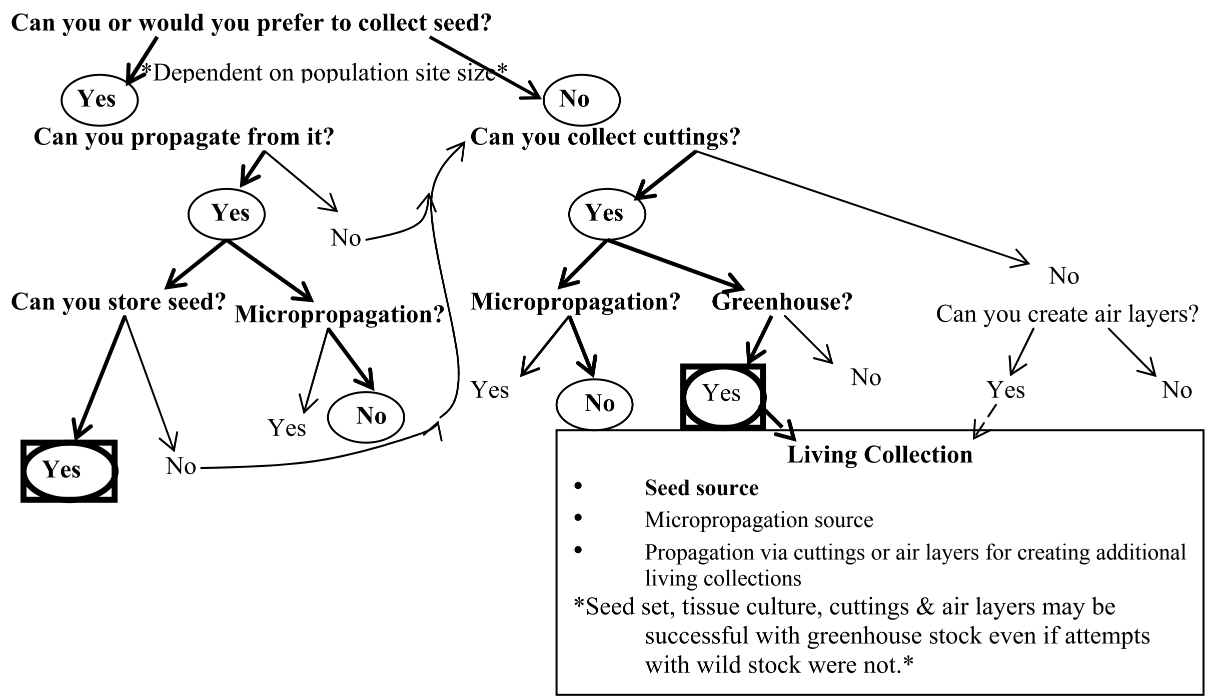
TaxonName: Tetramolopium filiforme **TaxonCode: TetFil**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Puhawai	Manage for stability	2	3	8	1	2	3	18	0	0	19	2	3	An augmentation was begun and the wild site was monitored
Waianae Kai	Manage for stability	30	8	1	30	8	1	0	0	0	30	8	1	No monitoring in the last year
	Total for Taxon:	32	11	9	31	10	4	18	0	0	49	10	4	

Propagation & Genetic Storage

1) At this time, what is the preferred propagation technique?	**2)** At this time, what is the preferred genetic storage technique?	**3)** Is more genetic storage testing needed?	**4)** Are additional steps required for obtaining enough seed?
Cuttings and seed	Seed	No	Yes; living collections as seed source for smaller population sites

Prioritizing Genetic Storage & Propagation Techniques



Collection: Seed set is low, and only a small proportion of achenes have developed embryos at maturity. One of the collections this year was from 59 individuals in one of the population sites within the ʻŌhikilolo PU. Collections averaged less than six non-empty seeds per head. Heads were mature and a very large majority of them were intact, greatly increasing the chance that the non-empty and therefore heavier seeds still remained in the head. When viability is factored in, there are approximately two viable seeds per head, indicating that 25 heads per plant would need to be collected to meet genetic storage goals. Also, collections from June 2006 from one greenhouse plant had hundreds of seeds, while collection from August 2006 had a significantly less number of seeds. This may indicate that there may be some seasonality involved in the number of viable seeds produced. Whether or not this is reflected in wild plants, greenhouse stock will continue to be observed to determine if there is a more specific time of year that would be best to collect.

Due to the large number of heads that need to be collected for adequate genetic representation, NRS proposes to take cuttings from small population sites for greenhouse living collections to serve as seed sources. One seed collection from a wild plant typically yields a very low number of viable seeds (< 50). After only seven months, an initial germination test of seeds from greenhouse grown Keaʻau plants has produced over 400 viable seeds. Since it is impractical to create a living collection for PUs with thousands of individuals, NRS proposes to continue seed collections, but to aim for representation from more individuals (>50), even if it means less than 50 seeds from each. This will alleviate frequent visitations to the same 50 individuals to reach genetic storage goals and acquire broader representation from within these larger PUs. If NRS collect from new individuals at each visit, genetic storage goals will not be met for all individuals, but more individuals will be sampled.

Propagation: Cuttings and seed are both appropriate propagation techniques. Propagation from cuttings is extremely successful, showing over 90% success rate. Many germination treatments have been tested with seed collected from greenhouse stock, and no special germination requirements are necessary. Seedlings are vigorous and plants are mature approximately six months after sowing.

Seed Storage Research: Over half of these seeds stored and tested at the Seed Conservation Lab are from greenhouse stock from the Pūhāwai PU. Three collections from plants in Mākua in 1999 and one from Mākua in 2000 have been used for seed storage trials. These four collections have recently undergone 5-year storage testing. No decrease in viability has been noted for stored seeds at the three tested temperatures: 24C, 4C, -18C. The main challenge with this taxon is its low seed viability. Fresh and stored germination averages range from 0-80%, with higher germination rates from more recent tests, due to the discarding of empty seeds. Carefully eliminating empty seeds from all collections will aide in tracking a change in viability over length of time in storage. Since this has not happened for the older collections currently in storage, NRS will collect seed for more storage testing from greenhouse stock once established.

Genetic Storage: The Micropropagation Lab has been unsuccessful in establishing *T. filiforme* in culture via seeds. The Lab's attempts at cuttings from other species of *Tetramolopium* have also failed, but this taxon has not been tested. Many species in the family Asteraceae are very sensitive to the sterilization techniques necessary for micropropagation. The lab has been continually and successfully researching methods to avoid oversterilizing while remaining free of contamination (Nellie Sugii pers. comm., 2005). NRS will collect cuttings and seed from greenhouse stock in attempt to establish these in tissue culture now that new sterilization methods are in place. Seed storage, however, will remain the primary genetic storage technique, and once storage minimums are achieved, refresher collections at the most would need to occur every five years.

Since *T. filiforme* is such a small plant, greenhouse plants can be used as ex-situ seed sources for individuals in small population sites 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, quickly producing enough seeds to reach storage goals. NRS will continue to collect seed from wild populations with large numbers of individuals. As shown in the table below, NRS has focused seed collections on the Kahanahāiki PU and on the lowest plants in the ʻŌhikilolo PU because they face the highest fire threat. In the coming year, NRS will collect from the unrepresented PUs.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Tetramolopium filiforme							
Kahanahaiki	45	0	32	66	0	0	41
Kalena	9	0	0	0	0	0	0
Keaau	30	41	0	17	0	0	2
Makaha/Ohikilolo Ridge	300	0	0	0	0	0	0
Ohikilolo	2442	552	1	109	0	0	42
Puhawai	1	2	9	4	0	1	4
Waianae Kai	30	8	0	1	0	1	0
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				197	0	2	89

Outplanting Issues

In the last year, NRS outplanted *T. filiforme* for the first time into the Pūhāwai PU. *Tetramalopium filiforme* grows on very exposed, open and rocky slopes. The plants had to be planted into very shallow cracks in the rock cliffs by staff on rappel. Twenty-eight mature individuals were planted in February 2006. When they were monitored in June, 18 had survived (65%) and four had flowers. The plants that were dead were observed to have been planted in the driest areas and the ones in relatively wetter spots were doing well. NRS will supplement this site in the coming year. It was challenging to produce plants in the greenhouse that resembled the short stature very woody and hardy looking wild plants. The plants were grown in full sun at the Pahole Mid-elevation Nursery and fertilizer was limited throughout the growing period.

Timing germination and transplanting is important to produce plants at the best size in the best size pot for outplanting.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Tetramolopium filiforme

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki	Genetic Storage	Yes	No	No
Kalena	Manage for stability	No	No	No
Keaau	Genetic Storage	No	No	No
Makaha/Ohikilolo Ridge	Genetic Storage	No	No	No
Ohikilolo	Manage for stability	Yes	Partial	No

Action Area: Out

TaxonName: Tetramolopium filiforme

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Puhawai	Manage for stability	Partial	No	No
Waianae Kai	Manage for stability	Partial	No	No

Manage for Stability PUs:

‘Ōhikilolo: The ‘Ōhikilolo PU contains well over the 50 mature individuals required for stability. Estimates given to the MIP in 2000 were based on multiple observations from over fifteen sites on ‘Ōhikilolo Ridge. NRS compiled over fifty observations from all over ‘Ōhikilolo Ridge since 1997 and found that the summary numbers of plants estimated in each of these observations exceeds the estimate given in the MIP. NRS have been attempting to visit each of these sites in an effort to gauge any population fluctuations in this large PU. Weeds are not considered a significant threat to this PU and ungulates no longer threaten plants in this PU. Fires are only a high threat to the plants found in the lowest makai site. Within the makai site, fire would likely not reach all of the plants as most are on very large steep cliffs that do not harbor much fuel. Most of the plants in this PU are found on the ridges further back in the valley and are not continuous with the large amount of fuel in the lower part of the valley. Otherwise this PU has a stable number of mature individuals, the known threats are controlled, genetic storage techniques are known and collections are adequate.

Pūhāwai: The table below displays the population trend that NRS has observed since monitoring first began in 1999. This population has declined steadily and in 2005, no immature plants or seedlings were found. When the site was monitored in May 2006, there were new seedlings and immature plants, but two of the matures had died.

Rare Plant Monitoring Data

Monitoring Date	Mature	Immature	Seedling	Total Mat. & Imm.
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
July 2005	3	0	0	3
May 2006	1	2	3	3

The number of plants in all age classes has decreased over the years. NRS have observed the Pūhāwai site to be a much drier habitat than ʻŌhikilolo ridge. There appear to be no other obvious limiting factors to the Pūhāwai population. Ungulates are not known from this area and weeds have not been noted as a threat. Collections of cuttings have been grown in the Army nursery and these plants have produced thousands of seeds which have been stored. The amount of appropriate habitat present at Pūhāwai is a key limiting factor to the continued existence of this population. NRS introduced plants to a chosen MIP reintroduction site below Puʻu Kūmakaliʻi.

Waiʻanae Kai: The Waiʻanae Kai PU as a whole is not robust and most plants are not accessible for management because they occur on an inaccessible cliff with unstable rocks. This area is also very under-surveyed. NRS will conduct more surveys for this taxon with the HINHP Botanist 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.

Kalena: This is a new PU discovered by NRS while monitoring a site with *Plantago princeps* var. *princeps* in the last year. The PU is within the AA for SBW and has been added as a fourth MFS PU for this reason. Mature seeds were collected from seven founders for storage. In the coming year, NRS will be growing stock from these collections for a proposed reintroduction into the Pūhāwai augmentation. This site will be monitored and collections will be made for genetic storage. Goats are a concern in this area and NRS will be working on assessing the control needs in the next year.

- Should the Kalena and Pūhāwai stock be mixed in the augmentation site for the Pūhāwai PU, or should we establish two separate sites?

Other PUs:

Kahanahāiki*:* The Kahanahāiki population of *T. filiforme* is located on a small cliff surrounded by *Diospyros sandwicensis* forest. This cliff is fairly devoid of vegetation, with only small, sparse shrubs present. This PU is located in an area affected by the July 2003 fire, which burned to within 20 meters of the site. The population is now buffered by only a small strip of forest and subsequent fires could eliminate this population. This site is not fenced, but ungulates are not a threat to this population as the plants occur on a cliff. There are no weed threats on the cliff; however, NRS have conducted weed control in the forest above and below the *T. filiforme* cliff, specifically targeting weedy tree species. NRS may begin controlling *P. maximum* in the forest closest to the cliff in order to reduce the amount of available fuel for fire. Genetic storage collections have been established for this PU.

Kea'au:. The first estimates for this site were based on the HBMP Botanist's observation from the ridge crest in 2002. In the last year, NRS monitored this site on rappel and collected seeds from 20 mature plants for genetic storage. The estimates may be revised again as further monitoring is likely to discover more plants. This PU is within the Kea'au Public Hunting Area and is not proposed to be fenced. Goats do not seem to be able to get to the plants to damage them, but the whole area is severely browsed and the habitat will continue to degrade as the goat population is left uncontrolled. No substantial and direct threat from weeds was noted, but fire may be of concern in the future.

Mākaha /'Ōhikilolo Ridge: This PU was originally lumped with the 'Ōhikilolo PU due to the close proximity of the sites, but was later treated separately to emphasize the differences in management (see taxon level discussion). The site is not fenced but this population is not considered a priority for management as it is located in such close proximity to the larger 'Ōhikilolo populations. Monitoring and collecting from the site has not been a high priority because it is assumed to be genetically similar to the 'Ōhikilolo stock. No significant weed threats have been observed.

3.1.27 *Viola chamissoniana* subsp. *chamissoniana*

Requirements for Stability:

- 4 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Threats controlled
- Complete genetic representation of all PUs in storage

How many of the 4 MFS PUs have stable numbers of mature individuals?	How many of the 4 MFS PUs have stable structure?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have them all completed?
1/4	0/4	0/4	3/4	0/4

Taxon Level Discussion

Since this taxon is found inside the Action Areas (AA) of both MMR and SBW, there are four PUs that are designated MFS. NRS split the ‘Ōhikilolo PU into two: the ‘Ōhikilolo PU, which is on the Mākua side of the fence on ‘Ōhikilolo ridge, and the Mākaha/‘Ōhikilolo Ridge PU which is on the Mākaha side of the ridge outside the fence. This was done to differentiate between the plants inside of the fence that will be MFS and those on the outside that are designated ‘Genetic Storage’. NRS also discovered an additional location for this taxon within the Mākaha PU (see Mākaha PU discussion below). In the last year, NRS continued to better organize the database population and count for this PU. This process has resulted in a much more accurate count of individuals. The Hālona PU must be investigated further as both subspecies are found at this site and the plants currently included in this PU may not have been accurately identified.

Major Highlights/Issues Year 2

- Weed management has begun around sites in the ‘Ōhikilolo PU.
- Goat sign was observed within the Mākua fence in the last few months and NRS have begun control.
- A collection of plants that has been kept in the greenhouse for many years has been duplicated by establishing cuttings from the collection.
- NRS has proposed that the Hālona PU be added as the fourth MFS unit.
- Successful establishment of cuttings from greenhouse plants in tissue culture at Lyon Arboretum.

Plans for Year 3

- The fence planned for a portion of the plants in the Mākaha PU will be completed.
- Continue to attempt a pollination study using the greenhouse plants before ruling out collecting from this living collection.
- Investigate the relationship between the two subspecies of plants found at the Hālona PU.

Action Area: In

TaxonName: Viola chamissoniana subsp. chamissoniana **TaxonCode: VioChaCha**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Keaau	Genetic Storage	40	10	0	40	10	0	0	0	0	40	10	0	No monitoring in the last year
Makaha/Ohikilolo Ridge	Genetic Storage	32	0	0	7	0	0	0	0	0	7	0	0	Data was updated in the last year
Ohikilolo	Manage for stability	377	2	0	433	10	0	0	0	0	433	10	0	A thorough census of a few known sites increased the number of plants
Puu Kumakalii	Manage for stability	44	0	0	44	0	0	0	0	0	44	0	0	Monitoring in the last year found no change
	Total for Taxon:	493	12	0	524	20	0	0	0	0	524	20	0	

Action Area: Out

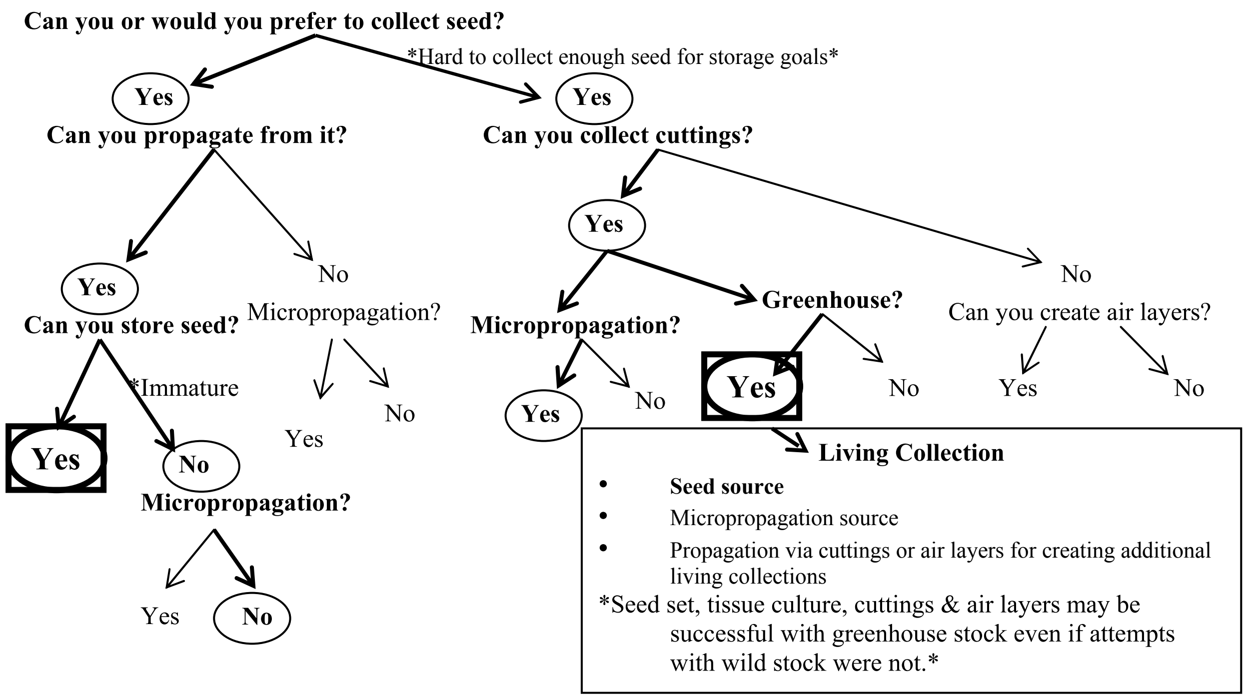
TaxonName: Viola chamissoniana subsp. chamissoniana **TaxonCode: VioChaCha**

Population Unit Name	Management Designation	NRS Mature 2005	NRS Immature 2005	NRS Seedling 2005	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Halona	Manage for stability	32	3	0	41	3	0	0	0	0	41	3	0	Monitoring in the last year found a few more plants
Kamaileunu	Genetic Storage	35	0	0	35	0	0	0	0	0	35	0	0	No monitoring in the last year
Makaha	Manage for stability	24	0	2	24	0	2	0	0	0	24	0	2	No monitoring in the last year
Puu Hapapa	Genetic Storage	10	0	6	13	0	0	0	0	0	13	0	0	A small change was observed in the last year
	Total for Taxon:	101	3	8	113	3	2	0	0	0	113	3	2	

Propagation and Genetic Storage

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Is more genetic storage testing needed?	4) Are additional steps required for obtaining enough seed?
Cuttings	Living collection for seed (currently); eventually just seed	No	Yes; living collection

Prioritizing Genetic Storage & Propagation Techniques



Collection: The only storage challenge remaining is collecting ample seed. Wild plants produce very few flowers at a time and each capsule contains less than 10 seeds. In order to overcome this hurdle, NRS collected cuttings from plants in the Pu‘u Kūmakali‘i and Pu‘u Hāpapa PUs because, at this time, they had the smallest number of founders. Unfortunately, the majority of fruit abort at various stages. Some of these aborted fruit contain unfertilized ovules and others contain immature seed. NRS plans to conduct hand-pollination crosses on greenhouse stock in attempt to increase seed set. NRS will use results to decide what type of propagule needs to be collected from founders, starting with the smallest PUs. If seed set increases for living collection stock, cuttings will be taken. If seed set still remains low for the living collection, cuttings for tissue culture or seed for storage (if available) will be collected.

Propagation: Micropropagation has not been a successful means of propagation for the immature seed tested at the Micropropagation Lab. Many immature fruit collections were brought to the lab but none were successful. One cutting from a wild plant was brought to the lab, but did not root. In August 2004, cuttings from Army Nursery plants were brought in and successfully established via tissue culture and remain healthy.

This taxon is easy to propagate from both seeds and cuttings. NRS have observed an approximate 60% success rate for cuttings. Cuttings of nursery plants have been used to secure clones and allow these founders to be kept for many years in cultivation. Seeds tested had the highest germination on agar with no special germination requirements.

Seed Storage: A collection of seed made in 1999 from ‘Ōhikilolo has undergone storage testing. Seeds were split into two storage treatments. Seeds tested after five years of storage at -18C and 8% relative humidity had a germination rate of 60% (15:25), which was significantly higher than the other treatment (24C) ($P < 0.05$). Seeds stored at -18C but at a slightly higher level of humidity should potentially last longer. This is the recommended storage condition for this taxon.

Genetic Storage: Determination of the most appropriate genetic storage technique is ongoing. Seed can be stored, so if seed can be collected from the living collections, then this process should be utilized to meet genetic storage goals for this taxon. If NRS is unable to collect seed from the living collection plants, then cuttings from this stock should be made to establish clones in tissue culture. Micropropagation may be less successful for cuttings from wild plants when compared with nursery stock. NRS will confirm this before trying to attain genetic storage goals via living collections in tissue culture.

Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Viola chamissoniana subsp. chamissoniana							
Halona	32	3	0	0	0	0	0
Kamaileunu	35	0	0	0	0	0	0
Keaau	40	10	0	0	0	0	0
Makaha	24	0	0	0	0	0	0
Makaha/Ohikilolo Ridge	7	0	0	0	0	0	0
Ohikilolo	433	10	0	0	0	7	5
Puu Hapapa	13	0	0	3	0	9	6
Puu Kumakalii	44	0	0	4	0	20	17
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				7	0	36	28

Outplanting Issues

NRS have yet to conduct an outplanting with this taxon and at this time augmentation is not being considered for any PU.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Viola chamissoniana subsp. chamissoniana

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Keaau	Genetic Storage	No	No	No
Makaha/Ohikilolo Ridge	Genetic Storage	No	No	No
Ohikilolo	Manage for stability	Yes	Partial	No
Puu Kumakalii	Manage for stability	Yes	No	No

Action Area: Out

TaxonName: Viola chamissoniana subsp. chamissoniana

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Halona	Manage for stability	No	Partial	No
Kamaileunu	Genetic Storage	Partial	No	No
Makaha	Manage for stability	Partial	No	No
Puu Hapapa	Genetic Storage	Yes	No	No

Manage for Stability PUs:

‘Ōhikilolo: NRS have been controlling ungulate threats to this population since 1995 beginning with the construction of a perimeter goat fence along ‘Ōhikilolo ridge. Weeds that threaten *V. chamissoniana* include *Erigeron karvinskianus* and *Melinus minutiflora*. NRS has conducted weed control in the vicinity of *V. chamissoniana* populations, focusing on areas that do not require rope access. In the coming year, NRS will continue to conduct more thorough monitoring of plants in order to refine population estimates. Most observations of this taxon are done with binoculars and most often juveniles and seedlings are not reported. However, when NRS is able to access these sites on rappel, the smaller size classes are found. This large PU has more mature plants than are necessary for stability and NRS will try to better determine the population structure in the coming year.

Pu‘u Kūmakali‘i: This population is peculiar for the taxon, as many of the plants found here are not located on cliffs. 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 but in the last year goats were observed in SBW. NRS have established snares in the area to control the goats. Pigs do use the main ridge trail on occasion, but pig sign has never been observed amongst the *V. chamissoniana* plants. *Melinus minutiflora* is present, but NRS have yet to implement grass control. NRS will control grass in the more accessible portions of this PU. A living collection has been established in the greenhouse to serve as a source for genetic storage trials as discussed above.

Mākaha: There are two sites with this taxon in the Mākaha PU. One site is outside of the proposed fence unit and the other is inside. The plants occur both in vertical areas as well as areas that are accessible to ungulates. NRS expect that this site will benefit from fencing. NRS have not begun any weed control actions in the area but will begin once fencing is complete. There are threatening weeds in the area and NRS will monitor their spread. NRS suggest that plants from the location outside the fence used for augmentation within the fence should it be necessary.

Hālona: 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 but there are currently no goat populations at the site. Goats have been observed recently in North Hālona. The same set of weeds which are present at other populations of this taxon are present at Hālona. However, these weeds are not abundant at the Hālona Site. NRS consider the weed threat to this site low. In the coming year NRS will further investigate the plants found at this site. Both subspecies are known from this site and some plants of the subsp. *tracheliifolia* may have been included in the population estimates above.

Other PUs:

Mākaha/‘Ōhikilolo Ridge: This PU was created by subdividing the ‘Ōhikilolo PU with the fence that runs along ‘Ōhikilolo ridge. These plants will be monitored opportunistically in combination with other actions in the area. Monitoring and collecting from the site has not been a high priority because it is assumed to be genetically similar to the ‘Ōhikilolo PU. NRS do not plan to control goats or conduct weed control in this area.

Kamaile‘unu: There are two sites that comprise this PU. NRS has been unable to relocate one site that National Tropical Botanical Garden Staff found in 2000 near Pu‘u Kawīwī. The second site has not been visited by NRS since 1999. These areas will be priority for monitoring in the next year. NRS does not have plans to control goats or weeds in the vicinity of these sites.

Pu‘u Hāpapa: NRS monitored this population in the last year and observed 13 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. Cuttings were taken from unrepresented plants and are being used in a living collection at the Army Nursery to produce seed for research and storage.

Kea‘au: The HBMP Botanist 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 ‘Ōhikilolo populations. Monitoring and collecting from the site has not been a high priority because it is assumed to be genetically similar to the ‘Ōhikilolo PU.

Chapter 3.2 Oahu Implementation Plan Rare Plant Status Update

This year is the first year NRS are reporting on the status of a portion of the OIP rare plant target taxa. NRS decided to report on 15 of the 23 OIP plant species because the OIP remains a draft. Species included have been monitored recently or have relevant research topics to report on. Once the OIP is finalized NRS will report on the status of all target taxa. For more discussion on the status of the OIP please see the Oahu Implementation Plan Status Update section of this document.

3.2.1 *Cyanea crispa*

Taxon Summary

Population Unit	Army Population Reference Code	Management Designation	Current no. of plants mature/immature	Target No.	Notes
Inside AA					6% in AA
Kawaiʻiki	KLO-A	Manage for stability	8	50	Kawaiiki MU
Outside AA					
Aihualama		None	1		
Kaipapaʻu		None	3		
Makaua	AKA-A	None	25		
Kapakahi		None	1		
Kawaipapa		None	1		
Maʻakua		None	2		
Maunawili		None	1		
Piʻa		None?	20		est >20: accessibility, site quality/manageability
Pukele		None	6		
Wailupe		Manage for stability	15	50	Wailupe MU
		Total	80		

Taxon Level Discussion

Cyanea crispa occurs in small populations in mesic to wet habitat in the Koʻolau Mountains, from both leeward and windward valleys. There are approximately 80 individuals extant throughout this geographical range. However, NRS have not surveyed offsite for this species, therefore, the numbers reflected in the table above are compiled from a combination of NRS and HBMP data. The Kawaiʻiki PU occurs within KLOA. There are approximately eight individuals, however, some or all of these individuals may be clones created as a result of trampling by pigs or humans. This PU is considered an unusual outlying population because the habitat and location are not consistent with current and historical observations. Because this population is at the edge of the species range it is considered important to manage. NRS are currently only managing the onsite Kawaiʻiki PU. Although, when the OIP is finalized NRS plan to manage Kawaiʻiki, Kahana, and Wailupe PU for stability.

Propagation and Genetic Storage

Suckers have been collected from Kawaiʻiki and established in the greenhouse. Fruit received from a Makaua plant was brought to the Micropropagation Lab in 1997. Seedlings were subcultured and propagules remain in tissue culture. Last year plants were removed and grown at both the Army Nursery and the Pahole Mid-elevation Nursery. Storage testing has been done on fruit from Lyon Arboretum greenhouse plants. Seeds have been stored for five years with no decrease in viability. Initial viability is high with no special germination requirements. Seeds appear to be the best genetic storage option, but suckers and cuttings may be equally successful at the Micropropagation Lab or the greenhouse if fruit are not available.

Unique Species Observations

It appears that the Kawaiʽiki PU is not very robust. These plants have not been observed to be reproductive in the last several years. NRS feel this population is affected by trampling either by pigs or humans, and by competition with weed species such as *C. hirta*, and *P. conjugatum*.

Outplanting Issues

It has been difficult for NRS to maintain stock from the Kawaiʽiki PU in either of the two greenhouse facilities utilized by the Army. NRS feel this stock would be better kept as a living collection within the newly constructed Helemano fence. However, NRS recognize that is not within the historical boundaries for this species. NRS plan to monitor this introduction in order to collect seeds for storage and eventual augmentation within the Kawaiʽiki MU.

Management Notes

The Kawaiʽiki PU may need augmentation because of the low numbers of individuals. Surveys should be done in nearby habitat both inside and outside the AA to find some source material for augmentation. If no new plants are discovered, the Kawaiʽiki PU may be augmented with stock from Kaipapaʽu or Maʽakua drainages on the windward side of the summit. NRS plan to construct the Kawaiʽiki MU fence in the next five years.

There are several small PUs containing one or a few individuals. However, the Army has determined that genetic storage collections are not a priority from non manage for stability PUs.

In the next year NRS plan to re-survey the Wailupe PU in anticipation of management in the area. Additionally, the Oʻahu PEP program plans to fence the Kahana PU in the coming year.

3.2.2 *Cyanea st.-johnii*

Taxon Summary

Population Unit	Army Population Reference Code	Management Designation	Current no. of plants mature/immature	Target No.	Notes
Inside AA					8% in AA
Helemano	KLO-A	Manage for stability	5	50	Helemano MU
Outside AA					
Waimanalo-Wailupe Summit Ridge		Genetic storage collection	12/1		NRS have not visited
Ahuimanu-Halawa Summit Ridge		Manage for stability	10-15	50	North Halawa MU
Waihee-Waimalu summit ridge		Genetic storage collection	10		NRS have not visited
Waimano	ANO-A	Genetic storage collection	10-15		
Waiahole-Waiawa Summit Ridge	AWA-A, AHO-A	Manage for stability	9/1	50	Waiawa MU
		Total	54-59/6		

Taxon Level Discussion

This taxon is extremely rare and is impacted by a broad range of threats including weeds, rats, ungulates and possibly slugs. NRS are currently only working with the Helemano PU. This PU was recently fenced within the large Helemano fence and NRS are striving to collect for genetic storage and future reintroductions. The O‘ahu PEP program is working with the other PUs of this species in threat abatements and genetic storage collections.

Propagation and Genetic Storage

Fruit, cuttings, and suckers have been collected from the three Manage for Stability PUs and brought to the Micropropagation Lab by NRS and PEP. Fruit were collected mature, immature, and aborted, found rotting on the ground. Though seeds from immature fruit of other species of *Cyanea* are typically viable and can be germinated in the lab, immature fruit collected from this taxon have produced very few seedlings. Cuttings and suckers have not been very successful. Viable seed, however, can be successfully germinated, subcultured, and maintained via tissue culture. Currently, four plants from Waiawa, one plant from Helemano, one plant from Halawa, and four plants from Waimano are represented in the lab. One plant each from Waimano and Halawa are represented in seed storage. These are recent collections and storage tests have not yet been collected. Based on all other species of *Cyanea*, seeds will probably store very well under the standard conditions for this genus.

Outplanting Issues

No outplanting of this species has been attempted to date. NRS will attempt to reintroduce this species into the Helemano MU once enough propagules are available.

Research Issues

At the Helemano site, immature fruit was observed over the past several years, but the plants have to produce mature fruit. In July 2006, immature fruit was observed and collected and sent to Lyon for propagation. When NRS returned 2 months later, most of the immature fruit were aborted. The remaining fruit were bagged on a subsequent trip in September in an attempt to catch any fruit that fell off the plants. Another trip is scheduled for November 2006 to collect the bagged fruit.

Surveys

A survey of a historical site in Helemano this year yielded no plants. More surveys will be scheduled in the next year.

PU Discussion

NRS's plans for PU management of this species are outlined in the table below.

Helemano

There is currently one site with five mature plants in the Helemano drainage of KLOA. This population is the northernmost population in the Ko`olau Mountains and one of the few known from the leeward side of the ridge. It is in a very intact native area. To reduce impact to the area, it is not monitored often. On the trips that NRS have taken to visit the site the focus has been on trying to secure stock for propagation and reintroduction. Cuttings have been taken on two occasions. Both were tried with traditional methods as well as tissue culture but unfortunately none have rooted. Viable seed has only been collected once from this population when part of a mature fruit was found on the ground. Two seeds germinated which resulted in approximately thirty plants growing in tissue culture at one time but they have all died.

The upper Helemano drainage fence will be finished by the end of this year. This will exclude ungulates from this fragile area around the *C. st.-johnii*, as well as protect numerous other endangered plant species, and secure additional habitat that may be used for reintroduction.

Priority Management Actions for *Cyanea st.-johnii* Army Stabilization PUs

Population Unit	Specific Management Actions	Timeline
Helemano	• Construct Helemano fence • Control priority weeds • Continue collecting propagules for augmentation and genetic storage • Augment PU	-Fence will be complete by end of 2006 -seed collections attempted for 2006
Ahuimanu- Halawa Summit Ridge	• Construct Halawa MU fence • Control priority weeds • Collect propagules for augmentation and genetic storage • Augment within Halawa MU	-NRS did not visit PU this year -construct MU, OIP yr 17 (sooner w/ fence crew)
Waiahole-Waiawa Summit Ridge	• Construct Waiawa MU fences • Control priority weeds • Collect propagules for augmentation and genetic storage • Augment within Waiawa and Waiawa Extension MUs	-NRS did not visit PU this year -construct MU, OIP yr 15 (sooner w/ fence crew)
Waimanalo-Wailupe Summit Ridge	• Collect for genetic storage	-NRS did not visit
Waihee-Waimalu Summit Ridge	• Collect for genetic storage	-NRS did not visit
Waimano	• Collect for genetic storage	-NRS did not visit

3.2.3 *Cyrtandra subumbellata*

Population Unit	Army Population Reference Code	Management Designation	Current no. of plants mature/immature	Target No.	Notes
Inside AA					~1% in AA
Kaukonahua	**SBE-A**	**Manage for stability**	**2/1**	**50**	**South Kaukonahua II MU**
Outside AA					
Punalu'u	**KOO-A**	**Manage for stability**	**100+**	**50**	**Needs survey; may not need fencing**
Kahana	**KNA-A/B**	**Genetic storage collections**	**8/7**	**50**	**Needs surveys to see if population is contiuous**
		Total	**110/4**		

Taxon Level Discussion
Cyrtandra subumbellata is found in a small portion of the windward Ko'olau Mountains, and at a single location on the leeward side of the range. On the windward side of the range the species has been documented from the valleys of Waikane, Kahana, and Punalu'u, and Kaluanui Gulch. The only leeward population for the species is in South Kaukonahua Gulch in SBE. A total of about 108 plants are known from the three current PUs. The South Kaukonahua PU, which is the only one in the AA, contains 2 mature and 1 immature plants.

Two of the three current PUs were found since 2000. The South Kaukonahua Gulch PU was found in 1994 on a biological survey of SBE. The Punalu'u plants were discovered only in 1995. In contrast, one Kahana population (KNA-A) became known to botanists in the early 1900s when the Schofield-Waikane Trail was built through the *C. subumbellata* PU. Although this species is currently only known from three PUs, habitat for this species remains largely unsurveyed.

Propagation and Genetic Storage
Plants can be propagated from seed. Two fruit collections were brought to the Micropropagation Lab. Fruit was collected by NRS in 1996 from South Kaukonahua gulch and by NTBG in 2001 from Punalu'u. Both collections had successful germination. Subculturing was successful but all remaining plants were contaminated and died in 2001. Other species of *Cyrtandra* that are currently at the lab are vigorous and healthy with very little contamination. One collection from Kahana was made this year and brought to the Seed Conservation Lab. Seeds had high fresh germination (88%). Based on all other tested species of *Cyrtandra*, this species will most likely be able to store.

Unique Species Observation
Hybridization between Hawaiian *Cyrtandra* species is very common. It is possible that the formation of hybrid populations between a given pair of *Cyrtandra* species occurred naturally in pre-contact times. Alternatively, it is also possible that the two species did not normally hybridize due to ecological reproductive barriers that effectively prevented hybridization. The introduction of non-native insects by humans and/or the loss of species specific native insect

species may have led to a breakdown of these reproductive barriers, allowing a higher than normal level of hybridization, thus further blurring species boundaries. Whether the frequency of hybridization observed today represents a threat to Hawaiian *Cyrtandra species* should be studied.

Outplanting issues
It will be important to utilize what is considered pure stock when outplanting this species. Collections for future outplantings should be made from pure stock and outplanted individuals should be followed to maturity to determine if they may be of hybrid origin.

Surveys
More surveys need to be conducted in the future to determine the extant of these PUs.

3.2.4 *Eugenia koolauensis*

Taxon Summary

Population Unit	Army Population Reference Code	Management Designation	Current no. of plants mature/immature/ seedling	Target No.	Notes
Inside AA					86% in AA
Western portion of ‘Ōhi‘a‘ai and ‘Ō‘io	**KTA-F**	**Manage for stability**	**36/19/62**	**25**	**Oio MU** Fenced, fuels controlled, weeded
‘Ōhi‘a‘ai and ‘Ō‘io	KTA-D, F, I	Genetic storage collection	40/28/70		KTA-D weeded
Kaiwiko‘ele and Kamananui	KLO-A, B	Genetic storage collection	16/16/15		
Kaunala	**KTA-B, E**	**Manage for stability**	**(64/69/88)**	**25**	**Kaunala MU** Fenced, fuels controlled, weeded
Aimuu	KTA- H	Genetic storage collection	unknown		Determine # plants in Aimuu
Pahipahi‘ālua	**KTA-A**	**Manage for stability**	**76/63/1240**	**25**	**Pahipahialua MU** Fenced, fuels controlled, weeded
Palikea Gulch	LKN-A	Genetic storage collection	3/0/2		Manage Waianae Stock above road
Outside AA					
Hanaimoa	HAU-A	Genetic storage collection	1		
Kaleleiki	KTA-C	Genetic Storage collection	25/30/200		Fenced, weeded
Papali		Genetic storage collection	1		
		Total	**174/ 236/ 517**		

Numbers within parentheses represent the number of individuals to be managed for stability within the PU.

Taxon Level Discussion

Eugenia koolauensis is threatened by fire, pigs, human trampling, weed competition, and plant pathogens, specifically, the *Puccinia* rust (‘ōhi‘a rust). Threat abatement has begun at the three largest populations of this taxon: Pahipahi‘ālua, Kaunala and West ‘Ō‘io. These sites were chosen for their size, accessibility, and quality of surrounding habitat. They were fenced this year, protecting them from pigs and trampling. Fuel control occurred in conjunction with ongoing weed control. Ironwood, the primary fire threat, was felled at the Kaunala site, and slash from last year’s ironwood removal efforts was cleaned from all three sites. These three sites also show significant impact from the ‘ōhi‘a rust. Of the remaining populations, most were not monitored in the past year, and ‘ōhi‘a rust impact is unknown. Weed control also occurred at the East ‘Ō‘io and Kaleleiki populations, but no control occurred at other populations. While this taxon does face an uphill battle, the continuing presence of a healthy population structure suggests that it may be able to overcome threats with management.

In the course of building fence around the Kaunala and Pahipahiʻālua populations, NRS discovered additional mature and immature *E. koolauensis*. These new plants are not reflected in the Taxon Summary table above because exhaustive counts at the populations were not conducted. However, NRS feel that they significantly add to the number of mature plants known at each location, and will conduct thorough censuses in the next year.

Propagation and Genetic Storage

Propagation trials are underway for this species. Over the past three years, only occasional fruit have been found on any *E. koolauensis* in the Kahuku region. One small collection was made in 2001. Fresh seeds have quick and high germination rates with no special germination requirements. A few seeds from this collection were stored in two different treatments and are currently being tested. NRS are currently experimenting with both cuttings and airlayers. Preliminary tests with cuttings have not been promising; it is very difficult to find appropriate material, perhaps because this species is so slow growing. Also, the ʻōhiʻa rust, which targets meristem tissue, further limits available material. The rust appears to stress affected plants; it will be interesting to see if this has an effect on the success of air layer attempts.

Unique Species Observations

In March 2006, NRS observed ʻōhiʻa rust damage on *Eugenia koolauensis* at Pahipahiʻālua. The rust subsequently was found at Kaunala and West ʻŌʻio. The entire Kahuku Training Area contains significant stands of *Syzigium jambos*, a primary carrier of the ʻōhiʻa rust. Other possible hosts are also abundant, including *Metrosideros polymorpha*, *Eucalyptus robusta*, and *Melaleuca quinqueveria*. The rust affects the new growth of *Eugenia*, as shown by Figures 1 and 2. For color photos, see http://www.botany.hawaii.edu/faculty/duffy/DPW.htm.

Figure 1 Two views of leaf damage on *E. koolauensis*

Some small, immature plants exhibited partial or total defoliation, Figure 3. This suggests the rust may limit the growth rate of this already slow-growing species, and perhaps even limit recruitment. All size classes are affected by the rust.


Figure 2. Healthy *Eugenia*


Figure 3. Immature, defoliated *Eugenia*

Figure 4. Flowers and buds

It may also affect the ability of the plants to reproduce, as flowers and buds are also damaged, as seen in Figure 4. At West ʻŌʻio, fuel reduction resulted in drastic opening of the canopy and increased light levels. NRS thought this might reduce the effect of the ʻōhiʻa rust by eliminating wetter microsites, but it appears to be the hardest hit population. Perhaps the change in light level stressed the plants and made them more vulnerable to the rust. Trees in Pahipahiʻālua occur in similar light levels and exhibit fewer signs of damage. Due to the widespread reach of the rust, and the impracticality of treating large numbers of trees in the wild, there is little NRS can do at this point to mitigate its affects. The severity of the rust is not totally clear, and NRS will continue to monitor *Eugenia*.

Outplanting Issues
While this species faces many threats, plant numbers in MUs are still relatively high. No outplantings are planned for this species. When propagation methods are developed, NRS will consider establishing ex-situ collections at botanic gardens, such as Waimea and Hoʻomaluhia. Reintroduction goals may change if threats to the species increase.

Research Issues
The largest threat currently facing *E. koolauensis* is the ʻōhiʻa rust fungus. Research needs to be done to fully determine how lethal the rust is to this taxon. Complicating this question is the lack of knowledge about the life history of this species. More information is needed on its growth rate, and its light requirements. Propagation techniques also need to be developed.

3.2.5 *Gardenia mannii*

Population Unit	Army Population Reference Code	Management Designation	Current no. of plants mature/immature	Target No.	Notes
Inside AA					50-58% in AA
Hale'au'au	**SBW-A**	**Manage for stability**	**3**	**25**	**Hale'au'au MU; need propagules**
Kaiwikoele, Kamananui, and Kawainui	KLO-C	None	12		
Kawai Nui and Kawai Iki	KLO-E	None	7		
Helemano and 'Ōpae'ula	**KLO-B**	**Manage for stability**	**33**	**25**	**Scattered throughout 'Ōpae'ula watershed; Lower Pe'ahināi'a MU**
Helemano and Poamoho	**KLO- D, F, G, H, I**	**Manage for stability**	**18**	**25**	**Scattered throughout Poamoho MU**
Kaukonahua	SBE-A	None	2		
Outside AA					
Kahana and Makaua		None	2		
Kaipapa'u to Punalu'u		None	3-5		
Kalua'ā and Maunauna	KAL-A	Genetic storage collections	6		
Kalauao		None	4		
Kapakahi		None	3		
Ihi'ihi-Kawawainui ridge	KTA-A	None	2		
Kamananui-Mālaekahana Summit Ridge	KTA-B	None	13		
Manana-Waimano Ridge		None	4		
Pamalu		None	2		
Pia		None	1		
Pukele		None	1		
Waialae Nui		None	1		
		Total			

Taxon Level Discussion

NRS continue to find more individuals of *G. mannii* during surveys for other plant species in the Koolaus. This year NRS found a total of 14 new plants in three different areas while surveying. The proposed Lower Pe'ahināi'a exclosure has been increased and will now protect approximately 19 individuals. NRS continue to determine the most effective propagation technique for this taxon.

Propagation and Genetic Storage
Both mature fruit and cuttings were taken multiple times from the three trees remaining in Hale‘au‘au, and neither method succeeded. Fruit appear fully mature but no seeds have developed. Fruit with viable seeds were collected from the Helemano and ‘Ōpae‘ula PU and brought to the Micropropagation Lab. Seeds germinated but could not be subcultured very successfully so tissue culture is most likely not a genetic storage option. Seeds were viable, and seedlings were propagated in the greenhouse. One fruit could contain a couple hundred seeds, and other species of *Gardenia* have good storage potential. Therefore, seed is probably a very good storage option for trees with viable fruit. Other agencies have collected from other plants in the Ko‘olaus and these also contained viable seeds but failed to establish in tissue culture. NRS will continue to collect fruit from the Ko‘olau PUs for storage testing. NRS also plan to attempt to air-layer the Hale‘au‘au plants this coming year, although this is a daunting task given the height of the trees and the logistical inaccessibility of the area. This year, two air-layers were installed on a greenhouse plant at Pahole Mid-elevation Nursery. Both air-layers were successful. Air-layers may be the best propagation technique for plants where viable seed cannot be collected, and these plants can be maintained as a living collection. NRS will continue to monitor phenology and pollination biology of MFS populations to better understand collection potential.

Research Issues
The main priority for research is seed storage and propagation potential of this species. Augmentation of MFS populations will not be possible until this taxon can effectively be propagated.

Surveys
No surveys were done specifically for *G. mannii* this year, however this taxon is frequently found during surveys for other species, especially in the Ko‘olaus. Five new plants were found this year in the Lower Pe‘ahinā‘ia MU during a rare plant survey.

3.2.6 *Huperzia nutans*

Population Unit	Army Population Reference Code	Management Designation	Current no. of plants mature/immature	Target No.	Notes
Inside AA					58% in AA
Kawainui-Koloa Summit Ridge	KLO-C	Manage for stability	1	50	Koloa MU
Kahana and North Kaukonahua	KLO- B, D; KNA-A	Manage for stability	4	50	N. Kaukonahua MU KLO-A + D inside; KLO-B propagule source Kahana portion needs survey
South Kaukonahua	SBE-A	Manage for stability	1	50	S. Kaukonahua MU
Outside AA					
Kaipapau		Genetic storage	2		Needs survey
		Total	8		

Taxon Level Discussion

NRS face many challenges in the stabilization of *Huperzia nutans*. So far, all attempts to propagate this species have been unsuccessful. Therefore, the current management focus for this species has been on the development of propagation techniques. Due to the scarcity of material, NRS have been working on this issue using the closely related *H. phyllantha*. In addition, NRS have been working with researchers at Lyon Arboretum and the University of Hawaii Horticulture Department on developing techniques for the tissue culture on both *H. nutans* and *H. phyllantha.* The propagation of this species from spores appears difficult at this time as the gametophytes are subterranean, non-photosynthetic, and require a mycorrhizal fungal association.

Unique Species Observations

NRS collected what they believed to be vegetative material of *H. nutans* for tissue culture. This material was growing approximately 1-2 inches above the moss substrate. However, this specimen was apparently already developing sporangia and was unsuccessful in tissue culture. Immature spores collected from this material did not germinate. NRS plan to examine this species more closely in the field before collecting vegetative material for tissue culture in the future.

Research Issues

The main priority for research is developing propagation techniques. NRS feel that due to the low number of extant individuals, testing should be done on the more common *H. phyllantha*. In addition to tissue and spore culture, NRS plan to test the viability of airlayers on *H. phyllantha*, with the hope that it may be a means of propagating *H. nutans*.

Surveys

No surveys have been conducted in the past year specifically for this species. No surveys are planned for in the near future, however NRS have been looking for this and any other rare species on all Koʻolau surveys.

3.2.7 *Labordia cyrtandrae*

Taxon Summary

Population Unit	Army Population Reference Code	Management Designation	Current no. of plants mature/immature	Target No.	Notes
Inside AA					97% in AA
Makaleha to Hale‘au‘au	ALA- G thru N, P; SBW-A, C, D; LEH-A, B, C	Manage for stability	44/1	100	East Makaleha and Kaala MU. Much of the population will be protected by strategic fencing.
Outside AA					
Manana		Manage for stability	1/1	50	More surveys needed
		Total	45/2		

Taxon-specific issues

This species is dioecious therefore genetic collections from male plants are obtained via air layering, cuttings or pollen storage. Although, some individuals may occasionally produce perfect flowers. More female plants than male plants have been observed. Some plants occur in extremely steep areas making it necessary to use ropes to reach them. There are numerous historical accounts of this species in the Ko‘olaus, however currently there are just two plants known at one site.

Taxon Threats

Labordia cyrtandrae is threatened by pigs, goats, black twig borer, fruit predation by insects, and non-native plant species such as *Rubus argutus*.

Propagation and Genetic Storage

Fruiting times have been difficult to predict. Also, the majority of the fruit observed and collected typically contain empty seeds or seeds which have been predated. Viable mature and immature seed delivered to the Micropropagation Lab has been germinated, propagated *in vitro* and then grown in the greenhouse, and successfully outplanted. NRS will collect immature fruit if available. There has been moderate success with airlayers (20-25%), and even lower success with cuttings. Air layers will be attempted from all possible individuals if plants are large and healthy enough. Table 1 shows collection history and statistics for *L. cyrtandrae* in the Wai‘anaes. A total of 78 seeds from 3 individuals have been received at the Seed Conservation Lab. Initial germination was high. A few seeds were tested after being stored for two years. Two out of ten seeds did germinate but it is uncertain as to whether the ones that did not germinate lost viability during storage or never had an embryo. Efforts will be made to determine whether seed predation or lack of pollination causes a high number of aborted fruit.

A major challenge to overcome in achieving complete genetic storage for *Labordia cyrtandrae* is the limitation on viable seed available. NRS propose to represent a geographic sampling of wild plants in the greenhouse. Then NRS will attempt to hand-pollinate and control seed boring insect pests in the greenhouse to determine if seed set can be increased. Initially this technique will be tested for a small number of plants to see if it is effective. NRS is concerned that plants may not flower and/or produce fruit at propagation facility at a much lower elevation. If this approach is successful, NRS will increase living collections in the greenhouse to obtain enough seed for seed storage. A good mix of male and female plants from a geographic range of wild sites will be the goal for greenhouse stock. Priority for collection should be on representing plants that are not within an ungulate fence. Secondly, NRS will focus on representing each of geographical nodes designated in Figures 1 and 2. There is already some representation of each node in genetic storage. The number represented of the total founders shown in Figure 1 and 2 includes plants that are only represented at reintroduction sites. NRS will try to balance nodal representation and to ensure this representation is at an ex situ site rather than in a wild reintroduction. In the next year, NRS will work to represent these six nodes with three founders each with a focus on collecting male plants, as 13 of the 14 plants currently represented are female. The following are the priority collection actions for this taxon:

- Collect from all plants that are unprotected from pigs and not represented in reintroductions (asterisked by population reference code in Table 1)
- Re-monitor reintroductions including the three on State land (ALA-A thru ALA-C). Duplicate reintroduced stock and store *ex situ* if not already.
- Represent each of the six nodes shown in Figure 1 in the greenhouse living collection with three founders. Specifically focusing on male plants.
- Conduct experimental greenhouse crossings and fruit protection to increase seed set.

Table 1 Summary of *Labordia cyrtandrae* management and collection history.

Key

***=priority for collection. M=Male, F=Female and Unk=unknown. Propagules attempted: IF=immature fruit, MF=mature fruit, C=cutting, A=airlayer. Represented at reintroduction column source (seed, cutting, etc) listed if known.**

Pop ref code-#	Sex M/F Unk	Propagules attempted	Current representation *ex situ* (seed, airlayer, etc.)	Represented at reintroduction ? (seed, airlayer, etc)	#airlayers/ #cuttings collected	Mature Fruit/ Imm Fruit Collected	Notes
Node 1							
ALA-G-1	F	IF, C, MF, A	1 airlayer; 23 seeds in storage	Yes 11 from seed at ALA-A reintro	1/10	3/12	
ALA-G-2	M	C,IF	None	No	0/4	0/2	
ALA-G-3	F	C, IF	None	Yes 1 from IF at ALA-C reintro	0/15	0/12	
ALA-G-4	Unk	C	None	No	0/2	0/0	
ALA-G-5	F	MF, C, A	None	Yes 2 at ALA-O reintro	4/3	2/0	
ALA-G-6	F	C, A, IF	None	Yes 1 at ALA-O reintro	4/3	0/0	
ALA-J-1	M	MF	None	No	0/0	5/0	Single plant could be lumped with ALA-G
Node 2							
ALA-H-1	F	C, IF	17 seeds in storage	Yes 1 at ALA-B reintro	0/7	0/9	Last monitoring

							11/19/03
ALA-H-2	F	C, IF	None	Yes 4 plants from seed at ALA-B	0/7	0/7	Last monitoring 11/19/03
ALA-H-3	M	C	None	No	0/7	0/0	Last monitoring 11/19/03
Node 3							
ALA-I-1	Unk	A	None	No	1/0	0/0	
ALA-K-1	Unk	C, A	None	No	2/2	3/2	
ALA-K-2	Unk	C	None	No	0/1	0/1	
ALA-K-3	Unk	C, A, MF	None	No	0/4	0/3	
ALA-K-4	Unk	C	None	No	0/1	0/1	
ALA-K-5	Unk	C	None	No	0/1	0/1	
ALA-K-6	Unk	C, MF, IF, A	1 airlayer; 18 microprop.	No	6/3	0/3	
*ALA-K-7	Unk	C, F	None	No	2/2	0/2	
ALA-K-8	Unk	A	None	No	2/0	0/0	
ALA-K-9	Unk	None	None	No	0/0	0/0	
ALA-K-10	Unk	None	None	No	0/0	0/0	
*ALA K-11	Unk	None	None	No	0/0	0/0	Not yet tagged. MB or DS need to relocate
ALA-L-1	Unk	C, A?	None	No	2/2	0/0	Too small and sickly for airlayering Could have been one plant same as L-2
ALA-L-2	F	MF, A	25 microprop.	No	2/0	2/0	Two airlayers installed 10/10/06. Could have been one plant same as L-2
ALA-L-3	F	A	None	No	0/0	0/0	Two airlayers installed 10/10/06
ALA-L-4	F	None	None	No	0/0	0/0	Need rope can airlayer
ALA-L-5	Unk	None	None	No	0/0	0/0	Need rope can airlayer
ALA-M-1	F	None	None	No	0/0	0/0	Not remonitored

							since found 6/2/04
ALA-M-2	F	None	None	No	0/0	0/0	Not remonitored since found 6/2/04
ALA-N-1	Unk	None	None	No	0/0	0/0	Not remonitored since found 6/2/04
*ALA-P-1	Unk	None	None	No	0/0	0/0	Recently discovered
SBW-A-1	F	IF, C	None	Yes 1 at ALA-O	0/2	0/1	Last monitoring 8/29/02
SBW-A-2	F	IF, C	None	Yes 10 from immature seed grown in microprop planted at ALA-O	0/4	0/14	
Node 4							
SBW-C-1	M	C	None	Yes 2 at ALA-C reintro and 1 at ALA-O	0/2	0/0	
SBW-C-2	F	MF, IF, C	None	Yes 1 from seed via microprop at ALA-A reintro	0/3	0/0	
SBW-C-3	Unk	C, A	None	2 plants at reintro ALA-C	4/2	0/0	
SBW-C-4	Unk	A, C	2 airlayers	3 plants at reintro ALA-C	2/2	0/0	
*SBW-D-1	Unk	None	None	No	0/0	0/0	Plant too small for airlayer. Monitor for fruit.
Node 5							
LEH-A-1	F	A	1 airlayer;	No	3/0	0/0	
*LEH-A-2	Unk	None	None	No	0/0	0/0	
*LEH-B-1	Unk	A	None	No	1/0	0/0	
*LEH-B-2	Unk	A	None	No	1/0	0/0	
*LEH-B-3	Unk	A	None	No	1/0	0/0	
Node 6							
LEH-C-1	Unk	A	1 airlayer;	No	3/0	0/0	

Map removed,
available upon request

Figure 1
Many of the sites with a high percentage of plants represented have been known and monitored by NRS for many years (early letters in alphabet). Some of the newer population reference codes (letter in later half of the alphabet) were more recently discovered and thus are not as well represented.

Map removed,
available upon request

Figure 2

Outplanting Issues
Four separate augmentation sites were founded in 2003 (ALA-A – ALA-C) and one in 2004 (ALA-O) in the Ka‘ala area using material from one wild subpopulation. The founders represented at each site are shown in Table 2. The three sites ALA-A thru ALA-C are located on State land near the access road to Mt. Ka‘ala. NRS will seek permission to monitor these sites in the coming year. The ALA-O site is in a more remote location on the Schofield Barracks side of the Mt. Ka‘ala Summit. It was established in October 2004. It was expanded with more plants in 2005. Some individuals have since flowered. Whenever possible the sex of the plants will be noted before reintroductions to anticipate cross pollination potential. If it is not possible to maintain *L. cyrtandrae* plants in the greenhouse, NRS may choose use these reintroductions as sites for conducting hand pollination and fruit protection.

Table 2 Representation in Reintroductions

Pop Ref Code-#	Male/Female	Representing Founder	Notes
ALA-A-1		ALA-G-1	From seed?
ALA-A-2		SBW-C-2	Airlayer from wild plant?
ALA-A-3	F?	ALA-G-1	From seed?
ALA-A-4		ALA-G-1	From seed?
ALA-A-5	M?	ALA-G-1	From seed?
ALA-A-6		ALA-G-1	From seed?
ALA-A-7		ALA-G-1	From seed?
ALA-A-8		ALA-G-1	From seed?
ALA-A-9	F?	ALA-G-1	From seed?
ALA-A-10	M?	ALA-G-1	From seed?
ALA-A-11		ALA-G-1	From seed?
ALA-B-1		ALA-H-2	From seed?
ALA-B-2		ALA-H-2	From seed?
ALA-B-3		ALA-H-2	From seed?
ALA-B-4		ALA-H-2	From seed?
ALA-B-5		ALA-H-2	From seed?
ALA-C-1		SBW-C-4	?
ALA-C-2		SBW-C-4	
ALA-C-3		SBW-C-4	
ALA-C-4		SBW-C-3	
ALA-C-5		SBW-C-3	
ALA-C-6		SBW-C-1	
ALA-C-7		SBW-C-1	
ALA-O-1		ALA-G-?	
ALA-O-2		SBW-A-2	
ALA-O-3		SBW-A-2	
ALA-O-4		SBW-A-2	
ALA-O-5		SBW-A-2	
ALA-O-7		SBW-A-2	
ALA-O-8		SBW-A-2	
ALA-O-9		SBW-A-1	
ALA-O-10		SBW-A-2	
ALA-O-11		SBW-A-2	
ALA-O-12		SBW-A-2	
ALA-O-13	F?	SBW-A-5	
ALA-O-14		SBW-A-5	
ALA-O-15		SBW-A-6	

Management Notes

Any individuals outside the Ka‘ala and East Makaleha MUs will be used as propagule sources for genetic storage and outplanting within fenced areas at Ka‘ala. In addition, any plants accessed via SBW will be used as propagule sources in anticipation of difficulty in getting access to SBW. Airlayers and seed stock should be collected from these individuals as soon as possible. Individuals in East Makaleha will be protected from ungulates within the East Makaleha MU, those that fall outside proposed MUs will be protected with strategic fencing or brought into fences via augmentation. In the next year, NRS will work to survey appropriate habitat on Ka‘ala at the summits of Wai‘anae Kai and Mākaha Valleys.

Table 3.2.18 Priority Management Actions for *Labordia cyrtandrae* Army Stabilization PUs

Population Unit/Subunit	Specific Management Actions
SBW	• Secure stock from plant SBW-D-1
East Makaleha (LEH)	• Fence East Makaleha MU • Control priority weeds • Survey • Airlayer or collect seed to represent all plants
Ka‘ala (ALA)	• Complete strategic fenceline • Control priority weeds • Continue airlayering unrepresented individuals • Monitor outplanting
Manana	• Survey • Control priority weeds • fence

Research issues

Research on the black twig borer may help protect this species (see chapter 6). This threat and other insect predation may contribute to the little/ low recruitment.

Surveys

More surveys in East Makaleha are needed to determine the full extent of the population. Surveys for additional individuals near Manana and other historical Ko‘olau areas should also be conducted.

3.2.8 *Lobelia gaudichaudii* subsp. *koolauensis*

Taxon Summary

Population Unit	Army Population Reference Code	Management Designation	Current no. of plants mature/immature/seedlings	Target No.	Notes
Inside AA					13% of wild individuals
Kaukonahua	**SBE-A**	**Manage for stability**	**3 / 45/2**	**75**	**South Kaukonahua MU**
Outside AA					
Kīpapa		**Manage for stability**	**30/100/20**	**75**	**Kīpapa MU; Mixed with subsp..** *gaudichaudii,* **needs survey**
Waiawa portion of Waiawa to Waimano	**AWA-A**	**Manage for stability**	**0/80**	**75**	**Waiawa MU**
Waiawa to Waimano		None	**0/180**		**Est. 180 ind. from Waiawa, Manana and Waimano**
Kawai Iki Bog Fence	**KLO-A**	None	**2/ unknown**		**Mixed with subsp..** *gaudichaudii,* **needs survey. Within Koʻolau Bog fence**
		Total	**35/325/22**		

Taxon Level Discussion

This taxon is endemic to the higher elevations of the northern and central portions of the Mountains on Oahu. Only four PUs have been recorded to date. They are distributed from the Kaipapaʻu-Kawai Nui summit ridge in the north, to Waiawa and Waimano in the central Koʻolau Mountains. One hundred immature *Lobelia gaudichaudii* subsp. *koolauensis* were counted in Kīpapa this year. However this count probably included vegetative *L. gaudichaudii* subsp. *gaudichaudii* in addition to *L. gaudichaudii* subsp. *koolauensis.* The identification of vegetative plants of *L. gaudichaudii* to the subspecies level in the field might be possible once one becomes familiar with vegetative differences between the two subspecies. Collections were made in September 2005 from the three plants within the SBE-A population, and 45 immature plants were counted. The Kaukonahua and Kīpapa PUs may need to be augmented with plants grown from propagules in those areas. The managed portion of the Waiawa to Waimano PU is currently at stabilization numbers but requires fencing. A new PU was added at the Kawai Iki bog fence, where collections were made from two mature *L. gaudichaudii* subsp. *koolauensis* last October.

The monocarpic nature of *L. gaudichaudii* subsp. *koolauensis* presents NRS with management challenges. The stem bearing the inflorescence dies after flowering and fruiting, and plants are often single stemmed. Stabilization targets may not be realistic for a monocarpic taxon (this is a similar challenge for the *Sanicula* taxa being stabilized). Accurate counts of immature *L. gaudichaudii* subsp. *koolauensis* are difficult to assess since it is hard to distinguish vegetative subsp. *gaudichaudii* from subs. *koolauensis*. The lobelias at the Lehua Maka Noe Bog were thought to be subsp. *gaudichaudii,* until two plants were identified as subsp. *koolauensis* by NRS in October of 2005. This positive identification was made based on the color of the flower's corollas, which was characteristic of subsp. *koolauensis*. Life history research for *L. gaudichaudii* subsp. *koolauensis* would be beneficial to stabilization of this taxon.

The Kawai Iki PU is situated within the one acre Koʻolau Bog fence. NRS conduct ungulate control in the vicinity of the Kaukonahua PU. Weed control is not currently conducted at any of the existing PUs although NRS do conduct *P. cattleianum* control along the Koʻolau Summit Trail which runs past the Kawai Iki PU.

Propagation and Genetic Storage
This taxon has been successfully propagated from seed and seed is the preferred propagation technique. A 1999 collection from Waiawa has been used for storage testing. Seeds did not survive storage at 24C or -18C but remained viable at 4C. Germination rates at 4C were highly variable over the past five years and it is uncertain if there is any decrease in viability. This treatment will continue to be tested. There are 1,593 seeds in storage from six plants from two PUs, the Kawaiʻiki Bog fence PU and the Kaukonahua PU. Fruit has also been brought to the Micropropagation Lab. Seeds germinated but seedlings either quickly died or were transplanted to test tubes and became contaminated. Seed is the preferred genetic storage method. Cuttings and airlayers are not considered to be viable options for propagation since most plants are single stemmed.

Unique Species Observations
Lobelia gaudichaudii subsp. *koolauensis* has been seen flowering primarily from May through October, and fruiting from July through November.

The Waiawa to Waimano PU extends as far as 1 km (0.6 mi) leeward of the Koʻolau summit ridge, which is unusual for this taxon. This can be explained by the fact that the bog-like vegetation in which this taxon characteristically grows extends farther to the leeward side of the Koʻolau summit ridge here than anywhere else in the mountain range.

Outplanting Issues
Although more common than *L. gaudichaudii* subsp. *koolauensis*, *L. gaudichaudii* subsp. *gaudichaudii* is also rare (species of concern). As with subsp. *koolauensis*, it occurs only in the summit areas of the Koʻolau Mountains, and it can be found in similar habitats. This co-occurrence of the two subspecies should be studied. Growing side by side suggests that the two taxa may be reproductively isolated from one another, yet there may be potential for hybridizing. It is debated whether it is acceptable to outplant one next to the other, but this would limit the available area of prime habitat for reintroductions.

Research Issues
Further research into the reproduction of *L. gaudichaudii* subsp. *koolauensis,* should be conducted, specifically with respect to possible hybridization with the more common subsp. *gaudichaudii*. The identification of vegetative plants of *L. gaudichaudii* to the subspecies level in the field would also useful since subsp. *gaudichaudii* and subsp. *koolauensis* often occupy the same habitat types, are difficult to distinguish vegetatively, and are seldom found reproductive. Life history research for *L. gaudichaudii* subsp. *koolauensis* should be conducted.

3.2.9 *Melicope lydgatei*

Taxon Summary

Population Unit	Army Population Reference Code	Management Designation	Current no. of plants mature	Target No.	Notes
Inside AA					95% in the action area
Kaiwiko'ele-Kawai Nui Ridge	**KLO-K**	**Manage for stability**	**3**	**25**	**Kawailoa MU**
Kawai Iki and 'Ōpae'ula	**KLO-A thru J (except H)**	**Manage for stability**	**45**	**25**	
		Total			

Taxon Level Discussion

This year, 22 more individuals of *M. lydgatei* were found in the proposed Lower Pe'ahināi'a MU during a survey for this taxon. The proposed fence for this management unit will be expanded to include all of these plants, and will thereby protect approximately 31 plants. Weed control in this exclosure will also be crucial given that weeds such as *C. hirta* and *P. cattleianum* are abundant. Surveys in the Kaiwiko'ele to Kawai Nui Ridge PU will be conducted in hopes of locating more individuals. No fences are currently planned for that PU, however NRS are looking for means of storing and propagating material of this population until a small or large-scale fence is proposed. Two cuttings collected from the Kawai Iki and 'Ōpae'ula PU were established and are currently flowering and have immature fruit in the Pahole Mid-Elevation Nursery. Several seeds were also collected from two different plants this year for storage and propagation testing.

Research Issues

The areas that need further investigation for this taxon are propagation and seed storage methods. Plants have been grown from cuttings and seed at the Micropropagation Lab, however, more collection effort is needed to determine success of this method. NRS will determine if the seeds from the greenhouse plants are viable, and if so, NRS may continue to use greenhouse stock for propagation research. With a sizeable population now known in Lower Pe'ahināi'a, NRS will be able to monitor phenology of plants more closely, collect seed for storage and germination trials, and conduct propagation trials in the Army Nursery and at the Lyon Micropropagation lab.

Surveys

The following two surveys were conducted this year for this taxon: in the Lower Pe'ahināi'a area, and on the ridge between Kawainui and Kawaiiki Drainages. Plants were found in the Lower Pe'ahināi'a area, in Waimano, and in Poamoho.

3.2.10 *Phyllostegia hirsuta*

Taxon Summary

Population Unit	Army Population Reference Code	Management Designation	Current no. of plants mature/imm/seedling by Pop. Ref. code with Observer and date of last observation	Notes
Inside AA				~77% in AA
Wai'anae				
Mohiākea-Hale'au'au	**SBW- A, B, C**	**Manage for stability**	**SBW-A 0/3/0 JR 8/02** **SBW-B 25/25/25 MB 2/00** **SBW-C 50/0/0 JL, KK 12/96**	**Ka'ala to Kalena MU** ~25/25 inside fence
Wai'eli	SBS-A	Genetic storage collections	SBS-A 7/5/3 VC 5/03 SBS-A 1/0/0 MW 3/06	Two separate locations have been seen in the area
Ko'olau				
Koloa	**None**	**Manage for stability**	**Reintro.**	**Koloa MU- stock from Kawai Nui/Kawai Iki**
Kawai Iki	KLO-D	Genetic storage collections	KLO- D 2/0/0/ JL, VC 5/99	Use as stock for Koloa MU
Kaipapa'u-Kawai Nui Summit Ridge	None PAP-A	Genetic storage collections	None- 4/0/0 JL Date? PAP-A- 1/0/0 JL, KW 2/06	NRS does not know the site with 4 plants. PAP-A was discovered this year
Kaukonahua	SBE-A	Genetic storage collections	SBE-A 4/2/0 KK, JR 2/01	
Helemano and Opaeula	KLO-B, C, E, G	Genetic storage collections	KLO-B 5/4/0 MK 5/06 KLO-C 1/4/0 MK, JL 2/99 KLO-E 0/1/0 KK, HF 8/03 KLO-G 1/0/0 JR, DS 8/03	KLO-B Different narrow leaf type (GSC)- MK
South Helemano	KLO- F	Genetic storage collections	KLO-F 1/0/0 VC, DS 3/03	
Outside AA				
Wai'anae				
Kalua'ā	**KAL-A (southern fenceline); ELI-A, B, C (all immature)**	**Manage for stability**	**KAL-A 2/7/12 KK, SC, KW 2/06** **ELI-A 0/0/0 JR, SC, DS 6/06** **ELI-B 0/1/0 JR, SC, DS 6/06** **ELI-C 0/12/0 JR, SC, DS 6/06**	**Kalua'ā MU seasonal fluctuations in #**
North 'Ēkahanui	EKA-A	None	EKA-A 0/0/0 DS 2/06	
Mākaha-Wai'anae Kai Ridge	None	None	None 2-3/0/0 JL Date?	
Huliwai	HUL-A	None	HUL-A 3/9/0 DS 4/06	South Branch of Huliwai
Ko'olau				
Kaipapa'u Gulch	None	None	None 1/0/0 JL Date?	
Kaluanui	None	None	None 5-6/0/0 JL Date?	
		Total	**115-117/73/40**	

Taxon Level Discussion

On O'ahu, this species is found in both the Wai'anae and Ko'olau Mountains. In the Wai'anae Mountains it is found from Hale'au'au to 'Ēkahanui, and in the Ko'olau Mountains it ranges from

Kaukonahua to Kawainui and is found in both windward and leeward locations. There is a great deal of undersurveyed *P. hirsuta* habitat in the Koʻolau Mountains. In the Waiʻanae Mountains this species has been known to occur in larger groups. Many of these large sites have not been seen recently by NRS and their status is unclear. Most Waiʻanae PUs contain very low numbers and NRS has clearly documented a steady decline. Weeds, ungulates, and landslides are the primary causes of this decline. Without immediate attention this taxa is likely to disappear from many PUs. In the next year NRS will monitor, collect and develop reintroduction plans and sites. As seed storage is currently not feasible, NRS will use the Lyon Micropropagation Lab to maintain stock for storage and future outplanting.

Propagation and Genetic Storage

Plants are easily propagated from cuttings and seeds. Fresh seeds have high germination rates and seedlings are vigorous and easy to propagate. Seeds have been tested at the Micropropagation Lab and plants can be subcultured and maintained *in vitro*. The seed storage potential for this taxa is high based on past experience using other mint species. However, testing is not complete and larger seed collections are needed. Large seed collections will be difficult for Waiʻanae PUs and may be possible from Koʻolau PUs. However, NRS have not been systematically monitoring these PUs. Large collections can also be made from reintroductions once established. Until seed storage levels are established this species will be maintained in micropropagation. Stock from Kaluaʻā, Poamoho, ʻĒkahanui and Opaeula PUs are currently represented in the greenhouse. Seeds were also collected from the Waiʻeli population this past year.

Unique Species Observations

In the Waiʻanae Mountains population sizes are observed to be larger and growing on steep rocky slopes in mesic-wet forest. However, in the Koʻolau range this species is generally found as only single individuals or very small populations growing in wet forest.

Outplanting issues

In the Koʻolau Mountains *P. hirsuta* has a widely scattered distribution that makes it difficult to encompass 75 individuals within one MU. Therefore, all the populations within the action area (from Kawai Iki to Kaukonahua) and adjacent windward areas (Kaluanui and Kaipapaʻu) will be managed as a propagule source for a Koloa PU reintroduction. NRS will investigate the differences in micro-sites while monitoring and collecting from these PUs in order to determine if the Koloa reintroduction will be an appropriate site for all PUs. Any macro-morphological differences will also be studied among the PUs to determine if this approach will result in the loss of important ecotypes. As information is gathered NRS will have the MIP review plans.

The PU north of Kolekole pass (Mohiākea-Haleʻauʻau) will be reintroduced to Kaʻala. *P. hirsuta* has been recently found in this area. There are now fenced sites on the slopes of Kaʻala where this species should thrive. The known PUs that occur South of Kolekole pass (Waiʻeli, Kalua'ā and Huliwai) will be incorporated into a reintroduction at Kaluaʻā. In the next year NRS will make collections from the PU for a trial outplanting next winter.

It should be noted that TNC has outplanted *P. hirsuta* three times at three sites in the Waiʻeli and Kalua'ā area over the last 4 years using about two dozen plants for each outplanting attempt. Two of the three outplantings are considered failures given the lack of any seedlings and the death of most outplants. The third outplanting is only 6 months old and its success or failure remains to be seen. This fairly short lived species seems to rely on high seed production and replacement as a primary reproductive strategy. Reasons for the outplanting failure include poor microsite selection resulting in poor vigor and only a few plants surviving to maturity. These difficulties with TNC's outplanting attempts underscores the difficulties faced by NRS in establishing stable populations for a species with naturally dynamic populations.

Research Issues
Seed storage potential for this species needs to be investigated; however, this will likely not be completed until reintroductions are established.

Surveys
In the last year some sites within the Honouliuli Preserve were revisited to update population numbers and monitor threats. No new populations were discovered.

Population Unit Level Discussion

Manage for Stability PUs:

Mohiākea to Hale'au'au
This PU is made up of three sites; Hale‘au‘au, Kalena Notch and North Mohiākea. The highest priority action for this PU is to re-visit large wild populations (Kalena Notch and North Mohiākea). The North Mohiākea site had 50 individuals but has not been monitored since December 1996. The Kalena Notch site had approximately 25 individuals in all three age classes but has not been visited since February 2000. The Hale‘au‘au site had three immatures in August 2002. NRS will visit all three sites and make collections for storage and reintroduction at Ka‘ala (see outplanting issues section above).

Kalua‘ā
This PU is only separated from the Wai‘eli PU by the Action Area boundary. There are four sites within this PU. All sites were visited in the last year and one appears to have been extirpated. At the three remaining sites plants are not vigorous and there has been a steady decline. The declines are likely the result of weed competition as well as land slides (Dan Sailer TNC Honouliuli Preserve Manager pers. com 2006). The wild plants in Central Kalua‘ā (KAL-A) are fenced. In Wai‘eli there are three sites. The South fence site has been extirpated (ELI-A). NRS will continue to monitor this site for new plants. The site in the South-west corner (ELI-B) has one plant that is within the fence. The ELI-C site north of the North fenceline has 12 plants. These plants are just outside of the fence. NRS visited the site this year with TNC and determined that fencing was not necessary as the plants are growing in steep habitat. There are additional sites to search in the Wai‘eli area and NRS will work to survey these areas in the coming year. NRS will continue to monitor these populations and collect for storage and reintroduction. In the next year NRS will also search the fenced areas for an appropriate reintroduction site. Stock for this reintroduction site will come from all PUs south of Kolekole pass (see outplanting issues section).

Koloa
NRS are negotiating a Right of Entry/License Agreement with Hawaii Reserves Inc., the land manager of the Koloa parcel. After this agreement is in place, NRS will have formal authorization to pursue a Koloa MU fence. This action is considered the highest management priority for this taxon in the Ko‘olau Mountains. Once the fence is complete NRS will develop a reintroduction plan for the site (see outplanting section above). In the meantime, NRS will work to fully survey the area and determine if there are any naturally occurring populations.

Other PUs:

Wai‘eli
This MU occurs in close proximity to the Kalua’ā PU and is separated out because is it outside of the action area. There are two sites within this PU. NRS discovered one of these sites this year. One mature plant occurs at this site and seeds and cuttings were collected from this single healthy individual. The second site has not been visited since May 2003. NRS will monitor both sites in the next year and collect stock to reintroduce at Kalua’ā (see outplanting issues section above).

Kawai Iki
There is one site in this PU that was last visited in May of 1999. NRS will visit this site in the next year to monitor and collect stock for reintroduction at the Koloa PU (see outplanting issues above).

Kaipapa‘u-Kawai Nui Summit Ridge
NRS and the Hawaii Biodiversity Mapping Program (HBMP) Botanist discovered a new site in February of 2006 in this PU. Only the HBMP Botanist is familiar with the other site. NRS will work to collect from this site in the next couple years for reintroduction in the Koloa PU.

Kaukonahua
There is one site in this PU that was last visited in February of 2001. NRS will visit this site in the next year to monitor and collect stock for reintroduction at the Koloa PU (see outplanting issues above).

Helemano and Opaeula
There are four sites in this PU. These sites have been visited at various times over the past three years (see table above). NRS will work to collect from these sites in the next couple years for reintroduction in to the Koloa PU. The site near the Pe‘ahināi‘a summit (KLO-B) has a more narrow leaf than has been noted at other populations. This may be due to its location on the more exposed windward side. NRS will seek input from the HBMP Botanist regarding the significance of this difference and whether or not it should influence outplanting plans. In addition, the site at Lower Pe‘ahināi‘a is located a significant distance away from the summit and NRS and the MIT should decide if this stock should be planted at the summit area in the Koloa PU (see outplanting issue section above).

South Helemano
There is one site in this PU that was last visited in March of 2003. NRS will visit this site in the next year to monitor and collect stock for reintroduction at the Koloa PU (see outplanting issues above).

North and South ʻĒkahanui
The North ʻĒkahanui population was extirpated in the last year and another recent historic location in South ʻĒkahanui is also extirpated (Dan Sailer TNC Honouliuli Preserve Manager pers. com. 2006). NRS will monitor the North ʻĒkahanui site in the coming year and search for any regeneration.

Mākaha-Waiʻanae Kai Ridge
This is a population known only by the HBMP Botanist. NRS will get directions regarding the location in the next year and visit the site while conducting other management in the area to determine status. As this PU has no management designation for NRS, if plants are found they will be reported to the watershed planner and management suggestions made.

Huliwai
This PU contains one site that was last visited in April of 2006. NRS will visit this site in the spring of 2007 to monitor and collect stock for reintroduction at the Kaluaʻā PU (see outplanting issues above). This population has been declining over the past several years due to landslides, ungulate activity, and the small number of mature individuals.

Kaipapaʻu Gulch
This site has no management designation for NRS and is outside the area of NRS operations. NRS will not visit the site but will encourage other agencies to begin management of this site.

Kaluanui
This site has no management designation for NRS and is outside the area of NRS operations. NRS will not visit the site but will encourage other agencies to begin management of this site.

3.2.11 *Phyllostegia mollis*

Taxon Summary

Phyllostegia mollis

Population Unit	Army Population Reference Code	Management Designation	Current no. of wild plants mature/immature/ seedlings	Current no. reintro/augmentation
Inside AA				
Mohiakea	SBW-A	Genetic storage collections	0/1/2	0
Wai'eli	ELI-A, SBS-A	Genetic storage collections	1	0
Outside AA				
Huliwai	HUL-A	Genetic storage collections	0	0
'Ēkahanui	EKA-B	Manage for stability	0	0
Reintroductions Outside AA				
Kalua'ā	KAL-B and KAL-C	Manage for stability	Reintro.	14/0/0 (11 at KAL-C and 3 at KAL-B)
		Total	1/1/2	14/0/0

Phyllostegia mollis* x *P. parviflora* var. *lydgatei

Population Unit	Army Population Reference Code	Management Designation	Current no. of wild plants mature/immature/se edlings	Current no. reintro/augmentation
Outside AA				
Puali'i	PUA-A	Manage for stability	0	0
		Total		

Taxon Level Discussion

The current status of this taxon is very bleak. Plants are extirpated from all but two of the five known sites. The two remaining sites are on Army land at Schofield Barracks South and West Ranges. Augmentation must be used extensively to achieve stabilization for this taxon.

Propagation and Genetic Storage

This species is easily propagated from tip cuttings as well as seeds. There are no special germination requirements. Fresh germination is high, with no decrease in viability after 19 months of storage. One plant from Mohiakea and three plants from Waieli are represented *in vitro* in the Micropropagation Lab. Seeds have been germinated and subcultured in the lab. Greenhouse cuttings have been brought to the lab to have a backup collection of this stock. The security of this taxon *ex-situ* is very critical to the future management possibilities for this taxon since wild populations are so limited and reintroduction success is low. The tables below outline the current *ex situ* status of this taxon as clones in the greenhouse and in seed storage.

The genetic storage strategy for this taxon is to use whatever we can to back up any available stock. NRS will work to represent all stock via cuttings at the Lyon Arboretum Micropropagation Lab which is the safest long-term storage. All stock that is in living collections in nurseries will be stored. Any seeds produced in the greenhouse and at reintroductions will be collected for seed storage.

Genetic Storage Partial Storage Summary

	# of Potential Founders			Partial Storage Status		
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery
Phyllostegia mollis						
Ekahanui	0	0	1	0	0	1
Huliwai	0	0	1	1	0	1
Mohiakea	0	1	12	1	1	4
Pualii	0	0	1	0	0	1
Waieli	1	0	4	3	3	5
				Total # Plants w/ >=10 Seeds in Seedbank	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery
				5	4	12

Genetic Storage Goals Met Summary

	# of Potential Founders			Storage Goals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants that Met Goal
Phyllostegia mollis				
Ekahanui	0	0	1	1
Huliwai	0	0	1	1
Mohiakea	0	1	12	3
Pualii	0	0	1	0
Waieli	1	0	4	5
				Total # Plants that Met Goal
				10

Unique Species Observations/Taxon-specific issues

This species looks very similar to *Phyllostegia parviflora* var. *lydgatei*. *P. parviflora* and *P. mollis* once co-occurred in Pālāwai, Puali‘i and ‘Ēkahanui gulches and are difficult to differentiate. This has lead to some confusion with regard to existing collections both *in situ* and *ex situ*. In order to clarify this issue, Dr. Clifford Morden from U.H. conducted genetic analyses. The results were not completely conclusive but do indicate that the plant in question is likely a hybrid. Nonetheless, NRS will treat the Puali‘i population as a hybrid between the two taxa and will be treated separately in future management. This stock will be reintroduced into the Puali‘i area and not mixed with any pure *P. mollis* stocks. *P. parviflora* var. *lydgatei* is extirpated from the wild.

Research Issues

Outplanting techniques and site selection require some research as reintroduction survival rates are low for this taxon. Perhaps research in the area of drought susceptibility of this taxon would assist managers in understanding reasons for dramatic declines. Additional genetics would not be useful as all techniques will be limited by sample size.

Surveys

No surveys have been conducted recently for this taxon. In the next year NRS will direct some HBMP contract survey time to this taxon. Revisiting historical locations and searching adjacent sites will be the highest priority.

Discussion of Management Designations

The strategy for this taxon naturally involves substantial reintroductions. The manage for stability augmentations/reintroductions will be conducted in three zones. Figure 1, below, shows the designated population reference codes to be planted into the three core management sites, Kalua‘ā, ‘Ēkahanui and Puali‘i.

Map removed,
available upon request

Figure 1 Outplanting Zones for *Phyllostegia mollis*

Management Discussion

The priority actions for this taxon across the board are securing all stock available, maximizing greenhouse production to augment reintroductions at all three sites, and securing habitat for these reintroductions. Stock will be secured by replicating it and housing it in different nursery sites. Samples will also be moved into micropropagation.

Manage for Stability PUs

Kaluaʻā

Only SBS and SBW stocks are available for use in this MU. The Central Kaluaʻā MU fence continues to be maintained and provides secure habitat for management of this taxon. Two reintroductions have already been conducted into this fence. In addition, in the last year TNC staff, with assistance from NRS, completed a new fence in Waieli gulch protecting additional *P. mollis* habitat. Two reintroductions have been conducted in Kaluaʻā gulch. The KAL-B reintroduction was initiated in 2002 with 26 plants. The KAL-C site was established in February of 2006 with 16 plants. Of the total 42 plants outplanted, only 14 remain. These remaining plants look healthy. In the next year, substantial supplemental plantings are planned into the existing KAL-C site. Based on stock availability, an additional site may be established within the new Waieli exclosure. Weed control is on going at the Kaluaʻā reintroduction sites, see Chapter 2 for weed control details.

‘Ēkahanui

All the wild plants from this zone are extirpated. Stock is available from EKA -B for use in reintroductions. Subunit I of the ‘Ēkahanui MU contains some suitable habitat for this taxon. In addition, the NRS fencing crew expect to have Subunit II of this MU completed sometime in spring 2007. This will increase the available habitat for *P. mollis* reintroductions in ‘Ēkahanui significantly. Substantial reintroductions are planned for the coming year into this MU.

Puali‘i

The taxonomic status of this PU has been very confusing. Genetic testing done by Dr. Morden suggest that plants known from this region are hybrids between *P. mollis* and *P. parviflora* var. *lydgatei*. The plants in the greenhouse are from clones of these wild plants and therefore also hybrids. NRS will take care not to mix this stock with any pure stocks and will only manage these plants within the Puali‘i area. TNC will complete a new exclosure in Puali‘i gulch this fall which will provide a protected area in which to conduct reintroductions. TNC has already been conducting weed control at planned reintroduction sites for this winter.

Other PUs

Waieli

NRS continue to monitor the wild site in North Wai‘eli (Schofield Barracks South Range, SBS-A). One mature individual still exists a degraded site dominated by *Schinus terebinthifolius* and *Toona ciliata*. This extant individual is represented *ex situ*. In recent years, there were additional mature plants nearby. NRS will continue to monitor all sites where plants were previously found in Waieli in hopes of securing representation from additional founders. Plants have not been observed recently at the Central Waieli site (ELI-A).

Mohiakea

Range restrictions limit the access to this site. NRS consider revisiting this site to be one of the highest priority SBW actions and will carve time out of other tasks in order to conduct regular monitoring. Any new plants observed will be monitored and collected from to maximize founders available for stabilizing this taxon.

3.2.12 *Pteris lidgatei*

Taxon Summary

Population Unit	Army Population Reference Code	Management Designation	Current no. of plants mature/immature	Target No.	Notes
Inside AA					61% in AA
Kawaiiki	KLO-A	Alternate management site	3/0		
Kawainui	KLO-D	Manage for stability	0/1	50	New PU
North Kaukonahua	KLO-B	Manage for stability	0	50	North Kaukonahua MU
Helemano	KLO-C	Alternate management site	2/2		New PU- Just outside Helemano MU
South Kaukonahua	SBE-A	Manage for stability	6/0	50	est. >10
Outside AA					
Waimano		None	0/2		
Kaluanui		None	?		
Kahakuloa, Maui		None	8/0		
Kauaula, Maui		None	?		
		Total	19/5		

Taxon Level Discussion

This species occurs primarily along steep stream banks and waterfalls and therefore may not require ungulate fencing. Recent monitoring of this species found that two known populations are no longer extant (KLO-B and the old Kawainui PU). However, two additional populations were discovered this year. A total of four new plants were found just below the new Helemano fenceline (KLO-C) and one new individual was found a few hundred meters away from the last known plants in Kawainui drainage. The KLO-A and SBE-A populations have not been monitored in over 6 years. The Waimano PU was also revisited this year. Two previously known individuals were relocated after 13 years. These individuals were still immature, thus plants may take many years to reach maturity.

At this time management priorities are focused on monitoring known populations, surveying for additional individuals, and working with researchers to develop a propagation method.

Propagation/Genetic Storage

This species has not been successfully propagated. NRS plan to collect mature sori for propagation this year if any material is available.

Unique Species Observations

Recent observations show that individuals may remain immature for greater than 10 years.

Outplanting Issues

No outplanting of *Pteris lidgatei* can be conducted until a propagation method is developed.

Research Issues

Propagation techniques need to be developed. Micropropagation methods may be utilized. Once successful propagation methods are known research is needed on the longevity and the growth rates of individuals.

Surveys

One survey was conducted this year specifically for *P. lidgatei* in Kawainui drainage. One individual was found. Four additional individuals were found along the Helemano drainage near the summit on a general survey. Additional surveys would be beneficial as habitat for this species is largely under surveyed.

3.2.13 *Sanicula purpurea*

Taxon Summary

Population Unit	Army Population Reference Code	Management Designation	Current no. of plants mature/immature	Target No.	Notes
Inside AA					92% wild plants in AA (for Oahu only), 17% of all wild plants statewide in Oahu AA
Kaukonahua-Punaluʻu Summit Ridge	KLO-C	Manage for stability	0/21	100	Kaukonahua-Punalu'u MU
Kahana-Kaukonahua Summit Ridge	KLO-B	Manage for stability	0/21	100	South Kaukonahua MU
Helemano-Punaluʻu Summit Ridge	KLO-A	Manage for stability	0/14	100	Poamoho MU
ʻŌpaeʻula-Punaluʻu Summit	KLO-E	Reintroduction	1/3		ʻŌpaeʻula MU
Outside AA					
PuʻukeahiaKahoe		None	0/1		
Kahaluʻu-Waimalu Summit Ridge		None	0/1		
Wailupe-Waimanalo Summit Ridge		None	0/3		
		Oahu Total	1/64		
Maui					
ʻEke		None	250		
Puʻu Kukui		None	Ca. 20-50		
		Maui Total	270-300		
		Species Total	335-365		

Taxon Level Discussion

There are two PUs of *S. purpurea* known from the KLOA action area and one from SBMR action area. *S. purpurea* plants within these PUs total about 56 plants, which is almost all of the plants on Oahu. On West Maui, the species is thought to number a few hundred. Currently none of the Oahu PUs have stable numbers. In order to reach this goal, augmentation may be needed. Helemano-Punaluʻu Summit stock was outplanted at the ʻŌpaeʻula-Punaluʻu Summit in 2000. The plants seem to be doing well there. One plant was observed flowering at the reintroduction site this past May and seedling recruitment has been observed. This plant is monocarpic so mature plants are rarely seen. Stabilization targets may be difficult to achieve unless they are based on the numbers of immature plants rather than mature.

Propagation and Genetic Storage

Fruit collected from the Helemano-Punaluʻu Summit population were successfully propagated in the greenhouse and outplanted at the ʻŌpaeʻula Summit. *Sanicula purpurea* will likely mimic its congener *S. mariversa* in storage potential and *S. mariversa* can be successfully stored. Bulk collections have been difficult to obtain from *S. purpurea* because of the sporadic and infrequent flowering patterns. Until sufficient bulk seed collections are obtained, NRS will store *S. purpurea* using techniques developed for *S. mariversa*.

Unique Species Observations
This species is short-lived and flowers inconsistently. Individuals are monocarpic and only a fraction of the population flowers in any given year. Therefore, mature fruit will be collected as they become available. The species is presumably insect-pollinated. The bristles on the species' fruits indicate a potential for dispersal by birds. Observations of *S. mariversa* have shown that plants are deciduous and tend to re-sprout several times before flowering. However, the seasonality of *S. purpurea* wild plants is still largely unknown. These traits make it difficult to determine the exact population size at a single visit. NRS expect that *S. purpurea* may be less seasonal than *S. mariversa* because of the extremely wet habitat in which it occurs.

Outplanting Issues
NRS outplanted four individuals grown from the Helemano-Punalu’u Summit PU into a site at the ‘Ōpae‘ula Summit in 2000 in order to work out reintroduction techniques for the taxon. Currently, all four of the reintroduced plants are still alive. One plant has reached reproductive maturity, and a new seedling was found near the mature plant. NRS did not have success outplanting *S. mariversa* and suspect this result was due to much drier conditions in the Wai’anae Mountains. The success of the first reintroduction attempt with this taxon give NRS hope that *S. purpurea* may be easier to reintroduce and manage than its congener.

Research Issues
Due to a lack of knowledge about the biology of wild plants, research on both *S. mariversa* and *S. purpurea* should focus on determining seasonality. Propagules may be faster and better produced for storage testing in the greenhouse if a few plants can be maintained. In this way NRS avoid impacting wild PUs. To keep these plants healthy, NRS will need to mimic the saturated conditions at wild sites.

Management Discussion
The ‘Ōpae‘ula Summit reintroduction is currently protected within the ‘Ōpae‘ula exclosure. *Sanicula purpurea* exists in very exposed low-stature windward summit crest vegetation. This type of habitat is not heavily impacted by pigs. The weed that most threatens *S. purpurea* habitat is *Axonopus fisifolius*, carpet grass. NRS can control this taxon with grass specific herbicides but will not conduct control until PUs are protected from ungulates. Following grass control, more bare earth is exposed. Ungulate impacts at a site can intensify. The highest priority action for this taxon is to collect propagules for genetic storage and testing.

3.2.14 *Schiedea trinervis*

Taxon Summary

Population Unit	Army Population Reference Code	Management Designation	Current no. of plants mature/immature	Target no. of mature plants	Notes
Inside AA					>95% in AA
Kalena to East Makaleha	ALA-A thru X; SBW-F, G; LEH-A	Manage for stability	166/169	150	Ka‘ala, Kalena and East Makaleha MUs
		Total	166/169		

Taxon Level Discussion
This taxon is restricted to the zone of wet forest habitat around Mt. Ka‘ala and Pu‘u Kalena which is 1,500 meters away from Ka‘ala. During the extensive ginger control and pig control work that NRS has conducted at Ka‘ala, many new locations of this taxon have been discovered.

Propagation and Genetic Storage
Plants are easily propagated from seed. There is no decrease in viability after more than six years of dry storage at 4C or -18C. Fresh seeds may initially be slow to germinate due to dormancy but typically have high germination (>75%). Seedlings have also been established in tissue culture from seeds, and these seedlings have been propagated in the greenhouse. Based on ease of seed collection, storage, and propagation, seed is the preferred method of genetic storage. There are over 20,000 seeds from 35 plants from the Kalena to East Makaleha PU.

Unique Species Observations
Many seedlings have been observed at populations of this taxon.

Research Issues
The NRS Research Specialist showed that in *S. obovata* there is significant mortality due to introduced slug predation. This threat is expected to affect *S. trinervis* as well. Research to develop at tool for slug control is a top priority for this taxon (see Chapter 6 for details).

Management Discussion

Kalena to East Makaleha
The majority of individuals within this population are protected within a strategic pig fence that encircles Mt. Ka‘ala Summit. The outlier portions of this PU are along the Kalena and Ka‘ala ridge and in East Makaleha. These areas are not protected from ungulates and goats are a threat at these sites. Thus, it is a high priority to collect seed from these areas. NRS are controlling *Psidium cattleianum* and *Hedychium gardernarium* across the Mt. Ka‘ala Summit which are the most significant weed threats to this taxon. Limited reintroduction has been conducted with this taxon as it is relatively abundant in intact native forest. The reintroductions that were conducted took place at a site on NARS land atop Ka‘ala. NRS will request permission to monitor this site in the next year. Management focus will be on habitat level threat control.

3.2.15 *Stenogyne kanehoana*

Taxon Summary

Population Unit	Management Designation	Current no. of plants mature/immature	Target No.	Notes
Inside AA				50% in AA
Hale‘au‘au	Manage for stability	1	50	Hale‘au‘au MU very large plant (>4 m^2)
Outside AA				
Central Kalua‘ā (South fork)	Manage for stability	0	50	Central Kalua‘ā fence
Reintroductions Outside AA				
Central Kalua‘ā (North fork)	Manage for stability	0/30	50	Will be of mixed stock, Kalua‘ā + Hale‘au‘au at site separate from old wild site.
	Total	1		

Taxon Level Discussion

This taxon is extremely rare. Until two years ago it was only known from one locale. Significant threats include feral pigs, weeds (particularly *Clidemia hirta*) and possibly low genetic variation. Plants flower very infrequently. The stabilization for this taxon emphasizes seed collection in order to capture more genetic variation, habitat protection and augmentation.

Propagation and Genetic Storage

Cuttings from greenhouse stock from all founders have been successfully established at the Lyon Micropropagation Lab in January 2006.

Unique Species Observations

Primarily, this taxon reproduces vegetatively. Very seldom have plants been observed with flowers or fruit. The Hale‘au‘au population has yet to be observed reproducing sexually.

Research Issues

A priority for research was establishing reliable vegetative propagation techniques. There was concern from early observations that if cuttings were taken from a runner, the whole runner would die down to where it hit the ground. The Army Horticulturist has established a successful method for collecting cuttings and has not observed any dieback of mother plants in the greenhouse.

Surveys

The HBMP Botanist conducted four days of survey for this taxon. Three days were spent in Schofield Barracks, West Range and one in Kalua‘ā Gulch. No new plants were discovered.

Management Discussion

Hale‘au‘au

This population was discovered in June 2004. A 30 x 20 meter fence was constructed to protect it from pigs in July of that summer. Since that time weed control was conducted at the site twice. Small *Psidium cattleianum* plants were removed with care not to alter the light regime at the site. Understory weeds including *Clidemia hirta*, *Rubus rosifolius* and *Rubus argutus* were controlled. In addition, the non-native grass *Paspalum conjugatum* was encroaching on the *S. kanehoana* plants and grass-specific herbicides were used to control them. No negative affects were observed on *S. kanehoana* near grass treatment area. *Acacia koa* juvenile plants are growing vigorously in fence exclosure. Access restrictions limit the number of visits to this population so the only visit made during this reporting period was in December 2005. Clones of plants from this population have been reintroduced into Kaluaʻā and are represented in the greenhouse and in micropropagation.

Kaluaʻā

The last remaining plant in this population died in March of 2005. The habitat in the vicinity of this population is very degraded. Stock from this PU is represented in reintroductions, in the greenhouse and at the Lyon Micropropagation Lab.

Kaluaʻā Augmentation

In the OIP draft stabilization plan, the Kaluaʻā site was to be augmented with only Kaluaʻā stock and another site in the north fork of Central Kaluaʻā was to be chosen where a reintroduction of mixed Kaluaʻā and Haleʻauʻau stock would be conducted. This approach was proposed by the HBMP Botanist based on concerns that a yet to be discovered wild populations may still appear.

A mistake was made and in the last year as a mixed stock augmentation was conducted along the southern Kaluaʻā fenceline approximately 50 meters from the historic Kaluaʻā location. The following are the options from this point forward considering that this taxon is likely genetically depauperate.

- Remove Haleʻauʻau stock from the south Kaluaʻā reintroduction
- Revise the draft OIP stabilization approach considering the need for genetic mixing in a species so rare and add another mixed site.
- Establish a pure Kaluaʻā stock reintroduction in North Kaluaʻā and maintain the mixed site in the south, after further survey efforts are conducted to ensure no other plants exist in the area.

NRS support the third option because there are only single founders from both sites so mixing is good, the chance of finding more plants is slim as much of the appropriate habitat has been well surveyed and because the stock already planted is too valuable to pull out and we run the risk of them dying.

Chapter 4.1: *Achatinella mustelina* Management

The MIP stabilization plan for *Achatinella mustelina* outlines protection measures for each Evolutionarily Significant Unit (ESU). Each ESU is considered a genetically distinct group and thus important to conserve in stabilizing the taxon. In order to reach stability for *A. mustelina*, NRS must work towards attaining the goals below.

Achatinella Stabilization Plan Summary

Long Term Goals:

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

Summary of Stabilization for *A. mustelina*

Overall, stabilization measures for *A. mustelina* are progressing well. Seven of the eight populations designated for management have some management in place. Four of the eight are protected within MU ungulate fences. In the next year, at least two more MU fences will be constructed protecting a total of six of the eight sites. Rat control is underway at six of the eight sites designated for management. Weed control is on going at seven of the eight manage for stability sites. All eight sites are represented in captive propagation at U.H. Research in the realm of *A. mustelina* dispersal and habitat utilization is on going as well as research about *Euglandina rosea* habitat utilization and feeding patterns. The biggest priority for the next year is to increase management at ESU-C sites. The numbers of snails within this ESU are greatly reduced and the situation is critical at wild sites. Rat control will be conducted year round at all sites with snails remaining in SBW and small ungulate fences will be constructed. Ground shell plots will be installed and monitored in combination with *E. rosea* searches.

Grouping of *A. mustelina* sites into ESUs

The ESU areas have been updated based on additional genetic sampling conducted this year (Figure 4.1.1). More details on the results of this sampling will be discussed within the specific ESU sections. Note that the exact shape and extent of each ESU is unknown and therefore the contours depicted are partially theoretical.

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 because of the geographic spread of these ESUs. All sites are represented at Dr. Michael Hadfield's laboratory at the University of Hawai‘i. Detailed snail captive propagation data is shown in Table 4.1.1. There are significantly fewer snails in the lab now than one year ago. This has been examined and noted by lab staff with some concern. An in depth analysis into the cause of this decrease is being investigated.

In communication with Dr. Hadfield, he noted the following patterns in survivorship of laboratory *A. mustelina*.

(1) Adult mortalities are high throughout, <56%; then decline as only 12 adults survive.
(2) High birth rates, seen in earlier intervals, naturally decline as adult numbers decline.
(3) Survival of pre-adult snails is high throughout.
(4) Adult numbers will increase in the next year, as will birth rate.

Table 4.1.1 Captive Snail Propagation Data

Population	ESU	Date	# juv	# sub	# adult	# Individuals
Peacock Flats	A	1995	0	0	6	**6**
		2003				**21**
		4/2004	8	11	4	**23**
		9/2005	3	15	2	**20**
		8/2006	1	12	3	**16**
ʻŌhikilolo – Makai	B1	2003	0	0	10	**10**
		4/2004	27	0	4	**31**
		9/2005	15	8	0	**23**
		8/2006	3	9	0	**12**
ʻŌhikilolo – Mauka	B1	2003	0	0	8	**8**
		4/2004	20	5	0	**25**
		9/2005	18	7	0	**25**
		8/2006	0	21	2	**23**
Kaʻala S-ridge	B2	2003	0	0	10	**10**
		4/2004	23	0	6	**29**
		9/2005	19	5	0	**24**
		8/2006	4	11	0	**15**
Alaʻiheʻihe Gulch	C	2003	0	0	10	**10**
		4/2004	14	4	4	**22**
		9/2005	17	5	0	**22**
		8/2006	2	20	0	**22**
Palikea Gulch	C	2003	0	0	10	**10**
		4/2004	20	1	8	**29**
		9/2005	22	3	2	**27**
		8/2006	12	13	0	**25**
Schofield Barracks West Range	C	2003	0	0	10	**10**
		4/2004	15	1	9	**25**
		9/2005	27	1	2	**30**
		8/2006	8	22	0	**30**
10,000 snails	D1	2001	0	0	9	**9**
		2003				**29**
		4/2004	8	22	0	**30**
		9/2005	3	24	3	**30**
		8/2006	1	24	3	**28**

Population	ESU	Date	# juv	# sub	# adult	# Individuals
Schofield South Range	D1	2003	0	0	10	**10**
		4/2004	18	7	3	**28**
		9/2005	24	2	0	**26**
		8/2006	11	12	0	**23**
Mākaha	D2	2003	0	0	10	**10**
		4/2004	16	0	8	**24**
		9/2005	23	0	3	**26**
		8/2006	10	14	0	**24**
ʻĒkahanui - Honouliʻuli	E	2003	0	0	10	**10**
		4/2004	24	2	3	**29**
		9/2005	22	2	0	**24**
		8/2006	7	9	0	**16**
Palehua Gulch	F	4/2004	4	0	4	**8**
		9/2005	20	0	2	**22**
		8/2006	5	14	0	**19**
TOTAL		2003				**138**
		4/2004				**303**
		9/2005				**299**
		8/2006				**253**

Juvenile=<10mm, Subadult=>10mm no thickened lip, Adult=thickened lip

Trends in deaths reported in six month blocks for 2004-2006 are shown in Table 4.1.2. The reason for the high adult mortality remains unclear. Perhaps it is due entirely to the natural senescence of originally collected adults. Perhaps wild collected snails have not adjusted to laboratory culture as well as snails that were born in the environmental chambers and grew up there. A new individual marking technique is being employed for lab snails to assist in addressing this concern.

Last year's MIP report raised questions related to the design of captive populations of *A. mustelina*. These questions were discussed at the January 2006 MIT meeting. The IT recommended that NRS collect more samples for genetic analysis from one ESU and analyze them at a finer scale to understand the genetic diversity within the ESU and to help guide lab population design. Until this genetic analysis is complete, the IT said not to mix wild populations in the lab and not to make any additional collections. NRS collected additional genetic samples from ESU B2 in the last year and genetic results are pending. When the additional genetics are complete NRS will re-visit the questions raised in this section last year.

Table 4.1.2 A. mustelina Laboratory Population Deaths 2004-2006

ARMY POPULATION DEATHS 2004-2006	jan-jun 04	jul-dec 04	jan-jun 05	jul-dec 05	jan-jun 06	jul-sept 06
Species (cage) location	**juv/sub/adult**	**juv/sub/adult**	**juv/sub/adult**	**juv/sub/adult**	**juv/sub/adult**	**juv/sub/adult**
A. mustelina (Ka'ala S-ridge) chamber 4 bottom	0/0/2	1/0/4	4/0/2	5/3/0	1/1/0	3/2/0
A. mustelina (Alaiheihei Gulch) chamber 5 top	1/0/3	1/0/3	1/0/0	0/0/0	0/0/0	0/0/0
A. mustelina (Palikea Gulch) chamber 5 top	0/0/1	1/0/4	5/0/3	1/0/1	0/0/1	0/0/1
A. mustelina (Ohikilolo Mauka) chamber 5 top	1/1/2	0/0/0	0/0/0	0/1/0	0/0/1	0/0/0
A. mustelina (Schofield West) chamber 5 top	1/0/1	1/0/3	1/0/1	3/0/2	0/0/2	0/0/0
A. mustelina (Makaha) chamber 5 top	1/0/2	2/0/2	2/0/1	1/0/2	0/1/0	0/1/0
A. mustelina (Ekahanui Gulch) chamber 5 bottom	4/1/4	1/0/2	0/0/0	2/1/0	1/2/0	2/1/0
A. mustelina (Ohikilolo Makai) chamber 5 bottom	3/0/2	4/0/4	4/0/0	9/5/0	0/0/0	0/0/0
A. mustelina (Schofield South) chamber 5 bottom	1/1/0	8/0/1	4/0/6	1/0/1	0/0/2	0/0/0
A. mustelina (Schofield) chamber 5 bottom	2/0/0	0/0/0	0/0/1	5/0/1	4/0/1	0/0/0
A. muselina (Palehua) chamber 1	1/0/0	0/0/0	1/0/1	3/0/2	0/0/0	0/0/0
A. mustelina (Peacock Flats) chamber 1	0/0/1	1/0/0	1/0/2	0/0/0	0/2/2	0/0/1
A. mustelina (10,000 snails) chamber 1	0/0/0	0/0/0	0/0/0	0/1/0	1/0/1	1/0/0
Mortality Totals	15/3/18	20/0/23	23/0/17	30/11/9	7/6/10	6/2/2
Births during period	23	24	26	7	5	2
Total live A. mustelina at end of period	319	329	317	284	263	255
Population totals end of **prior** period by age	182/59/53	189/72/58	213/74/41	221/74/22	209/63/18	128/126/12
Percent mortality by age class	8.2/5.1/33.4	10.6/0/39.7	10.8/0/41.5	13.6/14.9/40.9	3.4/9.5/55.6	4.7/1.6/16.7

Monitoring

The NRS Monitoring Manager continues to investigate ways to monitor A. mustelina in a variety of field situations. Over the last year NRS has become more familiar with the challenges of managing this taxon and the connected monitoring challenges. The following is a list from last year's report of priority snail monitoring issues:

- Determine best method for detecting predation at ESUs without conducting a ground search across the entire population.

Ground shell plot (GSP) installation and monitoring has been initiated in the last year. Ground shell plots have been installed in four of the eight field sites being managed for the MIP (Table 4.1.3). Appendix VII contains the ground shell plot methodology that NRS are currently using. NRS adapted this methodology from Dr. Hadfield's standard 5 x 5 meter plots. Ground shell plots are placed in high density areas within managed ESUs. The first plot clearing is time consuming. All shells are collected, measured and any predation noted. Live *Euglandina rosea* are exterminated. Plots located within regularly rat baited areas are monitored once per year. Plots located in un-baited portions of the ESUs are monitored quarterly.

Table 4.1.3 Current and Future Ground Shell Plot Locations and Sizes

ESU	Pop. Ref. Code	GSP Status	GSP Size	Frequency
A	MMR-A	KI-1	5 x 5 m	Annually
	MMR-B	Dr. Hadfield's	5 x 5 m	
	MMR-C	KI-2	5 x 5 m	Quarterly
B1	MMR-E	Planned for '07	N/A	Annually
	MMR-F	OH-1	~ 5 x 5 m	Quarterly
		OH-2	~ 2 x 2 m	Quarterly
		OH-3	~ 2 x 2 m	Quarterly
	MMR-G	Planned for '07	N/A	Annually
B2	LEH-C	Planned for '07	N/A	Quarterly
	LEH-D	Planned for '07	N/A	Quarterly
C	Various*	Planned for '07	N/A	Quarterly
D1	KAL-A	WA-1	5 x 5 m	Annually
		Planned for '07	N/A	Annually
D2	MAK-A	Planned for '07	N/A	Quarterly
	MAK-D	Planned for '07	N/A	Quarterly
E	EKA-A	Planned for '07	N/A	Annually
	EKA-B	EK-1	~3 x 3 m	Annually
F	PAK-C	Planned for '07	N/A	Annually
	PAK-G	Planned for '07	N/A	Annually

*These plots will be established in those populations which contain snails at sufficient densities to make them useful. These sites are yet to be determined.

- Monitor population trends over time at each ESU and determine monitoring frequency.

Ground shell plot data will be used in part to monitor population trends. In addition, NRS plan to utilize mark and recapture techniques where field sites meet the model assumptions. In the last year, NRS prepared and submitted a rare snail permit application to the USFWS for review and expect it to be issued by the end of the calendar year. Over the last year, NRS have observed Kevin Hall a PhD student at U.H., conducting mark and recapture using a new technique. Small typewritten numbers are printed on waterproof paper. These numbers are punched out with a leather punch and glued to the snail shell and sealed with super glue. NRS plan to utilize this technique in monitoring our managed sites as soon as our new permit is issued and the new methodology approved. NRS prefer this new technique because marks hold up in bad weather and are easily interpreted. The old method using India Ink-painted numbers, coated with varnish did not persist in field conditions.

- Determine the most effective rat grid set-up in topographically challenging areas (like Pu‘u Kaua).

NRS have not looked into this issue in the last year and are currently supporting Aaron Shiels, a PhD student from U.H., in studying rat density and home range in mesic forest on Oahu. This project should provide insight on habitat utilization of rats and thus may help in designing rat baiting grids for these scenarios. Appendix VIII is a copy of his proposal.

- Densities of *Euglandina rosea*.

NRS continue to support Marty Meyer, a PhD student at U.H. in hopes that his research on *E. rosea* will shed some light on this issue as well as other issues related to *E. rosea* ecology. Appendix IX is a summary of his research conducted over the last year. See brief summary in Research section below.

Research

Marty Meyer completed his first year of research primarily conducting feeding trials in the lab. His research showed that *E. rosea* prefers snails over slugs and prefers smaller sized snails over larger snails. *E. rosea* often consume the entire snail, including the shell, which may satisfy *E. rosea*'s calcium requirements. A summary of Mr. Meyer's first year of research is included as Appendix X. In the next year, Mr. Meyer will be conducting field studies to determine the movement patterns of *E. rosea* in the field. He will be tracking individual snails within native habitats in the Wai‘anae Mountains. His two field sites will be within ESU A and ESU F.

Kevin Hall, a PhD student at U.H., is working on a two to three year project studying *A. mustelina* in the Wai‘anae Mountains and *A. sowerbyana* in the Ko‘olau Mountains. Specifically, he is looking into dispersal of *Achatinella* species. This project has major management implications including helping to determine the effect of *E. rosea* exclosures on natural dispersal patterns, helping to refine monitoring techniques and providing insight to gene flow issues such as habitat fragmentation. To accomplish this he is marking and recapturing snails at his study sites. In addition, he is tracking a subset of snails using harmonic radar. Also, he is trying to employ genetic techniques to determine historical relatedness of populations. He has prepared a document with preliminary results of these studies and it is attached as Appendix XII.

Map removed,
available upon request

Figure 4.1.1 Grouping of *A. mustelina* sampling sites into 6 ESUs

ESU Updates

NRS did not census snails in most ESUs this past year in anticipation of a more extensive monitoring program being established with the NR Monitoring Program Manager.

ESU-A Pahole to Kahanahāiki

Table 4.1.4 Number of snails counted from ESU-A

Pop Ref Code	No. Snails	Date of Survey	Size Classes			Threat Control Summary			
			Lg >18 mm	Med 8-18 mm	Sml <8 mm	Pigs/ Goats	Weeds	Rats	*Euglandina*
MMR-A Kahanahāiki Exclosure	70	7/04	50	20	0	X	X	X	X
MMR-B Pahole Exclosure	19	9/06	14	3	2	X	X	X	X
MMR-C Maile Flats	159	8/06	21	56	82	X	X	X	X
KAP-C Kapuna Gulch (One-acre Site)	24	8/06	21	0	3	X	X	X	X
TOTAL	**282**		**101**	**90**	**91**				

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*.

The pig fence around the Kahanahāiki MU continues to be maintained as pig free. Snail habitat within the fence is weeded for both canopy and understory weeds (including introduced grasses). Rat control via snap traps and rat baiting continues to be maintained approximately every four weeks near the Kahanahāiki snail exclosure.

New this year is the two GSPs which were installed in Maile Flats at high density clusters of *A. mustelina*. The locations of the new plots are shown in Figure 4.1.2. One plot, KI-2, is in a portion of the site without active rat control and the other, KI-1, is just outside of the Kahanahāiki Exclosure where rat control is conducted on a regular basis. No rat predated shells were found at either plot this year. At GSP KI-1, two live *E. rosea* were collected in January. Both *E. rosea* were less than an inch in length. This reinforces our belief that *E. rosea* pose a threat to *Achatinella* sp. even if not frequently observed. In order to detect *E. rosea*, thorough searches are required. Kevin Hall from U.H. is using snails from one part of the Maile Flats population, MMR-C, in his research project described in the introduction to this chapter. To date, he has marked 159 snails; which is a larger number than have previously been counted across this entire Maile Flats region. He only marked snails within an area approximately 1000-1200 square meters or approximately 13% of the total area in MMR-C. Even without the mathematical components, marking snails is a great method to better estimate the true numbers at a site.

Marty Meyer will be conducting research with tagged *E. rosea* within this ESU in the coming year. He plans to mark snails and track their habitat utilization in a native Hawaiian forest setting.

Details of each population are discussed in the following sections organized by NRS population reference code.

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available upon request

Figure 4.1.2 Map and details of ESU-A

<u>MMR-A Kahanahāiki Exclosure</u>
In order to gauge the effectiveness of the weed control within this site, NRS analyzed data from a Land Condition Trend Analysis (LCTA) vegetation plot in the vicinity. This plot lies across both MMR-A and MMR-C. For detailed results please reference the Weed Chapter: Kahanahāiki MU/ Maile Flats/Middle West Quad. In summary, the data show a significant increase in native species cover over time in this plot. NRS continue to maintain and monitor the Kahanahāiki exclosure quarterly by re-stocking salt troughs and ensuring the electrical barrier is functioning. A summary of rat control data is shown in Table 4.1.5. Bait stations and snap traps are maintained on a monthly basis. GSP KI-1 will provide information on the effectiveness of this rat control.

Table 4.1.5 Kahanahāiki Snail Enclosure Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2002	4	351	309	88%	1	6	6
2002-2003	6	832	591	71%	7	6	12
2003-2004	6	958	732	76%	16	12	13
2004-2005	6	882	546	62%	38	12	13
2005-2006	6	828	642	78%	55	12	10

NRS prepared a call for proposals/designs for a new *E. rosea* barrier. It was suggested that creative ideas could come from challenging university engineering students in a competitive fashion. The call for designs will be submitted to appropriate university departments both within and outside of the State of Hawaii. A site visit will be scheduled allowing contestants to observe building constraints encountered in the area.

PAH-A (says MMR-B in table on pg 4-8) Pahole Exclosure
In the last year, Dr. Hadfield's staff conducted quarterly monitoring at this site and have been counting snails observed within a 5x5 meter quadrat. The table below shows the decline in numbers counted within this quadrat since 2001.

Table 4.1.6 Number of counted snails within the 5x5 meter quadrat at MMR-B

Year	2001	2002	2003	2004	2005	2006
Counted Snails	22	23	16	12	n/a	10

In 1993, 123 snails were counted within the same quadrat (Hadfield et al. 1993). Initial declines at the site in 1993 were attributed to rats and *E. rosea* predation. The table above shows that, although not as severely as in 1993, snails in the quadrat contain MMR-PenSet-01
One plant with a flowering head was found this year in the Lower ‘Ōhikilolo MU. NRS has monitored this site numerous times afterwards this year. NRS will continue to check this area. The potential of this plant spreading would be devastating considering its fire adaptation. With continued persistent monitoring, regeneration is unlikely to happen.

The decline in recent years may be due in part to the poor condition of the host plants, *Pisonia sandwichensis*, within the exclosure. NRS proposes conducting some *P. sandwichensis* restoration in the exclosure in an attempt to halt the decline in this population.

The current condition of the exclosure is poor. NRS were going to make repairs in the last year but upon further inspection, NRS determined the repairs to be quite extensive and believe that it needs to be rebuilt. In addition, a large koa limb which extends over the exclosure and serves as a pathway for rats and *E. rosea* would need to be removed. Neither State NARS staff nor NRS have been restocking rat bait at this site. The current NARS permit does not include rat control via bait or snap traps at this site. In the permit renewal request NRS will add this action in order to have more management options around the Pahole Exclosure. While exclosure issues are worked out, NRS could maintain rat control across the area to alleviate rat predation pressure on remaining snails. NRS have been controlling *Erharta stipoides* within the exclosure as it is incipient to the area (see Chapter 2 for details).

MMR-C Maile Flats

Management actions underway to protect snails in this site are described in general in the ESU-A overview. As mentioned above, rat baiting is not conducted across this entire site as no rat predation has been observed. GSPs are being monitored in order to detect rat predation if it does occur and rat control will be implemented. MMR-C Maile Flats is a perfect site for conducting aerial rat bait dispersal once approved. In addition, the discussion about the LCTA plot presented above in the MMR-A section applies here.

KAP-C Kapuna Gulch (One-acre Site)

This lower elevation site is located in highly degraded forest along the Mōkulei‘a trail. NARS Staff had planned to construct an *E. rosea* exclosure using new kinds of materials at this site because of the easy access and the flat terrain. They postponed this project because very few snails have been observed here recently. At the MIT meeting last year, NRS discussed the use of this site for an experimental reintroduction of *A. mustelina* stock if no snails could be detected. NARS staff recommended that NRS conduct more thorough survey of the area. NRS conducted this survey in August 2006 and counted a total of 24 snails at night. Since snails still inhabit the area, NRS now propose constructing the alternative *E. rosea* exclosure as NARS Staff had originally planned but instead of experimenting with reintroduction, moving snails into the exclosure for protection from the surrounding areas. This would be treated as an experiment of the potential for translocating *A. mustelina*. At sites where populations are extremely small, the technique could be applied in the future, making management more efficient.

ESU-B1 ‘Ōhikilolo

Table 4.1.7 Number of Snails Counted at ‘Ōhikilolo

Pop Ref Code	No. Snails	Date of Survey	Size Classes			Threat Control Summary			
			Lg >18 mm	Med 8-18 mm	Sml <8 mm	Pigs/ Goats	Weeds	Rats	*Euglandina*
MMR-E ‘Ōhikilolo Mauka	77	8/04	62	8	7	X	X	X	
MMR-F ‘Ōhikilolo Makai	210	8/04	166	22	22	X	X	X	
MMR-G Alemac Site	24	6/04	20	4	0	X	X	X	
MMR-H ‘Ōhikilolo Ko‘iahi Prikaa Reintro Site	16	6/04	9	7	0	X	X	X	?
MMR-I Hedpar MMR-B	2	5/04	2	0	0	X	X	X	X
MMR-J Lower Mākua site above camp	5	11/00	0	0	0	X	X	X	?
TOTAL	**334**		**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*.

ESU-B is very large. For management purposes it has been split into two portions. B1 includes ‘Ōhikilolo sites and B2 includes Central and East Makaleha sites. Table 4.1.4 summarizes the current information about each population reference code within this ESU.

Management of this ESU continues as it has in years past. The ‘Ōhikilolo ridgeline goat exclusion fence continues to be maintained and monitored. Goats have not been present at any of the sites with snails since January 2005. Weed control is conducted in forest surrounding most of the snail sites within this ESU for both canopy and understory weeds (including introduced grasses). In addition, restoration has begun with trees suitable for hosting *A. mustelina.* Rat control via snap traps and rat baiting continues to be maintained at least quarterly in areas where rat predation has been observed.

New this year are three GSPs (OH-1, OH-2, and OH-3) which were installed in MMR-F at high density clusters of *A. mustelina* (Figure 4.1.3).

Map removed,
available upon request

Figure 4.1.3 ESU-B1 ‘Ōhikilolo Ground Shell Plots

All three plots are in areas without active rat control and thus are monitored quarterly. NRS will respond by deploying rat bait if any predation is detected. The western rat control area shown in Figure 4.1.3 is maintained to protect a rare plant. The eastern rat control area is in place for protection of *A. mustelina*. No rat predated shells were found in the plots this year nor was any sign of *E. rosea* observed. This reaffirms our belief that there are no *E. rosea* on ‘Ōhikilolo. Two live *A. mustelina* were discovered on the ground in the plots. One of these was at least two meters away from the nearest tree. This observation is consistent with Mr. Hall’s observations of *Achatinella* occurring on the ground in other locations.

Map removed, available upon request

Figure 4.1.4 Location of ESU-B1 'Ōhikilolo *A. mustelina*

MMR-E 'Ōhikilolo Mauka

Figure 4.1.4 shows the location of each population reference code within ESU-B1. An expanded rat grid is being maintained at this site. Table 4.1.8 below shows rat control data from this site. Extensive weed control is ongoing. Restoration with *Acacia koa* has been conducted as the canopy is fairly open. NRS hope to supplement this restoration work with additional outplantings.

Table 4.1.8 'Ōhikilolo Mauka Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Snap Traps	# of Rats Trapped	# of Site Visits
1999	2	32	27	84%	6	4	3
1999-2000	2	128	114	89%	6	3	4
2000-2001	6	128	108	84%	6	0	3
2001-2002	6	224	199	89%	6	1	4
2002-2003	6	384	248	65%	6	3	4
2003-2004	6	384	363	95%	6	4	4
2004-2005	14	544	363	67%	14	6	3
2005-2006	14	896	725	81%	14	10	4

MMR-F ʻŌhikilolo Makai
The general management described above for this ESU is being conducted at this site. In addition, the ungulate exclosure constructed to protect habitat around the site is monitored and maintained quarterly.

MMR-G *Alectryon macrococcus* Site
Last year, NRS suggested monitoring for predation at this site and responding with rat control if predation is discovered. Because of the low numbers of snails at this site this action is not a high priority. A formal ground shell plot is not recommended because of low population density. The forest in this portion of the exclosure is very degraded therefore intensive weed control will not be conducted. A few canopy weeds of concern in the area will be controlled, including a large tropical ash, *Fraxinus uhdei*.

MMR-H ʻŌhikilolo Koʻiahi *Pritchardia kaalae* Reintroduction Site
An exhaustive survey has not been conducted at this site since June 2004. Since that time, some informal surveys have been conducted in conjunction with weed control work. Only four total snails have been observed in the area over the last year. NRS are not comfortable replacing the 2004 count with these numbers but instead will schedule an exhaustive survey for the coming year.

MMR-I *Hedyotis parvula* MMR-B Site
There is no new information about this site. The remote site is on a cliff, and therefore impractical to manage intensively.

MMR-J Above Lower Mākua campsite
NRS did not have access to this site because of unexploded ordnance (UXO) safety issues. The site has not been visited since November 2004. Permission was granted to resume camping at Lower Mākua and thus, NRS will conduct a night survey since the site is close to camp.

ESU-B2 East and Central Makaleha

At the pre IT meeting in January, it was decided that more sites should be selected in Makaleha and more snails sampled for genetic analysis to obtain a clearer understanding of the amount of diversity within one ESU. This ESU was chosen because it is easily accessible, can be visited on a day trip and snails are widely and patchily distributed over a large area. Samples have been collected and given to the lab at U.H. and micro-satellites results are pending. These results will provide the MIT information to be used in designing laboratory populations that best meet the goals of *ex situ* genetic representation. New sampling sites are displayed in Figure 4.5.

Figure 4.1.5 ESU-B2 Genetic Sampling

Table 4.1.9 shows the numbers of snails found in ESU-B2. There was a significant increase in the number of snails known from LEH-C which is discussed in the appropriate section below. The distribution of snails in ESU-B2 is shown in Figure 4.6. The priority management action for protecting snails in this ESU is the construction of the East Makaleha MU fence. Ecosystem-altering weeds are present in low densities. The habitat across ESU B2 is dissected by narrow ridges which drop off steeply on both sides into deep gulches. This terrain is too steep to construct an *E. rosea* exclosure similar to those in ESU-A.

Table 4.1.9 Number of Snails Counted in East Branch of East Makaleha

Pop Ref Code	No. Snails	Date of Survey	Size Classes			Threat Control Summary			
			Lg >18 mm	Med 8-18 mm	Sml <8 mm	Pigs/ Goats	Weeds	Rats	*Euglandina*
LEH-C (culvert 69)	423	5/23/06	241	119	63	X	X	X	X
LEH-D (culvert 73)	39	5/1/06	20	16	3	X	X	X	X
TOTAL	**462**		**261**	**135**	**66**				

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*.

Map removed, available upon request

Figure 4.1.6 ESU-B2 East Branch of East Makaleha

LEH-C Culvert 69

Additional surveys were conducted at this site in order to determine if there are sufficient numbers of snails within the proposed East Makaleha MU fence to meet stability requirements. The total number of snails reported last year was far less than the total 300 required for stabilization goals. In May 2006, NRS conducted a night survey which revealed substantially more snails within the proposed MU. A total of 423 snails were counted. Unfortunately, the snail habitat within this proposed MU is very steep and this does not lend itself to building a future snail exclosure. No live *E. rosea* were found.

LEH-D Culvert 73

No additional surveys were conducted at this site in the last year.

ESU-C Schofield Barracks West Range (SBW), Ala‘ihe‘ihe and Palikea Gulches

Table 4.1.10 Number of Snails Counted in ESU-C

Pop Ref Code	No. Snails	Date of Survey	Size Classes			Threat Control Summary			
			Lg >18 mm	Med 8-18 mm	Sml <8 mm	Pigs/ Goats	Weeds	Rats	*Euglandina*
SBW-A North Hale‘au‘au, Hame Ridge	8	1/05	5	2	1	X	X	X	X
SBW-B North Hale‘au‘au, one ridge north of Hame	0	1/05	0	0	0	X	X	X	X

SBW-C North Hale‘au‘au, just above *Pouteria* pair territory	7	1/05	4	3	0	X	X	X	X
ALI-B Western Palikea Gulch	6	3/23/05	4	1	1	X	X	X	X
ANU-A Manuwai Gulch	1	6/2/04	1	0	0	X	X	X	X
IHE-B Ala‘ihe‘ihe Gulch	10	3/22/05	5	4	1	X	X	X	X
TOTAL	**32**		**19**	**10**	**3**				

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*.

Little progress has been made in managing this ESU and the numbers of snails in the wild continue to be alarmingly low (see Table 4.1.10). Access restrictions limit the number of visits NRS can make each year to the most 'manageable' sites in this ESU (SBW-A, SBW-B and SBW-C) because they lie above the impact area within Schofield Barracks West Range (see Figure 4.1.7). NRS are preparing a risk assessment to construct ungulate fencing at one site within North Hale‘au‘au gulch at SBW-B. Currently, there are no snails at SBW-B but the site is flat enough that an exclosure could be constructed in the future and snails reintroduced from lab stock. The habitat at SBW-B contains appropriate host trees for *A. mustelina*, such as *Antidesma platyphyllum, Melicope peduncularis* and *Melicope kaalaensis*, in high densities. Please note that in last year's report SBW-P was included mistakenly in this ESU. Genetic data show that it falls within ESU-D and not ESU-C.

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available upon request

Figure 4.1.7 ESU-C Schofield Barracks West Range, Ala‘ihe‘ihe and Palikea Gulches

Schofield Barracks West Range SBW-A, B, and C
The habitat for *A. mustelina* at all of these sites continues to degrade as pig populations remain uncontrolled. The habitat can still rebound but ungulate fences are needed urgently. Weeds challenges are substantial, particularly, *Clidemia hirta*. SBW-A receives partial rat protection during the ʻElepaio breeding season (January through June). Increased protection for these sites is a top priority for *A. mustelina* management in the coming year. Populations in this ESU are too small to suffer any more loss and the habitat can't afford any more ungulate degradation. NRS hope to construct the fence at Haleʻauʻau in the next year and conduct weed control within. In addition, rat control grids around ʻElepaio should be expanded to include *A. mustelina* sites on the periphery and select stations should be baited year round to protect snails. Perhaps, because of access restrictions, NRS could employ aerial rat dispersal within this exclosure when available.

ANU-A (Manuwai), ALI-B (Palikea Gulch), IHE-B (Alaʻiheʻihe Gulch)
No additional surveys have been conducted at these sites in the last year. Therefore, the status remains the same as last year's report. The site in Palikea gulch still has good habitat and is not as steep as the other sites. Perhaps NRS could fence this site in order to keep management options open for Mt. Kaala NAR snails.

ESU-D North Kaluaʻā , Waiʻeli, Puʻu Hāpapa, SBS, and Mākaha

ESU-D is by far the largest ESU. For management purposes it has been split into two portions. D1 includes North Kaluaʻā, Waiʻeli, Puʻu Hāpapa, and SBS, and D2 includes Mākaha. The current status of snails at each population reference code in ESU D1 is shown in Table 4.1.10.

ESU D1 North Kaluaʻā , Waiʻeli, Puʻu Hāpapa and SBS

Table 4.1.11 Number of Snails Counted in ESU-D1

Pop Ref Code	**No. Snails**	**Date of Survey**	**Size Classes**			**Threat Control Summary**			
			Lg >18 mm	**Med 8-18 mm**	**Sml <8 mm**	**Pigs/ Goats**	**Weeds**	**Rats**	***Euglandina***
KAL-A Kaluaʻā and Waiʻeli	481	8/04	158	237	86	X	X	X	X
SBS-A Moho Gulch	0	3/04	0	0	0	X	X	X	X
SBS-B Puʻu Hāpapa	196	8/04	131	44	21	X	X	X	X
SBS-D north of UreKaa	11	9/05	8	1	2	X	X	X	X
TOTAL	**686**		**296**	**282**	**108**				

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*.

Two populations of snails (SBS-A and SBS-D) from lower North Waiʻeli, below Puʻu Hāpapa in Schofield Barracks South Range (SBS) were added to the status table this year (Table 4.1.11). These sites are located close to the managed portion of this ESU and seemed important to include even if numbers are extremely small compared to the KAL-A and SBS-B sites.

Map removed,
available upon request

Figure 4.1.8 ESU-D1 Kalua‘ā, Wai‘eli and Pu‘u Hāpapa

<u>KAL-A, Kalua‘ā and Wai‘eli (Land of 10,000 Snails)</u>
In the last year, a significant number of live *E. rosea* were observed in the core area for *A. mustelina*. NRS installed one GSP, WA-1, at this site in order to gauge the effectiveness of rat control and to assess patterns of *E. rosea* predation. One additional plot is planned in the area. While installing GSPs here, NRS is careful to avoid impacts to native terrestrial snails occupying the same habitat. No rat predated shells were found in the initial clearing of WA-1, however some mortality was observed in the medium size classes.

In the last year, TNC Staff, with assistance from NRS, completed the ungulate exclosure protecting the KAL-A site. This fence protects a large proportion of the habitat utilized by *A. mustelina* in this ESU from pigs. Rat control is conducted as it has been in years past through the maintenance of 24 bait stations and 30 snap traps. Rat control data from the last year is presented in Table 4.1.12. Rat bait was available all year long. In the last year, TNC Staff have initiated weed control in conjunction with restoration outplantings.

Table 4.1.12 Kalua‘ā and Wai‘eli Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2003-2004	16	680	547	80%	0	0	3
2004-2005	16	1280	655	51%	11	16	7
2005-2006	16	1774	1107	62%	16	16	7

SBS-B Puʻu Hāpapa

NRS will investigate strategic fencing options that may allow the removal of pigs from this portion of ESU D1. Weed control projects should be investigated and initiated. Table 4.1.13 is a summary of the rat control data since work began. Rat bait was available all year long in stations. Rat bait take has decreased somewhat within the last 2 years. NRS believe that this may be a result of the addition of 14 snap traps. Since the deployment of the snap traps in 2004-2005, NRS has captured 30 rats.

Table 4.1.13 Puʻu Hāpapa Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2000	8	240	159	66%	0	0	4
2000-2001	8	496	286	58%	0	0	8
2001-2002	8	680	401	59%	0	0	6
2002-2003	8	896	476	53%	0	0	7
2003-2004	8	1024	595	58%	0	0	8
2004-2005	8	896	408	46%	18	14	7
2005-2006	8	768	264	34%	12	14	6

SBS-A Moho Gulch

NRS conduct rat control at this site because of the historical presence of two native terrestrial snail taxa. Neither these snails nor *A. mustelina* have been observed in the area recently. NRS should reconsider their management presence at this site and perhaps discontinue rat control efforts. An ungulate fence was constructed to protect this snail site and for protection of a rare plant reintroduction. Weed control is ongoing for habitat improvement.

SBS-D North of Urekaa

This new site was discovered in the last year. Snails that resemble *Achatinella concavospira* and *A. mustelina* were seen there. Genetic samples will be collected in order confirm their identity. No management is underway at this site for *A. mustelina* as the number of snails known is small and the site is extremely degraded. If *A. concavospira* is confirmed, then NRS will consult with the USFWS on the new discovery of this taxon.

ESU D2 Mākaha

Table 4.1.14 Number of Snails Counted in ESU-D2 Mākaha

Pop Ref Code	No. Snails	Date of Survey	Size Classes			Threat Control Summary			
			Lg >18 mm	Med 8-18 mm	Sml <8 mm	Pigs/ Goats	Weeds	Rats	*Euglandina*
MAK-A (Isolau Ridge)	24	6/05	21	1	2	X	X	X	X
MAK-B (Kumaipo ridge crest)	15	1/05	11	4	0	X	X	X	X
MAK-C (Hesarb ridge)	2	6/05	2	0	0	X	X	X	X
MAK-D (ledge below Mauka LZ)	27	6/05	21	3	3	X	X	X	X
TOTAL	**68**		**55**	**8**	**5**				

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*.

This ESU will be discussed as one unit because very little management specific to *A. mustelina* is underway currently. Table 4.1.14 shows the current population numbers for ESU-D2. Figure 4.1.9 shows the known current distribution of *A. mustelina* in Mākaha Valley.

Mākaha MAK-A, B, C, D
Following completion of the Mākaha MU subunit I, NRS will initiate rat control in high density *A. mustelina* areas. NRS will install ground shell plots accordingly. Weed control is already underway in some of the areas with *A. mustelina*. Two additional surveys were conducted in the last year. NRS will continue to survey in order to verify the distribution of snails within the MU.

A PhD student from U.H. in the Botany Department, Aaron Shiels, will be conducting a research project on rats and their impact on seeds of particular native plants (see Appendix VIII). Next year he will be determining rat home ranges and densities within the mesic forests in the Mākaha MU. This information will be invaluable in determining if current baiting methods are adequate. NRS have funded this project almost exclusively.

Map removed,
available upon request

Figure 4.1.9 ESU-D2 Mākaha

ESU-E Pu‘u Kaua/‘Ēkahanui

Similar management is underway at all the known ESU-E sites with the exception of EKA-D at Pu’u Kaua. Table 4.1.15 summarizes the current population numbers for each reference code within this ESU. Figure 4.1.10 shows the geographical distribution of sites in addition to the one GSP that was installed this year.

Table 4.1.15 Number of Snails Counted in ESU-E

Pop Ref Code	No. Snails	Date of Survey	Size Classes			Threat Control Summary			
			Lg >18 mm	Med 8-18 mm	Sml <8 mm	Pigs/ Goats	Weeds	Rats	*Euglandina*
EKA-A (Mamane Ridge)	183	10/04	93	30	60	X	X	X	X
EKA-B (Plapri EKA-A site)	55	10/04	46	6	3	X	X	X	X
EKA-C (Plapri EKA-C site)	6	10/04	6	0	0	X	X	X	X
EKA-D (near summit of Pu‘u Kaua)	202	10/04	158	31	13	X	X	X	X
EKA-E (*Amastra* site)	13	10/04	9	3	1	X	X	X	X
EKA-F (*Amastra* site in a northern gulch of South ‘Ēkahanui)	3	2/1/06	2	1	0	X	X	X	X
TOTAL	**459**		**312**	**70**	**77**				

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*.

Figure 4.1.10 ESU-E Pu‘u Kaua/‘Ēkahanui

<u>ʻĒkahanui EKA-A, B, C, and E</u>
Management continues as it was being conducted last year. Rat control, weed control and pig fence maintenance all continue within this ESU. Recently, the NRS fencing crew has begun clearing fenceline for the construction of Subunit II of the ʻĒkahanui MU. NRS expect to finish this exclosure in the next year.

Rat control continues at this ESU with a total of 21 bait stations being re-stocked and 31 snap traps set. Rat data is presented in Table 4.1.16. Rat bait was available all year long in stations. Increasing numbers of site visits has yielded high counts of rats trapped, while the percent of bait taken has remained average. In 2005, two bait stations were added to the *Plantago princeps* var. *princeps* EKA-C site to achieve a better grid where both rare snails and plants are found. Last year's numbers differ from this year's because last year the calendar year was used to define the period and this year the reporting period was used.

Table 4.1.16 ʻĒkahanui Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Snap Traps	# of Rats Trapped	# of Site Visits
2004	2	64	22	34%	0	0	4
2004-2005	18	1186	542	46%	31	9	6
2005-2006	21	1940	1035	53%	42	42	7

One GSP (EK-1) was installed in the last year and is shown in Figure 4.1.10. The plot was placed on a 50˚ slope just downhill of a *Myrsine lessertiana* tree with high *A. mustelina* numbers. This was a good trial and demonstrated that it is logistically possible to monitor ground shell plots in steep terrain. It is important that there be some understory cover so shells can get caught in those tufts of vegetation and don't roll down the slope. The plot is approximately 9 m^2 in size. No fresh rat predation was detected but two live *E. rosea* were found. In addition, four old *E. rosea* shells were collected.

<u>Puʻu Kaua EKA-D</u>
This site is very steep and rat control would be difficult to implement. This site will be included in the ʻĒkahanui MU Subunit II fence which will be completed this year. Rat bait stations could be distributed along the crestline and along the main ridge trail to Puʻu Kaua and not in a traditional grid fashion in order to put some control in place (see research discussion from Chapter 4 introduction).

<u>EKA-F (*Amastra* site in northerly gulch)</u>
This site was discovered in the last year. NRS may take on rat control in the area following Subunit II fence completion. NRS will conduct additional surveys around this site to determine the extent and numbers of snails. *Alectryon macrococcus* is also present at this site and perhaps rat control efforts for snails can overlap with fruit protection for this taxon.

ESU-F Puʻu Palikea

The discussion for this ESU is lumped for sites where rat control is being conducted, PAK-A-I (excluding PAK-D). The management issues and treatment is very similar for these sites. Rat control is not being conducted at sites PAK-D and PAK-J because these sites are outliers. There will not be a specific discussion about these sites. The status of all populations within ESU F is shown in Table 4.1.17. The geographical distribution of these sites is shown in Figure 4.1.11.

Table 4.1.17 Numbers of Snails Counted in ESU-F

Pop Ref Code	No. Snails	Date of Survey	Size Classes			Threat Control Summary			
			Lg >18 mm	Med 8-18 mm	Sml <8 mm	Pigs/ Goats	Weeds	Rats	*Euglandina*
PAK-A Pu‘u Palikea Ohia spot	9	8/04	5	2	2	X	X	X	X
PAK-B `Ie`ie Patch	13	8/04	11	1	1	X	X	X	X
PAK-C Steps spot	19	8/04	14	3	2	X	X	X	X
PAK-D Joel Lau’s site	11	8/04	8	2	1	X	X	X	X
PAK-E Exogau site	6	8/04	4	1	1	X	X	X	X
PAK-F Dodvis Site	5	8/04	3	2	0	X	X	X	X
PAK-G Hame and Alani site just above Cyagri fence	22	8/04	13	6	3	X	X	X	X
PAK-H Hadfield’s study site at Pu‘u Palikea	7	01/06	4	2	1	X	X	X	X
PAK-I One ridge truck side of E and F	5	01/06	4	0	1	X	X	X	X
PAK-J North of proposed fence ridge	4	01/06	4	0	0	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*.

Map removed, available upon request

Figure 4.1.11 ESU-F Pu‘u Palikea

Pu‘u Palikea PAK-A-I (excluding PAK-D)
Rat control grids are re-stocked at least twice per quarter. Two new sites were added to the baiting grid in the past year, PAK-H & PAK-I. PAK-H is an old study site of Dr. Hadfield’s. Snails had not been observed at the site in a few years therefore rat control was not previously underway. Following the observation of live snails at the site in January 2006, baiting was initiated. There are a total of 33 baits stations and 42 snap traps in place at eight sites. Rat control data is presented in Table 4.1.18.

Table 4.1.18 Pu‘u Palikea Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2004 -2005	28	3342	970	29%	83	28	11
2005 - 2006	33	3387	1413	42%	70	42	10

Fence expansion to include all of the populations where rat control is underway will be initiated and may be completed in this upcoming year. Figure 4.1.11 shows this proposed fence unit. Weed control will be expanded after the fence is complete.

NRS have seen *E. rosea* at the site but do not yet know the extent or impact of this predator. Since this is a very accessible site, Marty Meyer plans to use this site to investigate *E. rosea* habitat utilization. In addition, NRS will install at least two ground shell plots to gauge rat control efficacy and to search for *E. rosea*. Kevin Hall is also conducting research at this site. A single snail at this research site was documented to move 20 meters over a four month period. This shows that perhaps *A. mustelina* spend more time on the ground than was previously expected.

Chapter 4.2 OIP Rare Invertebrate Update

Overall Discussion

The Army Natural Resources Program has been working with rare *Achatinella* species since its inception in 1996. Snail species included in the OIP include *A. apexfulva, A. bulimoides A. byronii, A. lila, A. livida,* and *A. sowerbyana.* In addition, *A. concavospira* on Army land is discussed below. Current and previous management of some of these species involves predator control (i.e. rat baiting), genetic sampling, monitoring, and collection. Predator control is being conducted at various sites in the Koʻolau range near rare snail populations. The bait gets old and unattractive to rats if it is not changed often. NRS try to restock these baits twice each quarter but weather often interferes with scheduled dates as was the case this year. NRS plan to monitor all populations via mark/recapture studies and ground shell plots in the next two years in order to design a more strategic rat baiting design. In addition, NRS is working with a UH graduate student to learn more about rat density and home range in Oʻahu forests. Management notes from the past year are organized by species below.

In order for NRS to conduct surveys for more populations of the OIP snail species, NRS is currently pursuing a formal license agreement with Kamehameha Schools for Punaluʻu, Waiʻawa, Waimano, and Waiʻau Valleys on Oʻahu. This will allow NRS to survey additional habitat for *Achatinella* in the Koʻolau Mountains. NRS hope to have this agreement signed before the end of 2006.

Genetic Sampling Status

This year, NRS collected genetic samples of *Achatinella* species in the Northern Koʻolau Mountains in order to provide more insight to the species level distinction of *A. byronii/decipiens* and determine ESUs for *A. lila, A. sowerbyana,* and *A. livida*. Table 4.2.1 outlines the genetic sample efforts made this year. Once genetic sampling is complete, NRS will review and revamp the stabilization plans for each of these species. Genetic samples were not collected from wild snails at populations that are represented in the U.H. tree snail lab. Lab snails will be used for this purpose. Figures 4.2.2, 4.2.4-41.6 show locations where genetic samples were taken this year.

Table 4.2.1 2006 Genetic collections for OIP species and ESU determinations in the Northern Koʻolau Mountains.

Species	Site	Army Pop Ref. Code	Date	Chirality
A. byronii	Windward Poamoho Cabin	KLO-B	4/18/06	3 dextral
A. byronii	Windward Poamoho Cabin	KLO-B	4/20/06	6 sinistral
A. byronii	Windward and North Poamoho Monument	KLO-F	4/19/06	6 dextral
A. byronii	West of Puʻu Pauao	KLO-D	8/22/06	3 dextral
A. lila	Windward and North Poamoho Monument	KLO-B	4/19/06	1 sinistral
A. lila	Windward side of notch north of Peahinaīʻa summit	KLO-E	5/3/06	3 sinistral
A. lila	Peahinaia Summit LZ	KLO-C	5/3/06	2 sinistral
A. livida	Radio LZ	KLO-C	8/24/06	3 sinistral
A. sowerbyana	Windward and North Poamoho Monument	KLO-C	4/19/06	1 dextral
A. sowerbyana	Poamoho Pond	KLO-A	8/23/06	7 dextral
A. sowerbyana	Windward side of Radio LZ	PAP-A	8/24/06	2 sinistral

Over the next year, NRS will focus on sampling the remaining *A. sowerbyana* sites. Priority sites are, ʻŌpaeʻula to Helemano (KLO-J Hypalon Site), Kawaiiki (KLO-S Bloody finger) and Lower Peahinaīʻa (KLO-K Puʻu Roberto). Following these additional collections, sampling the geographic spread of this taxon will be complete. Collections for the other *Achatinella* species are complete.

Surveys

In April of 2006, surveys were conducted on the windward side of the Koʻolau summit in the vicinity of the Poamoho Cabin. As recently as five years ago *A. byronii* had been seen on the summit near the cabin but these snails appear to be extirpated. After descending approximately 200 ft. on the windward side, a total of 23 *A. byronii* were counted. This is a good sign as only a small area had been surveyed here and NRS expects that through additional surveys more snails will be found.

In May a new area north of the Peahinaīʻa Trail and Summit LZ, on the windward side, was surveyed and a total of 42 *A. lila* were counted. This is a very large area of which only a very small part has been surveyed. In the future, NRS will conduct more surveys and develop a better understanding of the extent of the population.

In May again, a new area just on the windward side of the Summit LZ was surveyed. In this area 12 person hours were spent locating a total of nine *A. lila* and two *A. byronii*. This is a good sign as only a small area had been surveyed here and NRS expects that through additional surveys more snails will be found.

In August, a survey was conducted on the windward side of the Koʻolaus from Radio LZ. Here six *A. sowerbyana* were found. This area also warrants further surveys because only a minute portion of the existing habitat was searched.

Additionally, NRS conducted surveys in SBS for *A. concavospira* following the discovery of *concavospira*-like individuals in the vicinity.

Achatinella apexfulva

In the spring of 2005, NRS collected the last known extant individual to add to the captive propagation population. It is hoped that this lab population will benefit from this additional genetic input. The lab population remains small, though numbers have been increasing. NRS have committed to continued surveys for this species each year. Habitat for this species is largely undersurveyed. NRS will focus on the most recently known wild sites for surveying.

Achatinella byronii

Table 4.2.2 Taxon status for *A. byronii*

Population Unit	Army Population Reference code	OIP Population Numbers*	Current Total Number of Individuals*	Management Designation	Management Unit
Inside AA					
Poamoho	KLO-A, B, C, G	20-25	60/6/1	Manage for stability	Poamoho & Poamoho Pond
Pu'u Pauao	KLO-D	Est>10	0 seen at last survey	Manage for stability	
North Kaukonahua	KLO-E	~72-178	28/26/5	Manage for stability	North Kaukonahua
South Kaukonahua	SBE-A-E	Est.>14	12/1/1	Manage for stability	South Kaukonahua
Outside AA					
Below Peahinaia Summit	KLO-F	0	2/0/0	Manage for stability?	
	Total	116-227	102/33/7		

*total numbers of individuals are presented by size class (Large>15 mm/Medium 8-15mm/Small<8mm).

The most recent population estimate information is listed in Table 4.2.2. This species is partially protected from rats along the Poamoho summit area where NRS have a rat baiting grid that is restocked every 6 weeks. NRS began rat baiting along the summit of Poamoho trail in August of 2003. Table 4.2.3 shows the amount of bait taken and rats trapped since the baiting grid was established. This year bait take increased but this may be due to fewer site visits rather than an increase in rat density in the area. In the coming year NRS plans to conduct mark recapture tests and/or establish ground shell monitoring plots at all of the larger populations to determine population trends and predator presence in the area. See Appendix VII for a description of ground shell plot methodology. NRS also plan to install a rat baiting grid in the North Kaukonahua (KLO-E) population in the coming year.

Table 4.2.3 Poamoho (KLO-F) *A. byronii* Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2003-2004	8	384	321	84%	9	8	3
2004-2005	8	768	264	34%	18	8	6
2005-2006	8	384	248	65%	7	8	3

*This baiting grid also protects *A. lila* (KLO-B) and *A. sowerbyana* (KLO-C, FF, and GG).

Field observations show that *A. byronii* and *A. decipiens* are not morphologically distinct across any known geographical boundaries and there may only be one extant species represented by these populations. It appears the original distinction of these species by Pilsbury and Cooke was somewhat arbitrary, (Pilsbury and Cooke, 1912-1914) and Cooke considered *A. decipiens* to be a subspecies of *A. byronii* (Pilsbury and Cooke 1912-1914). Therefore, NRS are working with Dr. Mike Hadfield of the University of Hawaiʻi to resolve this issue using microsatellite genetic analyses. Genetic analysis results are expected soon and management will be adapted accordingly.

NRS attempted to relocate the SBE-A/C/D populations this year for genetic sampling but were unable to find any individuals (Table 4.2.2). NRS have been conducting more surveys on the eastern boundary of the Kawailoa Training Area (KLO) and Schofield Barracks East Range (SBE) in the Koʻolau Mountains. NRS have been finding a large number of *A. byronii* and other *Achatinella* species in this steep windward cliff habitat.

Map removed,
available upon request

Figure 4.2.1 ***Achatinella byronii*** **genetic sampling sites, 2006.**

Achatinella bulimoides

The recent rediscovery of *A. bulimoides* by NRS within and adjacent to the Kawailoa Action Area (AA) sparked a large survey and collection effort this year. NRS were able to collect 10 individuals for the captive propagation lab. NRS observed two additional individuals in the wild and anticipate that surveys will locate additional individuals. These individuals are located just outside the AA on the windward Koʻolau slopes. For the near future, management efforts will focus on surveys to determine the extent of remaining individuals. Once surveys are sufficient enough to determine the geographical extent of this population, a stabilization plan will be developed.

Achatinella concavospira

This species was not considered in either the MIP or OIP consultation because it was thought to be restricted to the southern portion of the Waiʻanae range and not within an Army AA. However, this year NRS found individuals at two sites within Schofield Barracks South Range (SBS) near the Puʻu Hāpapa summit (*A. mustelina* population reference codes SBS-B and SBS-D) which morphologically resemble *A. concavospira*. Morphologically, this species differs from *A. mustelina* by having a stouter appearance, larger aperture, and with the lowermost whorl being significantly wider. NRS plan to collect genetic samples when more *A. concavospira*-like individuals in the SBS area are encountered. NRS will also collect genetic samples from *A. concavospira* from other known sites for comparison (if needed by Dr. Hadfields genetics lab). If the SBS individuals are considered to be *A. concavospira*, NRS will develop a stabilization plan for this species with the help of field experts and the USFWS.

Figure 4.2.2 Location of possible *Achatinella concavospira* individuals within SBS.

Achatinella lila

Table 4.2.4 Taxon status for *A. lila*.

Population Unit	Population Reference code	OIP Population Numbers	Current Total Number of Individuals*	Manage for stability	Management Unit	Notes
Inside AA						
North of Poamoho Summit	**KLO-B**	**29**	**8/1/0**	**Manage for stability**	**Poamoho**	**Currently baiting**
North ʻŌpaeʻula	**KLO-E**	**3**	**32/8/2**	**Manage for stability**	**ʻŌpaeʻula**	**Not baiting, needs more survey**
ʻŌpaeʻula Summit	**KLO-C, D, F**	**6**	**10/2/1**	**Manage for stability**	**ʻŌpaeʻula to Helemano MU**	**Currently baiting**
	Total	**38**	**50/11/3**			

*total numbers of individuals are presented by size class (Large>15 mm/Medium 8-15mm/Small<8mm).

Genetic collections have been completed for the three currently known extant populations of *A. lila* (Table 4.2.4, Figure 4.2.3). NRS hope that genetic data will help direct the management of this species both *in situ* and *ex situ*.

Map removed, available upon request

Figure 4.2.3 *Achatinella lila* genetic sampling sites 2006.

The number of individuals *in situ* of this species is much higher than previously reported by NRS (US Army Garrison 2004) due to the discovery of a large group of individuals on the windward side of the summit to the north of ʻŌpaeʻula drainage. This population is by far the largest known for this species. NRS hope to fully survey and monitor this area in the coming year and determine if rat baiting is justified at this time.

NRS have been baiting at the ʻŌpaeʻula summit since 1999. Table 4.2.5 shows the rat control data for this area.

Table 4.2.5 ʻŌpaeʻula Summit (KLO-D, Summit) *A. lila* Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
1999-2000	4	88	18	20%	7	10	3
2000-2001	4	208	135	65%	0	10	4
2001-2002	4	400	159	40%	5	10	5
2002-2003	4	240	87	36%	9	10	4
2003-2004	4	320	255	80%	13	10	4
2004-2005	4	400	130	33%	17	10	5
2005-2006	4	400	171	43%	12	10	5

NRS also conduct rat control at the Poamoho summit (see table 4.2.3). This rat bait grid is restocked quarterly.

Achatinella livida

Table 4.2.6 Taxon Summary for *A. livida*

Population Unit	Population Reference code	OIP Population Numbers	Current Total Number of Individuals*	Management Designation	Management Unit	Notes
Inside AA						
Kawaiʻiki I (Crispa LZ)	**KLO-A**	**60**	**15/4/1**	**Manage for stability**	**Kawaiʻiki subunit I**	**Currently baiting**
Koloa (Northern LZ)	**KLO-B**	**10**	**0**	**Manage for stability**	**Koloa**	**Currently baiting**
Kawaiʻiki II (Radio LZ)	**KLO-C**	**77**	**40/21/16**	**Manage for stability**	**Kawaiʻiki subunit II**	**Currently baiting**
	Total	**147**	**55/25/17**			

*total numbers of individuals are presented by size class (Large>15 mm/Medium 8-15mm/Small<8mm).

This year no individuals were observed at the Koloa (Northern LZ; KLO-B) site. NRS have been conducting rat control at all the known *A. livida* sites. However, numbers have continued to decrease at Kawaiiki I (KLO-A) and Koloa (KLO-B). The last observation of live snails at the Koloa site in July 2004 was tied with the observation of three live *Euglandina rosea*. These *E. rosea* were killed but there were likely more in the area.

Rat baiting grids were established at the three remaining sites of *A. livida* in 2000 (Tables 4.2.7-4.2.9). Bait stations were increased from two to four in 2001 and then increased to six in 2002.

Six snaps were added to the grid in 2003 and increased to 12 in 2004. Bait take has remained relatively similar over the past four years at these three sites. However, in 2004-2005 NRS the number of rats snapped increased due to the increase number of site visits.

Table 4.2.7 Koloa (Northern LZ) *A. livida* Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2000	2	64	60	94%	0	0	3
2001	4	192	192	100%	0	0	5
2001-2002	4	368	357	97%	0	0	6
2002-2003	6	352	320	91%	10	6	4
2003-2004	6	384	312	81%	10	12	4
2004-2005	6	672	343	51%	34	12	7
2005-2006	6	384	201	52%	12	12	4

Table 4.2.8 Kawaiʻiki II (Radio LZ) *A. livida* Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2000	2	96	32	33%	0	0	3
2001	4	144	128	89%	0	0	5
2001-2002	4	320	314	98%	0	0	5
2002-2003	6	286	284	99%	1	6	4
2003-2004	6	380	313	82%	9	12	4
2004-2005	6	669	208	31%	29	12	7
2005-2006	6	288	241	84%	11	12	3

Table 4.2.9 Kawaiʻiki I (Crispa LZ) *A. livida* Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2000	2	96	72	75%	0	0	3
2001	4	204	148	73%	0	0	5
2001-2002	4	320	291	91%	0	0	5
2002-2003	6	256	256	100%	6	6	4
2003-2004	6	352	287	82%	13	12	4
2004-2005	6	636	248	39%	34	12	7
2005-2006	6	288	250	87%	14	12	3

NRS searched the Bishop Museum (BISH) *Achatinella* shell collections for examples of *A. livida* and found that the paratypes collected from the currently known *A. livida* sites more closely resemble collections labeled as *A. sowerbyana* from this location. The paratypes of *A. livida* from the area are much less white and instead have more gray coloration. The banding patterns are not as distinctive in the *A. livida* collections as the *A. sowerbyana* collections, whereas, extant snails from the northern "livida" populations have distinct banding patterns. However, NRS recognize that a morphological assessment may never provide conclusive population or species distinctions. NRS anticipate that new genetic analyses will provide guidance on the management of this species.

4.2.4 A comparison of BISH collections of *A. sowerbyana* and *A. livida*.

4.2.5 An individual from a current *A. livida* site.

To see color versions of photos see http://www.botany.hawaii.edu/faculty/duffy/DPW.htm

Map removed, available upon request

Figure 4.2.6 *Achatinella livida* genetic sample sites 2006.

Achatinella sowerbyana

Table 4.2.10 Taxon summary for *Achatinella sowerbyana*

Population Unit	Army Population reference code	OIP Numbers of Individuals	Total Number of Individuals*	Management Designation	Management Unit
Inside AA					
Poamoho Pond	**KLO-A**	**90**	**25/6/4**	**Manage for stability**	**Poamoho Pond**
Poamoho summit	**KLO-C, FF, GG**	**165**	**68/8/9**	**Manage for stability**	**Poamoho summit**
ʻŌpaeʻula to Helemano	**KLO-D-O,U, X, Y, Z, BB-EE, HH-II**	**96-150**	**107/23/7**	**Manage for stability**	**Opaeula to Helemano**
Kawaiʻiki	**KLO-K,P, Q, R**	**38**	**43/1**	**Manage for stability**	
Lower Peʻahināʻia	**KLO-S, T, V, W**	**31**	**28/1/2**	**Manage for stability**	**Lower Peahinaia**
Poamoho Kaukonahua Ridge	**KLO-AA**	**2**	**2**		
	Total	**423-477**	**273/39/23**		

*total numbers of individuals are presented by size class (Large>15 mm/Medium 8-15mm/Small<8mm).

The number of individuals for this species reported in 2005 in the OIP are higher than observations reported this year. This is due to a large drop in individuals seen at Poamoho Pond (KLO-A) and the Poamoho summit (KLO-C, FF, GG).

A. sowerbyana is considered to be the most common *Achatinella* species in the Koʻolau Mountains. This species shows a lot of morphological variation among populations. However, there are areas that have individuals of several morphological types represented. Tissue samples were collected from some of these populations and NRS expect that genetic analyses will aid in the management of these populations (Table 4.2.10).

Map removed,
available upon request

Figure 4.2.7 *Achatinella sowerbyana* genetic sampling sites 2006.

There are several sites within KLOA that NRS are currently baiting for rats and monitoring regularly. The summit of Poamoho (KLO-C) is currently baited for rats and restocked quarterly

(Table 4.2.3). In addition to the Poamoho summit, three other sites known to house populations of *A. sowerbyana* are controlled for rats (Tables 4.2.11, 4.2.12, 4.13). High snail counts from past surveys justified the need for rat control in the most recent rat bait grid (Table 4.10). Bait take was high at this site over this year, since it's creation on 3/20/06. Three fourths of the bait put out was consumed.

Table 4.2.11 ʻŌpaeʻula to Helemano (KLO-L, 290) *A. sowerbyana* Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2002	6	96	33	34%	0	0	2
2002-2003	6	480	175	36%	9	6	5
2003-2004	6	384	182	47%	3	12	4
2004-2005	6	576	133	23%	30	12	6
2005-2006	6	552	177	32%	22	12	6

Table 4.2.12 ʻŌpaeʻula to Helemano (KLO-M, Shaka) *A. sowerbyana* Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2002	6	96	59	61%	0	0	3
2002-2003	6	288	137	48%	4	6	5
2003-2004	6	384	246	64%	2	6	4
2004-2005	6	576	118	20%	32	12	6
2005-2006	6	480	216	45%	9	12	5

Table 4.2.13 ʻŌpaeʻula to Helemano (KLO-J, Hypalon) *A. sowerbyana* Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2005-2006	6	288	216	75%	7	6	4

Chapter 5.1: MIP ‘Elepaio Management

The initial Biological Opinion (BO) that triggered the development of the Mākua Implementation Plan (MIP) was issued in 1999. At that time, the O‘ahu ‘Elepaio (*Chasiempis sandwichensis ibidis*) was not listed as an endangered species. The 1999 BO included recommendations related to ‘Elepaio. These included conducting complete surveys of the Mākua Action Area (AA) for ‘Elepaio presence, monitoring of all known ‘Elepaio within Mākua Military Reservation (MMR) and installing and maintaining predator control grids around nesting pairs within MMR. In 2000, the U.S. Fish and Wildlife Service (USFWS) granted the O‘ahu ‘Elepaio endangered species status under the federal Endangered Species Act and in 2001 designated critical habitat on O‘ahu for the ‘Elepaio. In the *Supplement to the Biological Opinion and Conference Opinion for Proposed Critical Habitat for Routine Military Training at Mākua Military Reservation* issued in 2001, the recommendations from the 1999 BO became requirements. More recently in September 2004, the USFWS issued another BO that covered newly designated critical habitat within the Mākua AA for plants and ‘Elepaio. This BO outlined additional requirements related to this critical habitat. The sections below outline the status of the required actions from MMR Section 7 Consultations since 1999.

Current Status of ‘Elepaio in Mākua Action Area

Surveys & Monitoring

Extensive surveys for ‘Elepaio have been conducted in the Mākua AA within MMR. Currently at MMR, ‘Elepaio are known from the Kahanahāiki and ‘Ōhikilolo MUs, as well as from the East Rim Ungulate Control Area (UCA) (Figure 5.1.1). A total of 15 ‘Elepaio were known from within MMR, but going on current resight data from the past three years, only four birds are known (3 males and 1 female). Of these birds, no breeding pairs are known to exist. Seven of the 15 known birds within MMR have been captured and banded (Table 5.1.1). Areas outside MMR, but within the Mākua AA, that have had ‘Elepaio in the past included the Mokulē‘ia Forest Reserve (Kuaokalā) and the Pahole Natural Area Reserve. Surveys for ‘Elepaio in these two areas by NRS and State Biologists in 2004 resulted in no detections. Mākaha Valley is currently the only location outside of MMR, but within the Mākua AA, where ‘Elepaio are still found in large numbers. At the start of the 2006 breeding season, 44 individual birds including 10 pairs were known from the Mākua AA in Mākaha Valley (Figure 5.1.2). This represents a substantial increase in the number of ‘Elepaio known in the Mākua AA. The estimated number of pairs as stated in the 1999 BO was six. Currently there are 10 pairs known from the Mākua AA, all residing in Mākaha Valley.

<u>Kahanahāiki MU</u>
NRS have only known of four adult ‘Elepaio within the Kahanahāiki MU and one just outside the MU boundary. In 1996, three males and one female were banded (Table 5.1.1). Since that time, two of the banded males (ARRB and BGAW) have not been detected since prior to 2002 and these birds are thought to be dead. Of the remaining birds, no pairs are currently known. A breeding pair had existed at territory MMR-01 in Kahanahāiki Gulch, female BABW and male GBAR, for several years until the 2004 breeding season (Fig. 5.1.1). During the 2005 breeding season, only one bird was heard in response to tape playbacks. The solitary bird was visually

confirmed as the female BABW on 28 September 2005. With this visual confirmation of the female, it is presumed that male GBAR is dead, since the last sighting of this bird was during the 2004 breeding season (Table 5.1.1). The female BABW has remained solitarily in MMR-01 during the 2005 and 2006 breeding seasons. Monitoring of the pair during the breeding season had been on going since 1996. Breeding data for pair MMR-01 is presented in Table 5.1.2. The fates of the pair’s offspring are unknown. No recruitment into Kahanahāiki Gulch by the pair’s offspring has been observed over the years.

Table 5.1.1 ‘Elepaio Banding Data, Mākua Military Reservation

Bird[1]	Date Banded	Territory	Last Observed	Last Monitored	Disease[2]	Mate Observed[3]	Sex
ARRB	03/04/96	MM-012	03/04/01	02/07/02	Y	N	M
GBAR	03/04/96	MMR-01	05/26/04	05/23/06	Y	Y	M
BABW	03/04/96	MMR-01	09/28/05	05/23/06	Y	N	F
BGAW	03/04/96	MM-009	12/09/99	03/18/02	Y	N	M
ARGB	12/03/02	MMR-02	01/24/04	08/03/06	Y	Y	M
ABBB	12/11/01	MMR-03	08/03/06	08/03/06	N	N	M
AGWR	05/05/04	MMR-03	05/05/04	08/03/06	Y	Y	F

[1] = Band combination: A=Aluminum, R=Red, B=Blue, G=Green and W=White color bands.
[2] = Presence of disease when banded (Yes or No)
[3] = Presence of a mate when last observed (Yes or No)

Table 5.1.2 Kahanahāiki MU ‘Elepaio Pair (MMR-01) Breeding Data

Breeding Season	# of Nests Observed	# of Successful Nests Observed	Family Groups Observed[1]	# of Fledglings Observed
1996	1	0	0	0
1997	1	0	0	0
1998	0	0	1	1
1999	0	0	0	0
2000	0	0	0	0
2001	1	1	0	1
2002	1	1	0	2
2003	2	1	0	1
2004	2	1	0	1
2005	0	0	0	0
Total	8	4	1	6

[1] = Family Group is defined as when one or both adult birds of a pair are observed with a fledgling(s) when no nest was observed in the territory prior.

‘Ōhikilolo MU

As of 2004, five ‘Elepaio were known from the ‘Ōhikilolo MU. Of these birds, there were three single males and one pair. Two of the three single males were last sighted in 2000 and the third male was sighted in 2004. Of the one known breeding pair (MMR-02), the male was banded (ARGB) in 2002 and last resighted in January 2004 (Table 5.1.1). Access to this known pair in the ‘Ōhikilolo MU was not granted to NRS during the 2005 breeding season, due to safety concerns of hiking through the Improved Conventional Munitions (ICM) area. Access was granted for the 2006 breeding season after realignment of the ICM area (see Fig. 5.1.1). During visits to MMR-02 in January no birds were detected and in August an unbanded adult male was observed in the territory. With this sighting of an unbanded male occupying the pair’s former territory it is presumed that one or both of the pair is now dead. No breeding success was ever observed for this pair. Additional surveys will be conducted in this MU during the 2007 breeding season.

East Rim Ungulate Control Area (UCA)
As of 2004, five ‘Elepaio are known from the East Rim Ungulate Control Area. These five birds consist of three single males and one pair (MMR-03). The three single males were last resighted in 2001, while the pair was last observed during the 2004 breeding season. The male of MMR-03 was banded (ABBB) in 2001 and the female was banded (AGWR) in 2004. The female had active avian pox lesions when captured. Access to this pair was not granted during the 2005 breeding season, since access to this area is through the ‘Ōhikilolo MU. Access was granted for the 2006 breeding season. During territory visits in January and August, only the male (ABBB) was observed in MMR-02 with no sign of the female AGWR. It is presumed that the female AGWR is dead. No breeding success was ever observed for this pair. Additional surveys will be conducted in the UCA during the 2007 breeding season to identify remaining birds.

Kaluakauila MU
Two single male ‘Elepaio were originally known from Kaluakauila in the mid 1990’s, but have not been detected since prior to 2002.

Map removed,
available upon request

Figure 5.1.1 ‘Elepaio Distribution in Mākua Military Reservation (MMR)

Mākaha Valley

In 2005, NRS conducted extensive ‘Elepaio surveys on the north side of Mākaha Valley within the Mākua AA. A total of 44 birds were located during nine surveys conducted from January through August (Figure 5.1.2). Twenty single males, 10 pairs, and four juvenile (hatch year) birds were located during the surveys. NRS did not conduct any additional surveys during the 2006 breeding season, but continued to monitor known pairs. An additional pair was located in the Mākua AA during ‘Elepaio management in 2006. NRS will re-survey for ‘Elepaio in Mākaha Valley just prior to and during the 2007 breeding season.

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available upon request

Figure 5.1.2 ‘Elepaio Distribution in Mākaha Valley

Management Actions

‘Ōhikilolo MU & East Rim Ungulate Control Area (UCA)

In 2001, NRS initiated predator control efforts for the pair known at the time within the ‘Ōhikilolo MU. Predator control was initiated in 2002 for the known pair located in the UCA. The two pairs located within the ‘Ōhikilolo MU and the UCA were approximately 400 meters apart in the back of Mākua Valley. Four monitoring trips were conducted each in 2001 and 2002, three trips in 2003, five trips in 2004, no trips in 2005, and two trips in 2006. Predator control efforts during the ‘Elepaio breeding season from 2001 through 2006 are presented in Table 5.1.3. Bait stations were stocked and snap traps set in both territories in January 2006, but no pairs were detected over two days of territory monitoring. Since no pairs were detected during two site visits over two consecutive days at the start of the breeding season, rat control was not continued through the rest of the breeding season.

Table 5.1.3 ‘Ōhikilolo MU & East Rim Ungulate Control Area (UCA) Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2001[A]	6	600	265	44%	18	18	4
2002	12	1382	850	62%	22	27	4
2003	12	754	329	44%	13	24	4
2004	12	1380	711	52%	19	24	5
2005[B]	-----	-----	-----	-----	-----	-----	-----
2006	12	192	166	86%	10	24	2

[A] = Only UCA pair baited in 2001.
[B] = No predator control or monitoring visits took place during the 2005 breeding season.

Kahanahāiki MU

NRS had conducted predator control around breeding pair GBAR and BABW from 1996 until the 2006 breeding season. This pair had successfully fledged young over the years. Rat control data from 1998 through the 2005 breeding are presented in Table 5.1.4. NRS conducted weekly to bi-monthly maintenance of up to 12 rodent bait stations, 14 snap traps, and four Tomahawk® live traps over the years. A total of 132 rats have been snap trapped, and 25 mongoose and eight feral cats live trapped within the pair’s breeding territory since 1998. Predator control was not conducted during the 2006 breeding season, since only the female is remaining in the territory.

Table 5.1.4 Kahanahāiki MU Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
1998	5	NA	NA	NA	12	12	14
1999	5	NA	NA	NA	14	12	19
2000	12	736	310	42%	13	12	15
2001	12	1152	503	44%	15	12	14
2002	12	2834	1048	37%	37	12	16
2003	12	2225	587	26%	13	12	15
2004	12	1636	1127	69%	18	12	16
2005	10	932	406	44%	10	14	9

Mākaha Valley

During the 2005 breeding season, NRS assisted the Honolulu Board of Water Supply (BWS) with rat control and monitoring for three pairs of ‘Elepaio on the south side of the valley (Mākaha MU) and five pairs on the north side (Mākua AA). Rat control efforts for the 2006 breeding season consisted of 10 pairs within the Mākua AA of Mākaha Valley and four pairs within the Mākaha MU. Rat control was conducted in all 14 known pairs in Mākaha Valley to meet O‘ahu Implementation Plan (OIP) requirements. The results of predator control efforts can be found in the ‘Elepaio section of the 2006 OIP Status Update.

Chapter 5.2 OIP ‘Elepaio Management

The initial Biological Opinion (BO) that triggered the development of the O‘ahu Implementation Plan (OIP) was issued on 23 October 2003. In 2000, the U.S. Fish and Wildlife Service (USFWS) granted the O‘ahu ‘Elepaio (*Chasiempis sandwichensis ibidis*) endangered species status under the federal Endangered Species Act and designated critical habitat on O‘ahu for the ‘Elepaio in 2001. The 2003 BO requires the Army to manage 75 ‘Elepaio pairs through the control of alien rats during the breeding season at Schofield Barracks Military Reservation (SBMR). The BO presents three alternative methods for the management of 75 pairs at SBMR. Any or all of the following alternative methods can be followed in order to achieve the desired 75 pairs: 1) increase access for NRS at SBMR to a minimum of 45 days per year for the deployment and maintenance of rat bait stations in a larger number of ‘Elepaio pair territories than currently being managed; 2) the construction of three fenced exclosures consisting of 40 ha each to facilitate ungulate control, as well as rat bait stations and/or when registration is approved, broadcast of diphacinone to control rats; and 3) if three such exclosures cannot be constructed at SBMR, then the Army will manage the remaining number (75 less the number managed at SBMR) of ‘Elepaio pair territories at an appropriate off-site location agreed upon by NRS and USFWS biologists. NRS is currently pursuing management of ‘Elepaio on site at SBMR (~ 15 pairs) and offsite at three to four locations (~ 60 pairs).

In 2006, predator control was implemented during the breeding season in 82 ‘Elepaio territories at four locations (SBMR, Honouliuli Forest Reserve, Mākaha Valley, Moanalua Valley). NRS conducted rat control and monitoring of birds at SBMR and three territories in Moanalua Valley, while Pono Pacific was contracted to conduct rat control and monitoring of birds at Honouliuli Forest Reserve, Mākaha Valley, and Moanalua Valley. ‘Elepaio territories can be very dynamic from breeding season to breeding season or even through a breeding season. Status of territories can change from pairs to single birds; single birds to pairs; single birds to no birds; pairs to no birds; as well as new territories found with either a single bird or a pair in the course of monitoring. During the 2006 breeding season, rat control was initiated in territories in which pairs were observed during the 2005 breeding season and in territories observed to have pairs just prior to the start of the 2006 breeding season. With these dynamic changes in territory status, the number of pairs actually protected during the 2006 breeding season was 69 pairs. Table 5.2.1 summarizes the monitoring data collected during the 2006 breeding season and includes the anticipated number of pairs to be protected during the 2007 breeding season. Twenty-eight pairs successfully fledged at least 34 young in 2006.

Table 5.2.1. Summary of ‘Elepaio Monitoring and Protection in 2006

Area Managed	# of Territories Protected During the Season	# of Pairs Protected During the Season	# of Pairs Observed with Breeding Activity	# of Active Nests Found[1]	# of Active Nests with Confirmed Fledging Success[2]	# of Family Groups Found[3]	Total Number of Fledglings[4]	Anticipated # of Pairs to be Protected in 2007
SBMR	17	14	7	3	0	3(3)	3	13
Honouliuli	25	20	17	10	3(3)	6(6)	9	20
Mākaha	14	13	5	6	4(5)	1(2)	7	13
Moanalua	26	22	17	11	4(4)	9(11)	15	25
Waikane[5]	--	--	--	--	--	--	--	5
Totals	82	69	46	30	11(12)	19(22)	34	76

1 = Number of active nests found may include more than one nesting attempt in a given territory. An “active nest” is defined as a nest containing eggs or nestlings.
2 = Number of active nests with confirmed fledging success (number of fledglings)
3 = Family Group is defined as when one or both adults birds of a pair are observed with a fledgling(s) when no nest was observed in the territory prior (number of fledglings)
4 = Total number of fledglings observed calculated by summing the number of confirmed fledgling from monitored nests and the number of fledglings observed in family groups.
5 = Waikane Valley maybe included in the areas of ‘Elepaio management in 2007, if logistically feasible.

O‘ahu Training Areas

Schofield Barracks Military Reservation (SBMR)

The third largest population of ‘Elepaio on O‘ahu is located at SBMR. It consists of approximately 340 birds, comprising roughly 155 breeding pairs (VanderWerf et al. 2001). To date, NRS and Dr. VanderWerf have banded 65 birds over a ten year period in SBMR (Table 5.2.2). NRS has been monitoring these birds as frequently as access allows. The number of access days in recent years has increased (2001, 9; 2002, 11; 2003, 9; 2004, 9; 2005, 21, 2006, 12). Continual efforts are made each year to increase access into the range during each breeding season. Of the 65 banded birds, 36 of them have not been observed since prior to 2003. Banding has been conducted in five gulches in SBMR (S. Mohiākea, N. Mohiākea, Hale‘au‘au, Baby Water, W. Pule‘e), since 1996. In 2006, NRS monitored 23 territories of which 14 territories contained pairs (Figure 5.2.1).

Table 5.2.2. ‘Elepaio Banding Data, Schofield Barracks Military Reservation (SBMR)

Bird[1]	Date Banded	Territory	Last Observed	Last Monitored	Disease[2]	Mate Observed[3]	Range or Gulch	Sex
RGAR	03/06/97	NA	01/15/02	01/15/02	Y	N	SBS	M
BGAG	03/06/97	NA	08/06/98	01/15/02	Y	N	SBS	M
BGAB	08/30/96	HL-007	12/14/96	01/09/06	Y	N	Hale‘au‘au	M
RGGA	08/30/96	HAL-01	03/29/02	03/29/02	Y	N	Hale‘au‘au	M
RBAB	08/30/96	HAL-06	08/30/96	06/26/06	Y	Y	Hale‘au‘au	F
BGAR	08/30/96	HAL-06	02/13/03	06/26/06	N	N	Hale‘au‘au	M
ABGR	09/02/96	NA	12/22/00	03/29/02	Y	N	Hale‘au‘au	M
ABGG	09/02/96	NA	02/27/00	03/29/02	Y	Y	Hale‘au‘au	F
ABWB	09/02/96	NA	11/29/96	02/27/00	Y	N	Hale‘au‘au	M
RBBA	09/02/96	NA	09/02/96	02/27/00	Y	N	Hale‘au‘au	M
BAWG	09/02/96	NA	04/03/99	04/03/99	Y	N	Hale‘au‘au	M

Bird[1]	Date Banded	Territory	Last Observed	Last Monitored	Disease[2]	Mate Observed[3]	Range or Gulch	Sex
WGBA	09/02/96	HAL-07	09/02/96	06/26/06	Y	N	Hale‘au‘au	F
GBBA	02/14/97	HAL-05	02/18/02	06/26/06	Y	N	Hale‘au‘au	M
RABW	03/20/97	NA	05/23/97	04/03/99	N	N	Hale‘au‘au	M
ARRG	06/13/97	HAL-08	05/05/04	06/26/06	Y	N	Hale‘au‘au	M
WBAR	09/03/99	NA	08/29/02	08/29/02	N	Y	Hale‘au‘au	M
WWRA	05/02/04	HAL-08	06/26/06	06/26/06	N	N	Hale‘au‘au	M
WARG	05/02/04	HAL-07	06/26/06	06/26/06	Y	Y	Hale‘au‘au	F
BBAR	05/02/04	HAL-07	05/02/04	06/26/06	N	Y	Hale‘au‘au	M
BBAG	05/02/04	HAL-04	04/17/06	06/26/06	Y	Y	Hale‘au‘au	M
GGAG	02/23/05	HL-034	02/23/05	12/22/05	N	N	Hale‘au‘au	M
GWAW	02/23/05	HAL-03	03/30/05	06/26/06	N	Y	Hale‘au‘au	F
AWGR	02/23/05	HAL-06	04/17/05	06/26/06	N	Y	Hale‘au‘au	F
KARK	09/27/05	HL-007	01/09/06	01/09/06	Y	N	Hale‘au‘au	M
AMMG	09/27/05	HAL-03	04/17/06	06/26/06	N	N	Hale‘au‘au	M
BGWA	01/25/05	BAW-01	06/26/06	06/26/06	Y	N	Baby Water	M
AWGR	01/25/05	BAW-01	05/18/05	06/26/06	N	Y	Baby Water	F
RGAW	02/16/96	NA	02/14/96	02/14/96	N	N	N. Mohiākea	M
WGWA	02/16/96	BAN-08	02/18/01	07/13/01	N	Y	N. Mohiākea	F
AGBW	02/16/96	BAN-08	05/15/99	07/13/01	N	Y	N. Mohiākea	M
WRAG	02/16/96	NA	02/14/96	02/14/96	N	Y	N. Mohiākea	M
BRAW	02/16/96	BAN-08	02/18/01	07/13/01	N	N	N. Mohiākea	M
BWAB	08/31/96	NA	08/31/96	08/31/96	Y	N	N. Mohiākea	M
BGBA	09/29/96	BAN-05	06/16/03	03/08/05	Y	N	N. Mohiākea	M
WBRA	09/29/96	BAN-07	04/28/98	05/15/99	Y	N	N. Mohiākea	M
GWRA	09/29/96	BAN-07	09/29/96	05/15/99	Y	N	N. Mohiākea	M
GRBA	09/29/96	BAN-06	08/28/02	08/28/02	Y	N	N. Mohiākea	M
WGAR	11/20/98	BAN-01	02/26/00	06/26/06	N	Y	N. Mohiākea	M
RWBA	11/20/98	BAN-02	02/26/00	06/26/06	N	Y	N. Mohiākea	M
GAWW	11/20/98	BAN-01	07/13/01	06/26/06	N	Y	N. Mohiākea	F
BWGA	11/20/98	BAN-02	07/13/01	06/26/06	Y	N	N. Mohiākea	M
BABB	11/20/98	BAN-04	12/29/98	04/17/06	Y	N	N. Mohiākea	M
AGGW	08/28/02	BAN-02	06/13/05	06/26/06	N	Y	N. Mohiākea	M
WARW	08/29/02	BAN-04	06/22/04	04/17/06	N	Y	N. Mohiākea	M
GABG	08/29/02	BAN-04	02/15/03	04/17/06	N	Y	N. Mohiākea	F
WRAR	08/29/02	BAN-05	08/29/02	03/08/05	N	N	N. Mohiākea	M
WWBA	01/24/05	BAN-03	01/31/06	03/28/06	N	N	N. Mohiākea	M
AWWB	01/24/05	BAN-04	01/24/05	04/17/06	N	Y	N. Mohiākea	M
RRAR	01/25/05	BAN-05	01/25/05	03/08/05	N	N	N Mohiākea	M
ABGB	06/15/97	MH-035	01/20/05	01/20/05	Y	N	S. Mohiākea	M
WRGA	06/15/97	MOH-03	01/26/05	06/27/06	Y	N	S. Mohiākea	M
GAGB	06/15/97	MOH-08	01/30/06	06/27/06	N	Y	S. Mohiākea	M
GBAB	06/15/97	MOH-04	03/01/06	06/27/06	Y	N	S. Mohiākea	M
AWRR	01/17/00	NA	02/17/00	02/17/00	N	N	S. Mohiākea	M
WWAB	01/17/00	NA	03/27/02	03/27/02	Y	N	S. Mohiākea	M
RARG	01/17/00	MOH-02	12/29/05	06/27/06	Y	Y	S. Mohiākea	M
RABB	01/17/00	MOH-02	03/27/02	03/27/02	N	N	S. Mohiākea	F
BWWA	01/17/00	MOH-07	06/27/06	06/27/06	Y	N	S. Mohiākea	M
GRAR	01/17/00	MH-036	06/14/05	06/14/05	Y	N	S. Mohiākea	M
WRAB	01/17/00	MOH-09	05/18/03	05/18/03	N	N	S. Mohiākea	F
GARW	01/20/05	MOH-06	06/27/06	06/27/06	N	Y	S. Mohiākea	M

Bird[1]	Date Banded	Territory	Last Observed	Last Monitored	Disease[2]	Mate Observed[3]	Range or Gulch	Sex
ABRB	09/01/96	GUA-01	02/21/00	02/21/00	Y	N	W. Pule‘e	M
BRAB	09/01/96	GUA-02	09/01/96	02/21/00	Y	N	W. Pule‘e	M
ARGW	09/01/96	COF-01	01/10/01	01/10/01	Y	Y	W. Pule‘e	M
AWGW	01/14/00	LM-001	01/14/00	01/14/00	Y	N	W. Pule‘e	M

1 = Band combination colors: A=Aluminum, R=Red, B=Blue, G=Green, W=White, M=Mauve, and K = Black.
2 = Presence of disease when banded: (Y)es or (N)o
3 = Presence of a mate when last observed: (Y)es or (N)o

Breeding Behavior

Of the 14 pairs being monitored in SBMR, only 7 were observed to have breeding activity occurring during NRS site visits. A total of 6 nests were observed in various stages (building stage - 3, incubation stage - 1, nestling stage – 2). Nests were located in two introduced tree species (*Psidium cattleianum* - 3, *Schinus terebinthifolius* - 3). The three nests found during the building stage, subsequently had no activity at the nest during the next site visit. The nest found in the incubation stage had an undetermined out come, since upon the next site visit (~6 weeks) there was no activity at the nest and no sign of any fledglings in the territory. Of the two nests found in the nestling stage, one failed to an unknown cause and the other had an undetermined outcome. However three family groups (no prior nest found) were observed with one fledgling each. Three of 14 pairs (21%) were successful in fledgling young (3 fledglings, 0.2 fledglings per total number of pairs monitored in SBMR). The seven pairs for which breeding activity was not observed, most likely attempted nesting, but were not detected by NRS due to timing of site visits or failure in nesting attempts. In 2006, 14 pairs were observed through the breeding season, which was one fewer then in 2005 (Table 5.2.3).

Table 5.2.3. Schofield Barracks Military Reserve (SBMR) ‘Elepaio Breeding Data

Year	# of Territories Protected During the Season	# of Pairs Protected During the Season	# of Pairs Observed with Breeding Activity	# of Active Nests Found[1]	# of Active Nests with Confirmed Fledging Success[2]	# of Family Groups Found[3]	Pair Success[4]	Total Number of Fledglings[5]
2005	17	15	10	7	3(4)	2(2)	5	6
2006	17	14	6	3	0	3(3)	3	3

1 = Number of active nests found may include more than one nesting attempt in a given territory. An “active nest” is defined as a nest containing eggs or nestlings.
2 = Number of active nests with confirmed fledging success (number of fledglings)
3 = Family Group is defined as when one or both adults birds of a pair are observed with a fledgling(s) when no nest was observed in the territory prior (number of fledglings)
4 = Number of pairs that successfully fledged at least one young.
5 = Total number of fledglings observed calculated by summing the number of confirmed fledgling from monitored nests and the number of fledglings observed in family groups.

Map removed,
available upon request

Figure 5.2.1 ‘Elepaio Distribution on Schofield Barracks Military Reservation (SBMR)

Rodent Control

NRS initiated rat control for the 2006 breeding season from 22 December 2005 to 27 June 2006. Sixty-eight Protecta® rodent bait stations and 136 Victor® rat traps were installed in 17 ‘Elepaio territories in four gulches (Hale‘au‘au, N. Mohiākea S. Mohiākea, Baby Water) (Figure 5.2.1). Baiting grids within territories were focused around the core areas of each breeding pair. Depending on the terrain and size of a pair’s territory three to five bait stations were deployed, covering approximately 0.42 to 0.57 ha respectively. Two snap traps per bait station were deployed in each territory being protected. A total of 2,782 blocks (79kg) of molasses/peanut-butter flavored Ramik® Mini Bars (.005% diphacinone) were taken from bait stations. The amount of bait taken versus the amount of bait available was 49%. A total of 212 rats were caught in snap traps with an average of 40 rats per monitoring trip (5.3 monitoring trips). In 2005 and 2006, the number of rats caught in snap traps increased noticeably from the previous years do in part to increased number of snap traps and increased number of site visits during the breeding season (Table 5.2.3). Over the past five years bait take has averaged 50% within the four gulches. Territories will continue to be added for protection as pairs are found.

Table 5.2.3 Schofield Barracks Military Reserve (SBMR) Rat Control Data

Year	# of Territories[1]	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Snap Traps	# of Rats Trapped	# of Site Visits[2]
2001	NA	45	2520	1490	59%	60	22	2.3
2002	13	50	5263	3156	60%	88	71	3.7
2003	15	60	6096	2768	45%	120	115	4.0
2004	17	64	3887	2715	70%	120	97	2.7
2005	17	86	6763	1890	28%	164	210	5.7
2006	17	72	5635	2782	49%	136	212	5.3

1 = Number of ‘Elepaio territories being protected
2 = Average number of site visits (not all gulches are visited on the same day)

2007 Breeding Season

NRS will continue to 1) strive for increased access to SBMR during the breeding season, 2) increase the known number of pairs by conducting additional surveys, 3) band males and females to assess survival, and 4) conduct predator control within breeding pair territories. The anticipated number of pairs to be protected during the upcoming breeding season is 13 pairs.

Offsite ‘Elepaio Areas

Currently there are five offsite locations (Mākaha Valley, ‘Ēkahanui area of Honouliuli Forest Preserve, Moanalua Valley, North Halawa Valley, Waikāne/Kahana Valley) in which NRS either monitors ‘Elepaio and conducts predator control or only monitors ‘Elepaio. During the 2006 breeding season, Pono Pacific was contracted to conduct monitoring and predator control in Mākaha Valley, ‘Ēkahanui, and Moanalua Valley. Surveying and monitoring were conducted by NRS during two site visits to Waikāne/Kahana Valley in 2006. Last year’s status update mentioned North Halawa Valley as a potential location to manage ‘Elepaio for the 2006 breeding season, but after further inquiries with the landowner, this area is currently not an option, since ownership is in potential transition and at this time.

<u>Mākaha Valley – Honolulu Board of Water Supply</u>

For the past two breeding seasons the NRS has assisted Board of Water Supply (BWS) with monitoring and managing ‘Elepaio pairs in Mākaha Valley, through direct NRS assistance during the 2005 breeding season and the contracting of Pono Pacific during the 2006 breeding season to conduct predator control and monitoring.

The sixth largest population of ‘Elepaio on O‘ahu is located in Mākaha Valley. The population is estimated at 123 birds, comprising roughly 56 breeding pairs (VanderWerf et al. 2001). NRS and Dr. VanderWerf have banded 9 birds since 1999 (Table 5.2.4). Seven of the nine banded birds were observed in 2006. Extensive surveys were conducted in the first half of 2005 bringing the known number of birds to 62 individuals and including 13 pairs at that time. At the start of the 2006 breeding season 13 ‘Elepaio pairs were monitored and an additional pair was located in April 2006 (Figure 5.2.2).

Table5.2.4 ‘Elepaio Banding Data, Mākaha Valley

Bird[1]	Date Banded	Territory	Last Observed	Last Monitored	Disease[2]	Mate Observed[3]	Sex
RWAB	01/28/99	MAK-08	06/28/05	05/29/06	N	Y	M
ARGB	12/19/03	MK-011	01/11/05	01/11/05	N	N	M
ARWW	12/19/03	MAK-01	06/13/06	06/22/06	N	Y	M
AWRB	12/19/03	MAK-03	04/27/06	06/13/06	Y	N	M
BARW	11/10/04	MAK-02	05/25/06	06/09/06	N	Y	M
RABM	04/06/05	MK-033	04/13/06	04/13/06	N	N	M
ARWK	01/10/06	MAK-06	01/10/06	06/22/06	N	Y	F
GBAW	01/10/06	MAK-05	04/13/06	06/22/06	N	N	M
ARMB	01/10/06	MAK-07	04/13/06	06/22/06	Y	Y	M

[1] = Band combination colors: A=Aluminum, R=Red, B=Blue, G=Green, W=White, M=Mauve, and K=Black.
[2] = Presence of disease when banded: (Y)es or (N)o
[3] = Presence of a mate when last observed: (Y)es or (N)o

Figure 5.2.2 ‘Elepaio Distribution in Mākaha Valley

Map removed,
available upon request

Breeding Behavior

Of the 14 territories monitored during the breeding season, 13 were confirmed as being pairs. Five of the 13 pairs were observed to have breeding activity occurring during site visits (Table 5.2.5). A total of eight nests were found from six pairs at different stages (building stage – 3, incubation stage – 3, nestling stage – 1, Inactive – 1). Nests were located within three tree species (*Psidium* sp. – 4, *Aleutrites moluccana* – 1, Syzygium jambos – 1, Not Identified – 2). Two of the three nests initially found in the building stage fledged a total of three young, but it is unclear what the fate of the third nest was, since the adult female’s wings were found on the ground below the nest on the following site visit. The one nest found in the incubation stage failed possibly to high winds that occurred between site visits, since the nest was found on the ground. Of the two other nests found during the incubation period, one fledged one nestling and the other failed due to unknown causes. The one nest found during the nestling period fledged one nestling. One nest was found inactive, but later a family group with one fledgling was observed in the territory. Four of the 13 pairs (31%) were successful in fledgling young (7 fledglings, 0.54 fledglings per total number of pairs monitored). The eight pairs for which breeding activity was not observed, most likely attempted nesting, but were not detected by due to timing of site visits or failure in nesting attempts.

Table 5.2.5 Mākaha Valley ‘Elepaio Breeding Data

Year	# of Territories Protected During the Season	# of Pairs Protected During the Season	# of Pairs Observed with Breeding Activity	# of Active Nests Found[1]	# of Active Nests with Confirmed Fledging Success[2]	# of Family Groups Found[3]	# of Pair Success[4]	Total Number of Fledglings
2005	8	8	6	2	0	2(2)	2	2
2006	14	13	5	6	4(5)	1(2)	4	7

1 = Number of active nests found may include more than one nesting attempt in a given territory. An “active nest” is defined as a nest containing eggs or nestlings.
2 = Number of active nests with confirmed fledging success (number of fledglings)
3 = Family Group is defined as when one or both adults birds of a pair are observed with a fledgling(s) when no nest was observed in the territory prior (number of fledglings)
4 = Number of pairs that successfully fledged at least one young.

Rodent Control

Pono Pacific conducted rat control during the 2006 breeding season from 10 January 2006 to 29 June 2006. The number of protected territories increased from eight to 14 in 2006. Thirteen of the fourteen territories being protected had baiting initiated in early January, and the final territory had rat control initialed at the end of April. Depending on the terrain and size of a pair’s territory two to three bait stations were deployed, covering approximately 0.31 to 0.42 ha respectively. Two snap traps per bait station were deployed in each territory being protected. Forty-one rodent bait stations and 78 rat traps were installed in a total of 14 ‘Elepaio territories. A total of 2022 blocks (57kg) were taken from bait stations and 155 rats were caught in snap traps with an average of nine rats per monitoring trip (17 monitoring trips). One adult female ‘Elepaio was found predated in a new territory located in mid-April 2006. This occurred before bait stations and snap traps were deployed on the following visit after discovery.

The number of territories protected during the breeding season increased from eight in 2005 to 14 in 2006 (Table 5.2.6). The number of site visits increased from nine in 2005 to 17 in 2006. The amount of bait taken in 2006 nearly tripled the amount taken in 2005 with the addition of six new territories, although the number of rats trapped remained the same. Territories will continue to be added for protection as pairs are found.

Table 5.2.6 Mākaha Valley Rat Control Data

Year	# of Territories[1]	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Snap Traps	# of Rats Trapped	# of Site Visits
2005	8	28	2079	717	34%	28	145	9
2006	14	41	9628	2022	21%	78	155	17

1 = Number of ‘Elepaio territories being protected.

2007 Breeding Season

NRS will continue to assist BWS in surveying the few remaining side drainages for additional pairs, attempt to resurvey as many territories as possible, continue to band pairs to assess survival and assist in monitoring nesting activities. Predator control and monitoring in Mākaha Valley will be contracted to Pono Pacific for the 2007 breeding season. The projected number of pairs to be protected during the up coming breeding season is 13 pairs.

Honouliuli Forest Preserve - The Nature Conservancy of Hawaii

For the past two breeding seasons the NRS has assisted The Nature Conservancy (TNC) with monitoring and managing ‘Elepaio pairs in the ‘Ēkahanui area of the Honouliuli Forest Preserve, through the contracting of Pono Pacific to conduct predator control and monitoring.

The second largest population of ‘Elepaio on O‘ahu is located in the Honouliuli Forest Reserve with an estimated population of 418 birds, comprising roughly 209 breeding pairs (VanderWerf et al. 2001). Within the ‘Ēkahanui area, NRS and Dr. VanderWerf have banded 26 birds since 1999 (Table 5.2.7). During the 2006 breeding season, 25 territories were monitored and of those 20 were confirmed pairs (Figure 5.2.3).

Table 5.2.7 ‘Elepaio Banding Data, ‘Ēkahanui, Honouliuli Forest Reserve

Bird[1]	Date Banded	Territory	Last Observed	Last Monitored	Disease[2]	Mate Observed[3]	Sex
RRGA	02/17/99	NA	NA	NA	N	NA	M
ABGW	02/17/99	EKA-02	05/02/06	05/30/06	N	Y	M
AGBG	01/10/00	EKA-07	04/2004	04/18/06	Y	N	M
WARB	01/10/00	EKA-13	04/25/06	06/12/06	N	Y	M
ABBR	01/10/00	EKA-06	04/2004	04/18/06	Y	Y	M
GWAG	01/10/00	EKA-14	04/22/05	06/12/06	Y	Y	M
BWRA	01/19/00	EKA-11	04/23/06	06/06/06	N	N	M
BBWA	01/19/00	EKA-10	04/22/05	06/06/06	Y	Y	M
BARB	11/29/02	EKA-05	NA	06/12/06	N	NA	M
GAWB	11/29/02	EKA-25	NA	04/22/06	N	Y	M
BAWB	10/22/03	EKA-02	03/2004	05/30/06	N	Y	F
GABB	10/22/03	EKA-20	05/19/06	06/12/06	N	Y	F
GARR	10/22/03	EKA-04	05/18/05	06/12/06	N	Y	M
WRRA	10/22/03	EKA-21	12/15/05	06/12/06	N	Y	M
RWAG	11/07/03	EKA-33	03/2004	01/13/05	N	N	M
BAGR	11/07/03	EKA-09	01/13/05	06/12/06	Y	Y	F
WWAR	09/29/04	EKA-43	09/29/04	06/27/06	N	N	M
GRGA	12/14/04	EKA-22	03/10/05	06/06/06	N	N	M
WGRA	12/14/04	EKA-05	01/25/05	06/06/06	N	Y	M
WAWR	12/14/04	EKA-25	12/15/06	06/12/06	N	Y	M
WAGG	12/15/04	EKA-23	02/21/06	06/20/06	N	N	M
RAWG	12/20/04	EKA-17	03/10/06	06/20/06	N	Y	M
BWAW	12/28/04	EKA-04	02/21/06	06/12/06	N	Y	F
BWBA	02/28/05	EKA-41	02/28/05	05/30/06	N	Y	M
AMMW	12/28/05	EKA-16	12/28/05	12/28/05	Y	N	M
MAMM	12/28/05	EKA-43	12/28/05	06/27/06	N	Y	M

[1] = Band combination colors: A=Aluminum, R=Red, B=Blue, G=Green, W=White, M=Mauve, and K = Black.
[2] = Presence of disease when banded: (Y)es or (N)o
[3] = Presence of a mate when last observed: (Y)es or (N)o

Figure 5.2.3 Distribution of ʻElepaio in ʻĒkahanui

Map removed,
available upon request

Breeding Behavior

Of the 25 territories monitored during the breeding season, 20 were confirmed as being pairs. Seventeen of the 20 pairs were observed to have breeding activity occurring during site visits (Table 5.2.8). Thirteen nests were located within eleven territories in various stages (building – 7, incubating – 3, nestling stage – 3). Ten nests were located in three tree species (*Psidium* sp. - 8, *Pisona* sp. – 1, *Pouteria sandwicensis* – 1) and the remaining three nest trees were not identified. Nests initially located in the building stage had a number of outcomes: one stopped building, one was found on the ground (possibly due to high winds), one disappeared between visits, two continued into the nestling stage and had an undetermined outcome with no further activity found (possibly fledged), one failed in the nestling stage (nestlings observed dead in nest), and one went on to fledging one nestling. Two of the three nests found in the incubation stage had an undetermined outcome (possibly fledged) and the third nest successfully fledged one young. Two nests in the nestling stage, when found had undetermined outcomes (possibly fledged) and the third nest successfully fledged one young. In one territory, in which no nest was located two dead nestlings were found on the ground. Six family groups were located with each pair having one fledgling. Nine of 20 pairs (45%) were successful in fledgling at least young (9 fledglings, 0.45 fledglings per total number of pairs monitored). The six nests with undetermined outcomes may have fledged young, since the time interval between site visits was sufficient for nests to fledge young. The three pairs for which breeding activity was not observed, most likely attempted nesting, but were not detected due to timing of site visits or failure in nesting attempts.

Table 5.2.8 ‘Ēkahani ‘Elepaio Breeding Data

Year	# of Territories Protected During the Season	# of Pairs Protected During the Season	# of Pairs Observed with Breeding Activity	# of Active Nests Found[1]	# of Active Nests with Confirmed Fledging Success[2]	# of Family Groups Found[3]	# of Pair Success[4]	Total Number of Fledglings
2005	24	21	17	10	4(5)	11(12)	15	17
2006	25	20	17	10	3(3)	6(6)	9	9

1 = Number of active nests found may include more than one nesting attempt in a given territory. An “active nest” is defined as a nest containing eggs or nestlings.
2 = Number of active nests with confirmed fledging success (number of fledglings)
3 = Family Group is defined as when one or both adults birds of a pair are observed with a fledgling(s) when no nest was observed in the territory prior (number of fledglings)

Predator Control

NRS assisted TNC by contracting Pono Pacific for predator control and monitoring of 25 ‘Elepaio territories. Predator control for the 2006 breeding season was from 27 December 2005 to 27 June 2006. Sixty-one bait stations and 101 rat traps were installed in 24 ‘Elepaio territories in the ‘Ēkahanui area. Depending on the terrain and size of a pair’s territory two to three bait stations were deployed, covering approximately 0.31 to 0.42 ha respectively. Two snap traps per bait station were deployed in each territory being protected. A total of 3,582 blocks (101kg) were taken from bait stations. The amount of bait taken versus the amount of bait available was 28%. A total of 142 rats were caught in snap traps with an average of 7.9 rats per monitoring trip (18 monitoring trips). The number of rats trapped and the percent of bait taken increased in 2006

(Table 5.2.9). This increase can partially be attributed to the increased number of site visits and the baiting of territories not baited in the previous year.

Table 5.2.9 ‘Ēkahani Rat Control Data

Year	# of Territories[1]	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Snap Traps	# of Rats Trapped	# of Site Visits
2005	24	61	12371	1496	12%	99	127	16
2006	24	61	12756	3582	28%	101	142	18

1 = Number of ‘Elepaio territories being protected

2007 Breeding Season

Predator control and ‘Elepaio monitoring will be contracted to Pono Pacific for the 2007 breeding season. NRS will continue to assist with surveying for additional pairs, banding birds, and monitoring. The projected number of pairs to be protected during the up coming breeding season is 20 pairs.

Moanalua Valley – Damon Estate

The fifth largest population of ‘Elepaio on O‘ahu is located in the central Ko‘olau Mountains, which includes Moanalua Valley. The population for the central Ko‘olau Mountains is estimated at 206 birds, comprising roughly 103 breeding pairs (VanderWerf et al. 2001). NRS and Dr. VanderWerf have banded 19 birds since 2004 (Table 5.2.10). Prior to the 2006 breeding season, 33 pairs were known from multiple surveys starting in October 2004. At the start of the 2006 breeding season 25 pairs were protected and monitored (Figure 5.2.4). An additional territory was protected in late April. Of the 26 territories protected and monitored during the breeding season 22 were confirmed pairs. In May of 2006, four new pairs (MOA-36 through MOA-39) were found during a survey of a side drainage. These four pairs were be managed in 2007.

Table 5.2.10 ‘Elepaio Banding Data, Moanalua Valley

Bird[1]	Date Banded	Territory	Last Observed	Last Monitored	Disease[2]	Mate Observed[3]	Sex
RWAR	10/01/04	MOA-04	01/24/05	01/04/06	N	Y	M
BBRA	10/01/04	MOA-16	06/04/06	06/04/06	N	Y	M
AWBB	10/01/04	MOA-15	06/04/06	06/04/06	N	Y	M
RWWA	10/01/04	MOA-15	06/04/06	06/04/06	N	Y	F
GRGA	12/15/04	MOA-01	12/15/04	12/15/04	Y	Y	F
AGGG	12/15/04	MOA-02	12/15/04	12/15/04	Y	Y	M
ABRR	12/15/04	MOA-06	07/05/06	07/05/06	N	N	M
ABBB	12/15/04	MOA-28	12/15/04	12/15/04	N	Y	M
GAWR	12/16/04	MOA-09	05/10/06	05/10/06	Y	Y	M
BAWW	12/16/04	MOA-11	02/08/06	02/08/06	N	Y	M
RAWR	12/16/04	MOA-29	12/16/04	05/31/06	N	N	M
ABRR	12/16/04	MOA-10	07/05/06	07/05/06	Y	Y	M
WAGB	12/29/04	MOA-13	02/10/06	02/10/06	N	Y	M
WGGA	09/20/05	MA-062	09/20/05	09/20/05	Y	N	M
RMKA	09/20/05	MOA-08	09/20/05	03/22/06	N	Y	M

Bird[1]	Date Banded	Territory	Last Observed	Last Monitored	Disease[2]	Mate Observed[3]	Sex
KAGK	01/03/06	MOA-22	05/10/06	05/10/06	N	Y	M
MAMK	01/03/06	MOA-17	06/04/06	06/04/06	N	Y	M
KAWK	01/04/06	MOA-31	01/04/06	01/04/06	N	Y	M
ARKR	01/05/06	MOA-32	06/15/06	06/15/06	N	Y	M

1 = Band combination colors: A=Aluminum, R=Red, B=Blue, G=Green, W=White, M=Mauve, and K = Black.
2 = Presence of disease when banded: (Y)es or (N)o
3 = Presence of a mate when last observed: (Y)es or (N)o

Breeding Behavior

Of the 22 pairs managed, 17 were observed to have breeding activity occurring during site visits (Table 5.2.11). At total of 12 nests were located in various stages (building – 5, built – 2, incubating – 4, nestling - 1 stage). Nests were located in three introduced and one native tree species (*Psidium* sp. – 7, *Aleurites moluccana* – 3, *Hibiscus tiliaceus* – 1, *Metrosideros* sp. – 1). The 12 nests were located within nine territories. Three of the five nests initially found in the building stage successfully fledged one young each. Of the two remaining nests found in the building stage, one failed during the incubation period to undetermined causes and the other had an undetermined outcome (possibly fledged). Both nests that were found completely build both had undetermined outcomes (one possibly fledged and other not visited for > 1 month). Three of the four nests found during the incubation period failed (one nest on the ground (high winds), one nest gone from the tree, one with no activity), the remaining nest fledged one young. The one nest found during the nestling period had an undetermined outcome (possibly fledged). The three nests with undetermined outcomes may have fledged young, since the time interval between site visits was sufficient for nests to fledge young. Nine family groups were located with a total of 11 fledglings. Five pairs exhibited no breeding activity during site visits. This breeding season had 12 out of 22 pairs (54%) successfully fledging 15 young (0.68 fledglings per total number of pairs monitored). One pair was successfully in fledgling young twice during the breeding season.

Table 5.2.11 Moanalua Valley ‘Elepaio Breeding Data

Year	# of Territories Protected During the Season	# of Pairs Protected During the Season	# of Pairs Observed with Breeding Activity	# of Active Nests Found[1]	# of Active Nests with Confirmed Fledging Success[2]	# of Family Groups Found[3]	# of Pair Success[4]	Total Number of Fledglings
2006	26	22	17	11	4(4)	9(11)	12	15

1 = Number of active nests found may include more than one nesting attempt in a given territory. An “active nest” is defined as a nest containing eggs or nestlings.
2 = Number of active nests with confirmed fledging success (number of fledglings)
3 = Family Group is defined as when one or both adults birds of a pair are observed with a fledgling(s) when no nest was observed in the territory prior (number of fledglings)

Map removed,
available upon request

Figure 5.2.4 Distribution of ‘Elepaio in Moanalua Valley

Predator Control

Pono Pacific conducted rat control during the 2006 breeding season from 03 January 2006 to 29 June 2006. Seventy-five rodent bait stations and 143 rat traps were installed in 26 ‘Elepaio territories in the Moanalua Valley. Each protected territory consisted of three bait stations and six snap traps. A total of 2,235 blocks (63kg) were taken from bait stations. The amount of bait taken versus the amount of bait available was 14% for the season (Table 5.2.12). Monthly bait take was very low throughout the breeding season. A total of 316 rats were caught in snap traps with an average of 16.8 rats per monitoring trip (19 monitoring trips). The number of rats trapped was the highest at this site, since this was the first time any predator control has been conducted in Moanalua Valley.

Table 5.2.12 Moanalua Valley Rat Control Data

Year	# of Territories[1]	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Snap Traps	# of Rats Trapped	# of Site Visits
2006	26	75	16148	2235	14%	143	316	19

1 = Number of ‘Elepaio territories being protected

2007 Breeding Season

NRS will continue to surveying the few remaining side drainages for additional pairs, band pairs to assess survival and assist in monitoring nesting activities. Predator control and monitoring in Moanalua Valley will be contracted to Pono Pacific for the 2007 breeding season. The projected number of pairs to be protected during the up coming breeding season is 25 pairs. Land ownership of Moanalua Valley will be in transition from Damon Estate to the State of Hawai‘i.

Waikāne Valley/ Kahana Valley

NRS conducted two follow up surveys in early 2006 to determine the number of ‘Elepaio pairs present for potential future management actions. The surveys were conducted along the Ditch Trail walking north along the trail from Waikāne Valley into Kahana Valley (Figure 5.2.5). These surveys covered a distance of approximately 2 kilometers. A few additional pairs were located in Kahana Valley, but resighting of birds in previously located territories proved difficult, due to inclement weather and unresponsive birds to taped playbacks. NRS will conduct additional surveys before the 2007 breeding season to determine the feasibility of management actions.

Map removed,
available upon request

Figure 5.2.5 Distribution of ‘Elepaio in Waikāne Valley / Kahana Valley

Chapter 6: Research Activities

Research plays an important role in resource management. For a number of introduced pest species in Hawai‘i, little is known about their life histories, distributions, abundances and interspecific interactions, and therefore their potential impacts on native species. Furthermore, it is often not clear what the most effective and appropriate management actions are for a given alien species problem. In recognition of these facts, the O‘ahu Army Natural Resource Program (OANRP) hired a full-time Research Specialist (RS) in September 2005. Our new research program is focused on assessing the nature and magnitude of alien species threats on native species, and, where possible, developing control methods for the introduced pests that are deemed most damaging to native natural resources. In addition, Army Natural Resource Staff (NRS) have expanded efforts to collect, identify and properly store invertebrate specimens. These allow us to rapidly detect incipient pest species on Army lands and to potentially respond before continued spread makes eradication prohibitively expensive. Rare native species have also been discovered, notably, *Rhyncogonus fordi* (Coleoptera: Curculionidae) a species collected only once in the last 30 years (Samuelson, 2003). See Figure. 6.1 for collection details.

Figure. 6.1: *Rhyncogonus fordi* (Photo by L. Tuthilll). Collected 8/8/2006 on Kumai‘po Ridge, Mākaha, O‘ahu (elev: 762 m; Lat: -158.158047059; Long: 21.50294070351) and on 8/25/2006 on ‘Ōhikilolo Ridge, Wai‘anae Mtns., O‘ahu (elev: 884 m; Lat: -158.1933726996; Long: 21.513107143993). Collector: K. Kawelo. Identifications by G. A. Samuelson.

Organized by taxonomic group, this chapter will detail our activities as they pertain to certain target pests. For each, we provide an introduction to the problem, a description of research goals and, finally, our progress in fulfilling stated goals.

Euglandina rosea (Stylommatophora: Spiraxidae)

Problem statement:
The rosey wolfsnail, (*Euglandina rosea*), a medium, pink-hued, predatory land snail, is native to the southeast United States. Purposely brought to Hawai'i in 1955 to serve as a biocontrol, *E. rosea* failed to reduce populations of its intended target, the giant African snail, *Achatina fulca*. A generalist predator, *E. rosea* proved adept at finding prey in varied habitats, including native forests, where it became associated with the decline and endangerment of endemic snail species. Native snail populations in Maritius and French Polynesia responded similarly to *E. rosea* invasion.

Goals:
Examine the feeding behavior and ecology of *E. rosea* in native Hawaiian forest, assess their impacts on native snails based on population numbers and use results to aid in the development of an effective control program.

Action:
Occasionally, NRS provide funds and field assistance to University of Hawai'i at Mānoa (UH) graduate students whose projects achieve OANRP goals. One such project, addressing problems associated with *E. rosea*, has been underway for one year and OANRP has committed to supporting this research through the upcoming year. Research is carried out by Wallace Martin Meyer III (UH, Center for Conservation Research and Training) as part of his PhD thesis. NRS assists in monthly field surveys for *E. rosea* and collect *E. rosea* and (non-native) prey items for use in feeding experiments. Results from year one of this project, written by W. M. Meyer, appear in Appendix 10. Proposed research for the upcoming year includes an investigation of *E. rosea* movement and microhabitat preference (Appendix 9). Results from this work will improve the ability of NRS to protect native tree snails from the depredations of *E. rosea*.

Xylosandrus compactus (Curculionidae: Scolytidae)

Except where noted, data on the life cycle of *X. compactus* and hosts in Hawai'i are taken from Hara and Beardsley (1979).

Problem statement:
Native to Asia, the black twig borer *X. compactus* didn't become widely distributed in Hawai'i until 1960, nearly 30 years after its initial arrival in plant material from Singapore. In common with other members of the tribe Xyleborini, *X. compactus* depends upon on an ambrosia fungus, farmed in galleries bored into the vascular tissue of the host plant, for its development. Hawai'i hosts 21 endemic ambrosia beetles, many of which specialize on a single plant species. While native ambrosia beetles and other naturalized species, like *X. crassicus*, nest and rear young in dead wood, *X. compactus*, readily attacks healthy plants. In Hawai'i, active galleries have been found in 108 host plant genera spanning 44 plant families, making *X. compactus* a serious economic pest as well as a threat to native species. With such a wide range of hosts, *X. compactus* is nearly impossible to control through the removal of potentially infected vegetation alone.

The life cycle of *X. compactus* is such that damage to the host plant arises as a result of multiple activities: 1. the hole bored by the beetle upon entry (Figure. 6.2) 2. the formation of a gallery in which eggs are laid (Figure. 6.3), and, according to some researchers (N. Dudley, Hawai‘i Agriculture Research Center (HARC) *pers. comm.*) 3. disease-causing strains of the *Fusarium* fungus, which is inoculated into the new host plant by a gravid female. Upon reaching maturity, the female *X. compactus* leaves her parental gallery, having already mated with a male sibling, the majority of which die in place, never to emerge. On average, eight eggs are produced by the female at one time. These hatch within seven days, after which, larvae feed on fungus until they pupate and reach maturity. Another two weeks will elapse before these recently pupated females will leave the galley, at which time they will depart via the single hole bored by their mother.

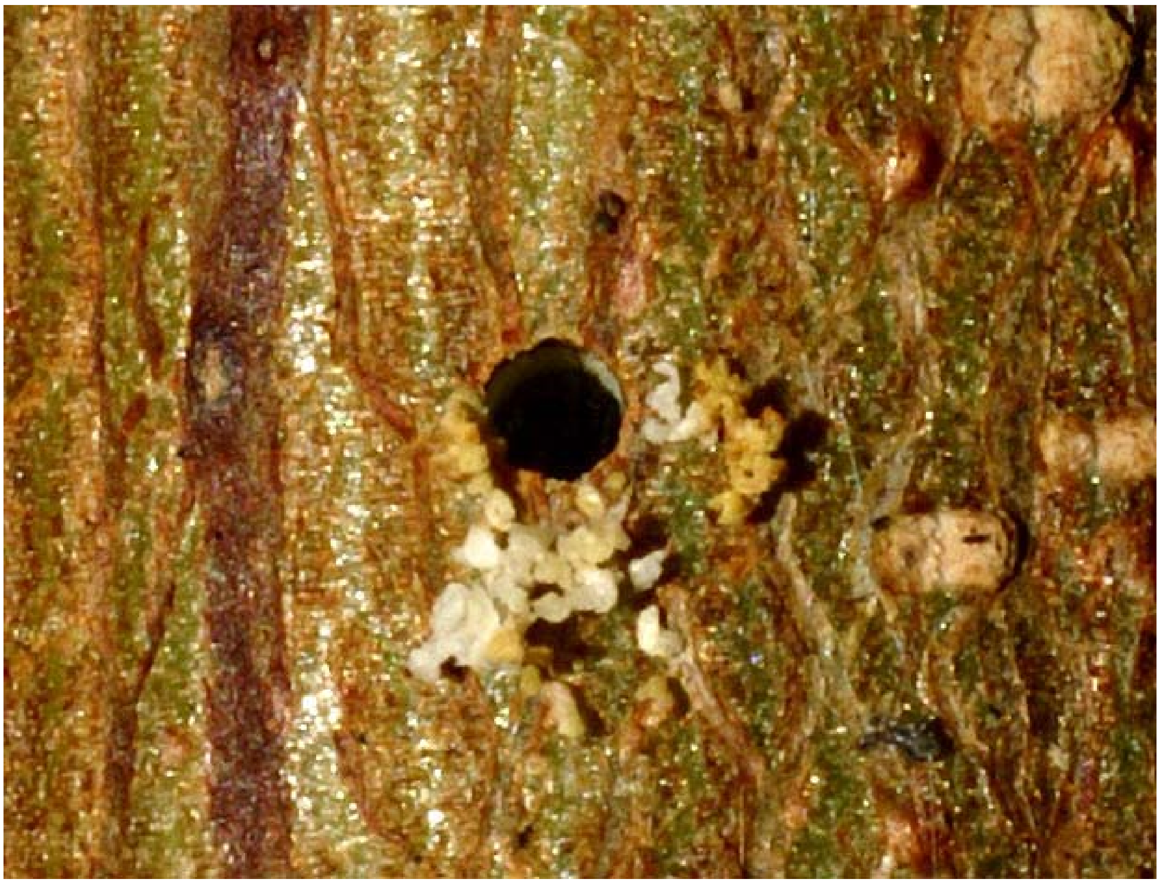

Figure. 6.2: Black twig borer entry hole into *Flueggea neowawraea* stem showing insect frass (photo by S. Joe).

Figure. 6.3: Black twig borer gallery in *Flueggea neowawraea* branch showing mature and recently pupated adult females alongside grubs (photo by H. C. Kuo).

Xylosandrus compactus is a major threat to a number of rare and endangered plants, notably *Caesalpina kavaiensis* (Fabaceae), *Alectryon macrococcus* (Sapindaceae) and *Flueggea neowawraea* (Euphorbiaceae), all of which are observed to suffer high attack rates. Because *X. compactus* resides primarily within the plant pith, chemical control options are limited. Greenhouse collections of *Flueggea neowawraea* are treated with Merit® (Bayer Crop Research, Triangle Park, NC), a systemic insecticide applied as a root drench. The number of entry holes on greenhouse plants differed little from those recorded from untreated, outplanted trees. This suggested treatment with Merit® did not deter *X. compactus* females from nesting and egg laying attempts. Closer inspection of 10 entry holes, however, yielded only three active galleries among the greenhouse individuals compared to eight among the outplanted population.

Goals:

Having found systemic insecticides cumbersome to deploy, slow to act and expensive, with only questionable efficacy, NRS sought out alternatives. NRS entered into a partnership with Nick Dudley, a forester with the HARC and Nancy Gillette, a research entomologist with the U.S. Forestry Service (UFS), to test the anti-aggregation pheromone Verbenone® (Phero Tech, Point Roberts, WA) against *X. compactus* among outplanted *Flueggea neowawraea* in Kahanhāiki Gulch. Verbenone® is currently used on the mainland U.S. to protect pine stands from boring beetles in the genus *Dendroctonus* (Curculionidae: Scolytidae) (Gillette *et al.* 2006). In previous work, Dudley and Gillette demonstrated ethanol effectively attracted *X. compactus* (Gillette *et al.*, *in prep*), presumably because it mimics the odor of rotting wood. When paired with Verbenone, however, they found ethanol attracted significantly fewer *X. compactus* than did ethanol alone or ethanol paired with other potential repellents (Gillette *et al.*, *in prep*). Thus, while Verbenone appears to repel *X. compactus*, our experiment will determine whether this effect is strong enough to protect *F. neowawraea*.

Little is known regarding *X. compactus* densities or population response to seasonal cues. Anecdotal observations suggest *X. compactus* numbers increase starting in late April, peak in August and begin to decline in October (E. Burbano, UH Plant & Environmental Protection Sciences (PEPS) *pers. comm*.). If true, then the deployment of repellents would be most effective at those times when numbers are high and damage to plants most severe. Therefore, NRS needed to devise ways to both monitor *X. compactus* and quantify its damage to *F. neowawraea*. Data from such endeavors are expected to provide information critical to *F. neowawraea* conservation.

Actions:
As in previous studies (Gillette *et al*., *in prep*; E. Burbano, *unpub. data*), we used counts of *X. compactus* attracted to ethanol-baited traps as an indicator of relative population size. An insecticidal strip (Vaportape® Hercon Environmental, Emigsville, PA) placed in the collecting cup killed any insects entering the trap. On June 15, 2006, six traps were hung at intervals of 20 m around the periphery of the Nike greenhouse (elev: 610 m, Lat: -158.195227096951, Lon: 21.5461005736750). Traps were emptied and re-baited weekly (Figure. 6.4). Samples collected through August yielded only three *X. compactus*. It is too early to say whether our methodology is flawed, or whether the low catch corresponds to actual numbers of *X. compactus* in this area. NRS plan to continue sampling through the end of the year, then re-assess whether the traps are working. Other Scolytidae found, from most to least common, were *Hypothenemus* sp.*; Xyloborinus spp.; Xyloborus spp*.; and *X. crassicus*. These groups are not known to bore living plants (Huang-Chi, *pers. comm*.) and, when opened, entry holes into *Flueggea neowawraea* have yielded only *X. compactus*.

Figure. 6.4: Black twig borer trap with collection cup removed. S. Joe is pictured collecting samples after which, the cup will be reattached to the bottom of the trap (photo by H.C. Kuo).

Counts of new entry holes accumulated over time by individual *Flueggea neowawraea* provide data on the frequency of *X. compactus* attack in the absence of treatments. This method has been used elsewhere (Gillette *et al*. 2006) to evaluate the success of experimental repellents. Using white latex paint, NRS marked all existing holes on outplanted *F. neowawraea* and have started recording new holes on a weekly basis. Preliminary results show trees accumulate one new entry hole per 2.4 inches of bole length every 9 days. An experimental test of Verbenone® efficacy in the field is planned but the design not yet finalized by all cooperators. At present, the experiment is planned to run for 90 days (the duration of efficacy recommended on the label) with some trees receiving Verbenone® and others serving as controls. Upon conclusion, attack rates between the treatment and control will be compared. Until that time, these trees will be resurveyed every 10 days to determine baseline levels of damage.

Solenopsis geminata (Hymenoptera: Formicidae)

Problem statement:

Solenopsis geminata, the tropical fire ant, has been present in Hawaiʻi for over 100 years and, as the name suggests, is capable of delivering repeated, mildly painful stings. Fire ants are notorious for their stinging behavior, and respond rapidly and aggressively to any disturbance. Listed among the top five most invasive ants in Hawaiʻi, *S. geminata* is common in dry, disturbed areas below 450 m elevation (Krushelnycky *et al*. 2005). Thought to be restricted to lowland areas, it was recently discovered at an elevation of 600 m on a ridge top on Army land

(Figure. 6.5). The threats posed to native species by *S. geminata* include reduced fledgling survival in seabirds (S. Plentovich, UH Zoology *pers. comm.*) and the displacement of native arthropods through predation and competition (Krushelnycky *et al*. 2005). Workers tend honeydew-producing homoptera, especially mealybugs, which, in turn, threaten native plants via overfeeding and disease transmission.

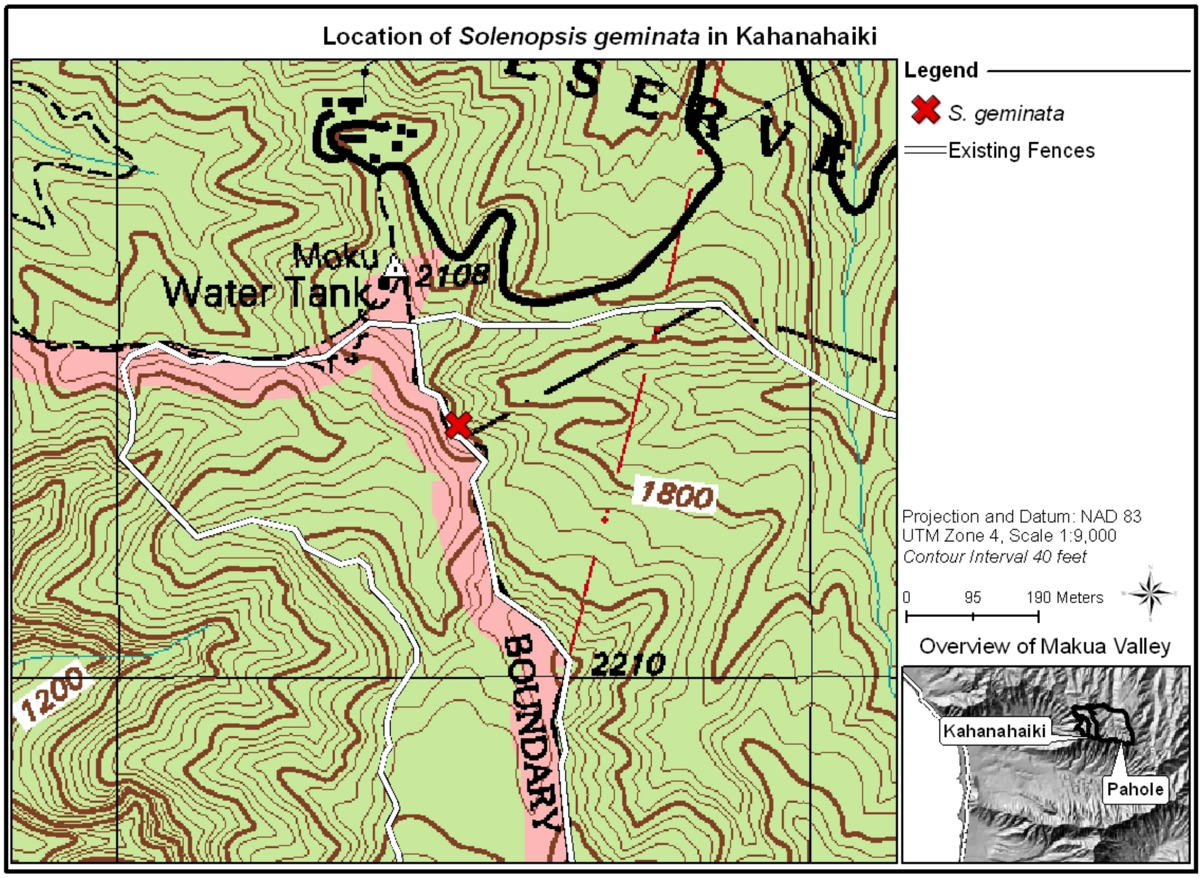

Figure. 6.5: Location of *Solenopsis geminata* (marked with a cross) in Kahanahāiki.

On March 24, 2006, Talbert Takahama (NARS specialist) reported having been stung by an unusual red ant along the Kahanahāiki fenceline. On May 6, 2006, NRS returned to the area with entomologist Paul Krushelnycky who identified the ant as being *S. geminata* and expressed surprise at it being established at such a high elevation. The following weeks were spent surveying the extents of infestation and searching surrounding ridges for additional colonies. No additional *S. geminata* colonies were found. A number of other ant species, including *Pheidole megacephala*, *Plagiolepis alluaudi, Technomyrmex albipes* and *S. papuana* were recorded from nearby areas but not considered for eradication. They were either innocuous or too well established for treatment to be effective. A 40 m transect with survey stations at 1 m intervals was established through the center of the *S. geminata* infestation following the fence line. NRS used methodology recommended by the Cooperative Extension Service (2004) to detect fire ants. Survey protocol involves visual searches for nests and foragers, as well as the use of baits to attract nearby foragers (if present). Chopsticks dipped in peanut butter served as bait. These were left under vegetation for 60 minutes, then retrieved and any ants found identified. In this manner, we judged the infestation covered an area roughly155 m^2 in size. It should be noted that the infestation abutted a steep cliff where further survey was impossible. Thus, the eastern boundary was determined by the geography of the area, not the absence of ants. We speculate this is, in fact, the actual boundary as the ants currently occupy an area that is hot, dry, exposed and with little vegetation while the cliff face is densely vegetated.

The mode by which *S. geminata* became established at such as remote location is unknown. The small area occupied and the low numbers of ants suggest *S geminata* is either newly arrived or that the habitat is marginal for their survival. Though winged, *S. geminata* queens are poor fliers (P. Krushelnycky, *pers. comm*). They may have been blown up by wind from lower elevations. If transported by humans, they may have hitchhiked on personnel gear or in fence material brought to construct the fence. It should be noted, however, that NRS is careful to clean gear and it has been nearly 10 years since the fence was constructed.

Goal:
Application of Amdro® Fire Ant Bait (Ambrands, Atlanta, GA) to achieve eradication of *S. geminata* from Kahanahāiki. Hydramethylnon, the active ingredient in Amdro, is used by U.S. Fish & Wildlife Service (USFWS) and the National Park Service (NPS) to control ants elsewhere in Hawaiʻi (such as offshore islands, Haleakalā National Park and Palmyra Atoll) and is considered safe to use in ecologically sensitive areas.

Actions:
Ant densities were monitored pre and post treatment using peanut butter baits left at 1 m intervals along the transect (described above). On April 25 *S. geminata* foragers were found at 48% (or 19/40) of all baits. Of this 48%, 5 ants, on average were present. The area was treated with 10.8 oz. of Amdro (the label rate) using a hand-held bait spreader on May 30 and, again on July 24, when *S. geminata* re-appeared. Ant eradication often requires multiple treatments because pupae are unaffected by ingestible pesticides. They are aestivating and, therefore, do not eat. Results from pre and post treatment surveys appear in Table 6.1. To date, *S. geminata* has not recurred. Monthly checks of the area will continue for 1 year after the latest treatment. If no ants are found during this time, monitoring will cease and the population will be considered eradicated.

Table 6.1. *Solenopsis geminata* monitoring results pre and post treatment

Date (2006) (MM/DD/)	# of baits with ants (of 40 total)	Visual search (2 person hours)	Notes
04/25	19	Present	
Treated on 05/30			
06/01	0	Absent	
06/05	0	Present	One nest found, but ants are behaving abnormally. Pupae present.
06/08	0	Absent	
06/15	0	Absent	
07/13	1	Present	Active nests found.
Treated on 07/24			
07/20	0	Absent	
07/27	0	Absent	
08/10	0	Absent	

Terrestrial slugs (Mollusca: Pulmonata)

Problem statement:

Hawai'i lacks native terrestrial slugs (Gastropoda: Pulmonata). A number of introduced species are now established (Cowie 1997) and, further, become widespread in mesic to wet native forest, most notably, *Deroceras reticulatum*, recognized around the globe as a serious pest. While few formal studies have been conducted to investigate the impacts that alien slugs are having on native flora, they are nevertheless widely regarded among local botanists to be key limiting factors to native seedling survival and responsible for the failure of several restoration efforts. Rare plant recovery plans drafted by USFWS (1995a, 1995b, 1997, 1998a, 1998b, 1998c, 1999, 2005) identify slugs as either current or potential threats to some 50 endangered plant taxa, most in the Campanulaceae. Two field trials at Lyon Arboretum in O'ahu (A. Yoshinaga, Lyon Arboretum, and C. Daehler, UH Botany, *unpub. data*) demonstrated slugs capable of reducing the survival of native *Cyanea angustifolia* seedlings by as much as 80%. These findings are in agreement with those found by Joe (2006) who showed slug exclusion significantly enhanced the survival of two native endangered plant species managed by NRS: *Scheidea obovata* (Caryophyllaceae) and *Cyanea superba* (Campanulaceae). Based on this data, we feel it is imperative to control slugs in the vicinity of vulnerable plant populations.

NRS has used both beer traps to control slugs and copper barriers to protect rare plants in the past, with mixed success. Both methods can only be used on a small scale. Copper barriers cannot practically be used to make exclosures larger than 1 m^2 and they run the risk of trapping slugs at the time of construction. During the wet season, when slugs are most abundant, the soil beneath the barrier tends to erode causing gaps slugs can exploit. Thus, to be effective, they need weekly maintenance. Beer traps, like the copper, are expensive, labor intensive and, because slugs cannot detect airborne odors from a distance of more than 10 cm (when "smelling" slugs touch the ground with olfactory tentacles) (South 1992), only able to lure slugs within a few feet of the trap, if at all. Chemical control using molluscicides is currently prohibited, as none are registered for forest or conservation use.

Goal:

Determine whether molluscicides might be used safely in a conservation setting. Work with cooperating agencies to get label permissions for use of molluscicides in forested areas.

Action:

Effective slug control in ecologically sensitive areas, while desirable for those seeking to protect native plants, is cause for concern among native snail conservationists. NRS, has been working with members of the Hawai'i Department of Agriculture (HDOA) Pesticide Branch and the USFWS to identify molluscicides which show promise for eventual use in conservation. A dialog on issues pertaining to invasive gastropod control took place at the 2006 Hawai'i Conservation Conference. The symposium, organized by NRS and U.S. Geological Survey staff brought together snail and slug experts from UH and USDA as well as pesticide specialists from USFWS. Though the use of molluscicides to control slugs remains a contentious issue for native snail biologists, there was general agreement that, with proper research and careful application, nontarget impacts on native snails could be avoided.

Molluscicides commonly contain the active ingredients metaldehyde or methiocarb which, upon contact, can cause dehydration in mollusks. In addition, both of these compounds are hazardous to humans and animals (Dolder 2003; EPA Doc. 1994). In contrast, iron phosphate (brand name Sluggo® Neudorff Co., Fresno, CA), a biochemical molluscicide registered in 1998, is not toxic to birds, mammals, fish, or (apart from mollusks) invertebrates (EPA 1998). It's mode of action, once ingested by the slug, is to interfere with digestion, causing death within 48-72 hours. Because of these promising attributes, Sluggo® is considered the most promising molluscicide for eventual use in a forest setting. Neudorff Co. representatives have agreed to negotiate with EPA to amend the label, while NRS have agreed to carry out research in support of this change.

The habitat requirements of native tree snails in the genus *Achatinella* (Achatinellidae), overlaps with that of many of the endangered plant species targeted by slugs and there is little doubt that, if consumed, Sluggo® would prove toxic to native snails. *Achatinella* are believed to feed exclusively on epiphytic algae and fungi (Hadfield and Mountain 1980) and they are not ground-dwelling. These observations suggest that *Achatinella* might not be attracted to, or come into contact with, Sluggo® (which would be broadcast on the ground). The diets of most groups of native snails, however, have yet to be studied (R. Cowie, UH Zoology, *pers. comm.*) and it is therefore unknown whether they would consume Sluggo® if it was encountered.

In order to determine whether Sluggo® might be ingested by native tree snails, NRS conducted a feeding trial wherein captive-reared snails were offered inert (non-toxic) bait (Figure. 6.6). Unable to perform experiments using a listed species, *Partulina redfieldi* served as subjects rather than *Achatinella*. The laboratory conditions and fungus diet given to both species is identical and behavior shown by *P. redfieldi* (in this instance) was considered applicable to *Achatinella* as well (M. Hadfield, UH Zoology *pers. comm.*). Nontoxic bait similar to Sluggo® was mixed according to a recipe provided by Neudorff Co. representative. For the purposes of this experiment, red food coloring was added to the bait so it could be identified later in snail fecal samples. From 3:30 pm July 14 to 11:00 am July 15, 2006 snails had access to 4 g of bait stuck to the side of their container adjacent to their regular food (fungus in agar) (Figure. 6.7). Fecal samples confirmed 2 of the 8 snails sampled the bait, though in minute amounts (Figure. 6.8). We conclude from this trial that, if placed in areas accessible to native tree snails, Sluggo® may be consumed.

Figure. 6.6. Inert bait mixture offered to experimental subjects. The recipe follows: 0.5 cup old fashioned oats cooked in 1 cup boiling water for 5 minutes. 1 tablespoon of molasses. 0.25 teaspoon red food coloring. Blend in mixture until smooth.

Figure. 6.7. Presentation of bait and regular fungus diet to *Partulina redfieldii* experimental subjects.

Figure 6.8. Evidence of bait consumption by two separate snails. Circles mark areas with red bait.

Problem: A lack of basic knowledge regarding the distribution, species composition, population density, seasonality and feeding habits of slugs on Army lands and throughout Hawaiʻi, generally.

Goal: Fill in these knowledge gaps through data collection.

Action: NRS has endeavored to collect, voucher and identify slugs from remote areas (Table 6.2), which, in turn, has led to the discovery of species new to Oʻahu. In order to measure slug densities, we field tested a number of methods (Appendix 11) and used the most successful to implement long-term, slug monitoring stations in Kahanahāiki Gulch and Kaluakauila.

Table 6.2. Selected records of slug species collected on conservation lands. All identifications made by S. Joe. An asterisk (*) marks species new to Oahu based on (Cowie 1997; 1998; 1999).

Date	Collector	Locale	Slug species	Elev. (m)
9/11/2006	L. Morgan	Koʻolau Mountains	*Limax maximus*	792
8/29/2006	D. Forman	Three Points (Waiʻanae Mountains), West Makaleha	*Meghimatium striatum*	853
4/26/2006	J. Gustine	Mount Kaʻala	*Lehmannia valentiana**	884
2/27/006	W. Weaver	West range; Haleauau	*Limax maximus*	670
2/21/2006	M. Burt	Three Points	*Deroceras reticulatum**	853
9/15/2005	J. Beachy	KTA, Kaunala Gulch	*Meghimatium striatum*	243
8/31/2005	A. Yoshinaga	Lyon Arboretum	*Parmarion martensii*	88
12/1/2005	V. Costello	Waimano Camp Summit (Koʻolau Mountains)	*Meghimatium striatum*	808

Appendix I
Army NRS NARS Special Use Permit 2006

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

SPECIAL USE PERMIT
NATURAL AREA RESERVES SYSTEM

DEPARTMENT OF LAND AND NATURAL RESOURCES
1151 PUNCHBOWL STREET, HONOLULU, HI 96813

EFFECTIVE: April 5, 2006

EXPIRATION: April 5, 2007

RESERVES: Ka‘ena, Ka‘ala, Pahole

The Board of Land and Natural Resources or its authorized representative, with the approval of the Natural Area Reserves System Commission, hereby issues this Special Use Permit in accordance with: Section 195-5, Hawaii Revised Statutes, Section 13-209-5, Hawaii Administrative Rules pertaining to Natural Area Reserves; and Section 195D-4, Hawaii Revised Statutes and Section 13-107-4 Hawaii Administrative Rules pertaining to Threatened and Endangered Plant Species to:

Joel E. Godfrey,
Chief, Environmental Division
U.S. Army Garrison Hawaii
572 Santos Dumont Avenue, BLDG 105
Schofield Barracks, HI 96857-5013

Phone: 656-2878 Fax: 656-1039

to allow the Permittee, and his authorized designees within the Army Natural Resources staff, to conduct work in the above three Reserves as outlined in the permit application to help stabilize species of endangered plants. This work will be conducted by Permittee to enable the Permittee to fulfill its Section 7 Endangered Species Act species stabilization requirements for 27 target taxa of endangered plants in order to continue military training in Makua Valley. The U. S. Fish and Wildlife Service determined that routine military training would jeopardize the continued existence of these taxa and that the Army was to prepare an Implementation Plan (IP) to provide stabilization actions. These three Reserves contain some of the most intact areas of dry, mesic, and wet ecosystems remaining in the Wai‘anae Range of O`ahu.

GENERAL CONDITIONS

1. Besides conditions stipulated here, the Permittee will adhere to project specifications given in the permit application.

2. Disturbance of native vegetation and wildlife will be avoided as much as possible.

3. Reports:
   a. A field report will be submitted within five (5) weeks of project completion.
   b. Results of the project, as published or unpublished reports, also will be submitted. Reports will be submitted by Reserve and should cover all the activities requested under this permit. These individual reports shall be separate from the standard annual report produced by Army Natural Resources Staff (NRS) that encompasses all their activities.
   c. The reports will identify the Reserves as project sites and acknowledge the Special Use Permit as approved by the Board of Land and Natural Resources or its authorized representative, with the approval of the Natural Area Reserves System Commission.

4. Precautions will be taken to prevent introduction of plants or animals not naturally present in the area. Should an infestation develop, Permittee is responsible for eradication by methods to be specified by O`ahu Natural Area Reserves System (NARS) Staff - whether it occurs during or after the permit period, and even though it may be only indirectly attributable to the project activities.

5. This permit is not transferable.

6. This permit does not exempt the permit holder from complying with any other applicable rule or statute, and should be consistent with the Statutes, Rules and Management Policies of the Natural Area Reserves System.

7. The State of Hawaii shall be released and held harmless from any and all liability for injuries or death, or damage or loss of property however occurring during any activity related to this permit.

8. The Department of Land and Natural Resources will maintain control and supervision of State lands while this Permit is in effect.

9. Permittee shall not bring any heavy equipment onto the Premises except as necessary to access the Premises through the nearest road (i.e. a four-wheel drive vehicle) and provide necessary maintenance and improvements for access and fire suppression.

10. The Permittee shall observe and comply with all laws, ordinances, rules and regulations of the federal, state, municipal, or county government affecting the Premises or improvements.

11. In case the State of Hawai`i shall, without any fault on its part, be made party to any litigation commenced by or against the Permittee (other than condemnation proceedings), the

Permittee shall pay all costs, including reasonable attorney's fees, and expenses which may be incurred by or imposed on the State of Hawai`i; furthermore, the Permittee shall pay all costs, including paid by the State in enforcing the covenants and agreements of this permit, in recovering possession of the Premises, or collection of delinquent charges.

12. In the event any unanticipated cultural or historical sites, materials or remains (such as bone or charcoal deposits, human burials, rock or coral alignments, pavings or walls) are encountered by the Permittee and/or its contractors, all work shall stop immediately and Permittee will contact the State Historic Preservation Division in Honolulu at (808) 692-8015 immediately for further direction, as well as DOFAW staff (808) 973-9683.

13. The Division of Forestry and Wildlife reserves the right to add further conditions to this permit during the period of permit validity. The permittee will be informed of these changes in writing at least one week prior to the additional conditions taking effect.

14. Special Use Permits are granted for a maximum of one year at a time. If renewal or extension is necessary, at least one month prior to expiration of present permit, Permittee is required to submit a progress report detailing work completed within the present permit and plans for the new permit period. Failure to submit a written progress report and request a renewal of this permit prior to expiration may result in all work being ceased in the Reserves and a denial of access to all areas covered by this permit until this matter is resolved.

15. Hazardous materials:
    a. For the purpose of this, "hazardous material" shall mean any pollutant, toxic substance, hazardous waste, hazardous material, hazardous substance, o roil as defined in or pursuant to the Resource Conservation and Recovery Act, as amended, the Comprehensive Environmental Response, Compensation, and Liability Act, as amended, the Federal Clean Water Act, or any other federal, state, or local environmental law, regulation, ordinance, rule, or by-law, whether existing as of the date hereof, previously enforced, or subsequently enacted.
    b. Permittee shall not cause or permit the escape, disposal or release of any hazardous materials except as permitted by law. Permittee shall not allow storage or use of such materials in any manner not sanctioned by law or by the highest standards prevailing in the industry for storage and use of such materials, nor allow to be brought on the Premises any such materials except to use in the ordinary course of Permittee's business, and then only after written notice is given to the State of the identity of such materials and upon the State's consent, which consent may be withheld at the State's sole and absolute direction. If any lender or government agency shall ever require testing to ascertain whether or not there has been any release of hazardous materials by Permittee, then the Permittee shall be responsible for the reasonable costs thereof. In addition, Permittee shall execute affidavits, representations and the like from time to time at the State's request concerning Permittee's best knowledge and belief regarding the presence of hazardous materials on the Premises placed or released by Permittee.
    c. Permittee agrees to indemnify, defend, and hold the State harmless from any damages and claims resulting from the release of hazardous materials on the Premises

occurring while Permittee is in possession, or elsewhere if caused by Permittee or persons acting under Permittee. These covenants shall survive the expiration or earlier termination of this permit.

SPECIAL CONDITIONS

16. In a letter to the NARS Commission Executive Secretary, Betsy Gagné, from Army NRS Manager, Michelle Mansker, dated January 10, 2006 the Army NRS sent 12 pages of tables of actions, including 88 separate actions, that the Army NRS Staff plan to accomplish between March 2006 and March 2007. The Army NRS to authorized conduct all these actions with the exception of the collection of cuttings from *Flueggea neowawrea* trees in O`ahu Natural Area Reserves (NARs). The Army is to only collect seed from this species; no cuttings are to be taken from *Flueggea neowawrea* within the Natural Area Reserves..

17. The Army NRS will only use paid staff to carry out actions on the O`ahu NARS. The O`ahu NARS will not be available to the Army Environmental Program for the use of volunteers or service groups.

18. The number of days available to the Army NRS to work in Pahole NAR may be limited by the ability of the O`ahu NARS Staff to provide oversight and escort. The O`ahu NARS Manager may require that Army NRS be escorted by the O`ahu NARS Specialist IV or other designee when working in Pahole NAR.

19. The Army Environmental Program are encouraged to assist with DOFAW O`ahu NARS priority projects. These projects include but are not limited to the improvement, maintenance, and repair of: roads trails, fences, helicopter landing zones, irrigation systems, water catchment systems, shelters, and any other facilities or infrastructure that directly support either the O`ahu NARS Program or the Army Environmental Program. The Army NRS will also be encouraged to assist with weeding projects that are a priority of the O`ahu NARS Staff. The assistance the Army provides will be through Army NRS work and direct monetary support to purchase or lease equipment and hire personnel to complete the work; for example purchase or rental of a bulldozer, or provide funding for an equipment operator position. The exact level of monetary support will be established in the MOU between the State of Hawai`i and the Army, to address carrying out the Makua Implementation Plan.

20. Outplanting projects must be approved as stand alone projects. The O`ahu NARS Staff considers the attempt to stabilize rare plant species by outplanting plants propagated in a nursery into a wild population to be an experimental design. The O`ahu NARS Staff will have the ultimate discretion in deciding where outplanting sites will be located. Written request to do the outplanting project request to do the outplanting project must:
    a. Identify the species to be planted
    b. Provide a description of after planting care.
    c. Provide a detailed location for the outplanting including a detailed map.
    d. Identify the personnel doing the planting.
    e. Written outplanting plan shall be submitted by Army NRS to O`ahu NARS staff for approval at least 8 months prior to the outplanting project taking place.

All outplanting projects should have a research component that provides a baseline survey of habitat conditions at the proposed outplanting site prior to planting, and then monitoring those habitat conditions throughout the years the Makua Implementation Plan is in place. The research component will monitor parameters such as temperature, humidity, light intensity, etc. as identified by O`ahu NARS; such data can be collected by installing remote data loggers (i.e. Hobo Data Loggers) at each outplanting site. The Army NRS must receive written permission from the O`ahu NARS Manager or his designee prior to proceeding with the outplanting project. The O`ahu NARS Manager or his designee may stipulate that the Army NRS will assist with other DOFAW priority weeding projects as a condition to proceed with the outplanting project. Some of this assistance may be help in managing outplanting sites (i.e. Kapuna Stream site) that have already been developed and that have outplanted species included in the Makua Implementation Plan. The State of Hawaiʻi does not accept any responsibility to maintain, enhance or protect any outplanting sites that are created by the Army NRS when permission to proceed with the outplanting project is granted to the Army by O`ahu NARS Staff.

21. Cooperation at Pahole Rare Plant Nursery. The Army NRS and the Army Horticulturist will agree to develop a MOU with the O`ahu Branch of the Division of Forestry and Wildlife to formalize the relationship between the State of Hawaiʻi and the Army NRS and to establish an agreement to guide the day-to-day cooperation of the two agencies at the Pahole Rare Plant Nursery.

22. The Army will inform the O`ahu NARS Manager or his designee in writing at least two weeks prior to any trip to Ka`ala Natural Area Reserve and adjacent Army lands when allowing groups to transit through Ka`ala NAR for educational or service project related visits. The O`ahu NARS Program may direct what routes the Army NRS takes through the NAR and reserves the right to decline the request to transit through the Ka`ala NAR. The Army NRS will assist O`ahu NARS staff with rebuilding the Ka`ala boardwalk by providing materials and labor.

23. The Army NRS and any Botanist contracted by the Army NRS will limit their collection of Threatened and Endangered plants in Natural Area Reserves to the collection of seed. The Army NRS must request permission to collect from Threatened and Endangered Plant species in writing and must obtain the appropriate Threatened and Endangered plant collection permit from the Division prior to initiating seed collection activities. No collection of cuttings, collection of plant materials for vouchers, or air layers will be allowed; however, if voucher specimens are considered to be essential, specimens will be deposited in the Herbarium of Bishop Museum (Official State Repository); digital photographs are also considered to be suitable as herbarium specimens eliminating the need to make more collections than necessary of rare taxa. When the Army Environmental Program collects seeds of Threatened and Endangered plants on Reserves the State will be identified as the owner of these seeds and will be offered a portion of these seeds to be used for State of Hawaii propagation and outplanting programs. The Army NRS will also seek permission to draw any seed collected on State land that is currently in the seed bank at the Seed Conservation Lab at Lyon Arboretum. The Army NRS will also provide O`ahu NARS staff with information on the disposition of seed and propagules collected in the past from State

land by allowing access to this information from their database and assistance with retrieving this information from their database. The Army NRS will provide an annual report of all Threatened and Endangered plant collections on State land, including

a. Species.
b. Population.
c. Amount of propagules collected.
d. Disposition of propagules collected.

This report shall be separate from the standard annual report produced by Army NRS that encompasses all their activities. The Army Environmental Program will review the records of all past Threatened and Endangered plant species collection on State of Hawaiʻi land and will change the ownership of those collections from the Army to the State of Hawaiʻi.

24. The Army NRS will notify the O`ahu NARS Staff in writing at least one week in advance of any ungulate control activities within O`ahu NARs. Notification will identify the Army NRS staff doing the ungulate control activities, the methods to be used, and a map of the area where the ungulate control work will take place.

25. Permittee is responsible for explaining permit terms to the Army NRS, other Army Environmental Program Staff, individuals contracted by the Army Environmental Program, volunteers, and guests to ensure compliance at all times, including having a copy of the permit in the field at all times. Permittee will also identify the Point of Contact staff person for the day-to-day execution of this permit.

26. Permittee assumes responsibility for damages caused by stabilization actions if such damages are cognizable and payable under appropriate federal statutes and regulations.

27. Permittee will prepare all applicable legal and environmental documents required to conduct the stabilization actions.

28. Permittee will continue to be on, and follow terms of, the U. S. Fish and Wildlife Service Permit Number TE - 826600, and State of Hawai`i Threatened and Endangered Species Permit Number FHM06T&E-06, issued to Dr. Michael Hadfield, who holds the master permits for work on endangered *Achatinella mustelina* tree snails. Army NRS will continue to operate as Sub-Permittees.

______________________________ ____________
JOEL E. GODFREY date
Permittee

______________________________ ____________
PETER T. YOUNG, Chair date
Board of Land and Natural Resources

Appendix III: MMR July 3, 2006 Fire

APVG-GWV (200-3) 5 July 2006

MEMORANDUM FOR RECORD

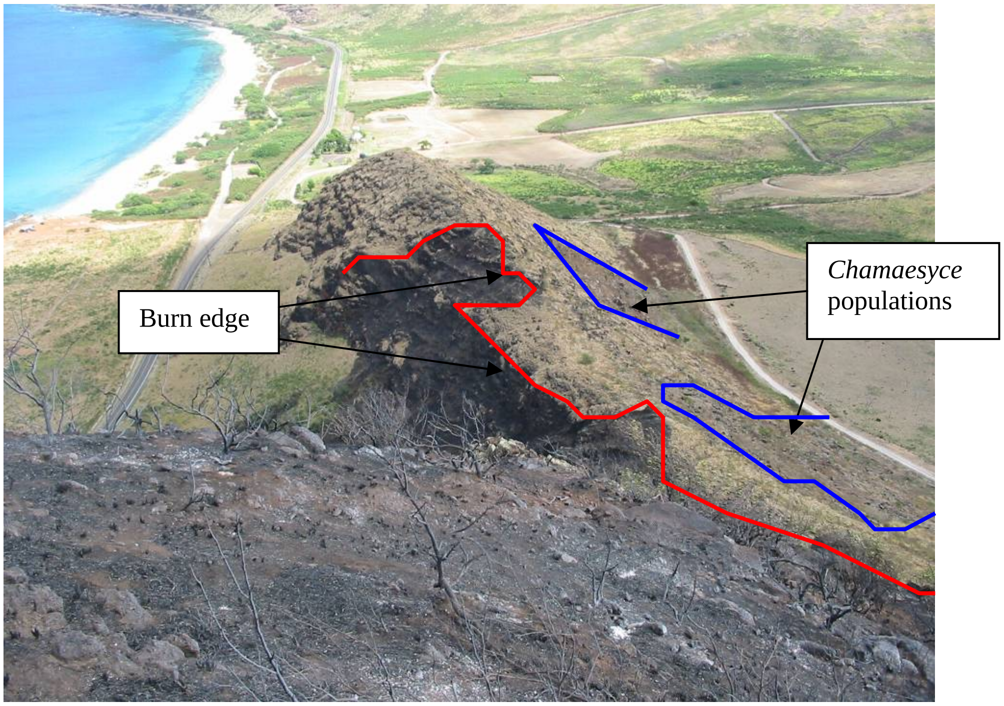
SUBJECT: Reconnaissance for Makua Military Reservation Fire started 7/3/06

On 3 July 2006, a fire started along Farrington Highway near the Kaneana Cave. The suspected cause of the fire is arson (possibly fireworks prior to Independence Day celebrations). See enclosed serious incident report submitted by Chief Enriques, IFSO (Encl. 1)

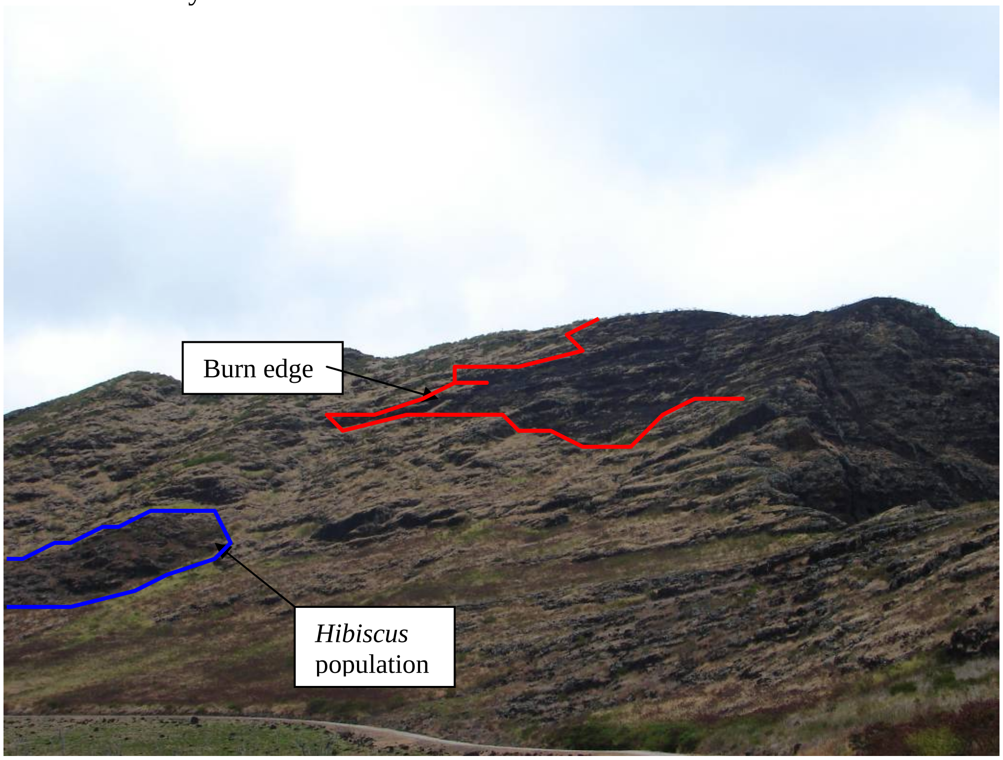
1. Natural Resource Involvement. Natural Resource field crews in Kahanahaiki Management Unit reported the fire at approximately 3:30 pm to the Natural Resource Baseyard. IFSO notified DPW Environmental (Bldg. 105) at approximately 3:45 pm. Peter Yuh called to notify the Natural Resource Office just after he heard the news. Chief Enriques requested Natural Resource Staff to head out to the fire to give guidance regarding where to direct firefighting resources. Ms. Susan Ching Harbin from the Natural Resource Office left the Natural Resource Baseyard for MMR at 3:45 pm. Natural Resource Staff at the baseyard contacted contract helicopter pilots to assist with firefighting activities. Richard Potts with Tropical Helicopters few out to MMR and assisted with water bucket drops. The fire burned approximately 20.2 acres.

2. Extent of Fire. Please see enclosed map showing the fire's extent (Encl 2). In addition photos are also included to illustrate the fires extent where natural resources are a concern.

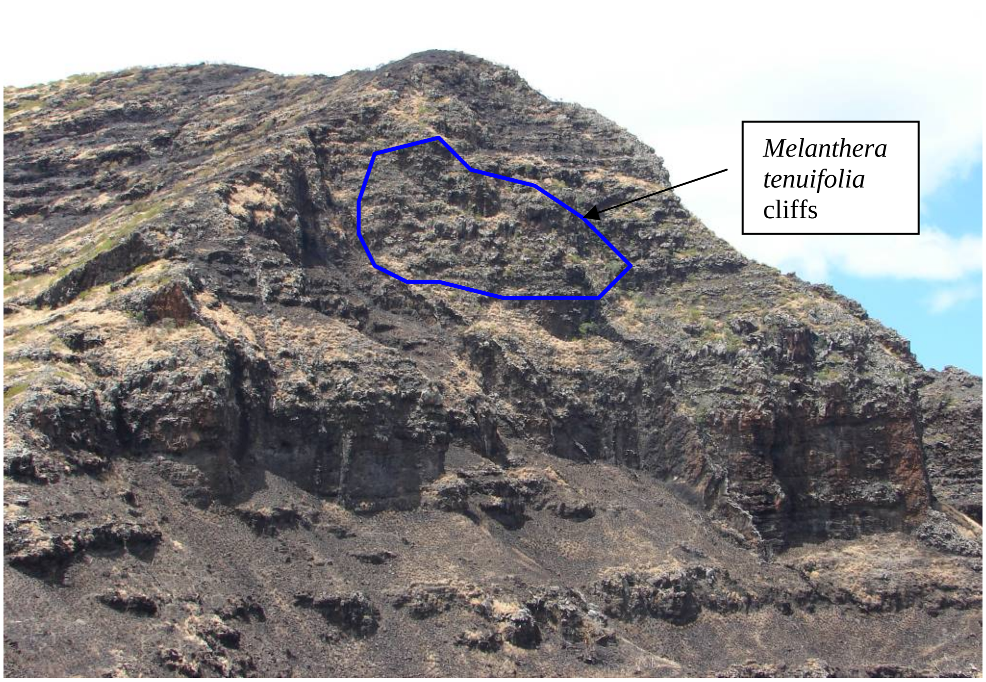
3. Natural Resource Impact. The photograph below is taken from Ohikilolo fence looking north toward Makua Range Control. The blue lines outline the edge of the grass control areas maintained by the Natural Resources Crew to protect two sites with *Chamaesyce celastroides* var. *kaenana*. The closest *Chamaesyce* plant to the edge of the burn was approximately 50 meters away.



The photo below shows the proximity of the fire's edge to the westernmost perimeter of the grass control area maintained by Army Natural Resource Staff to protect *Hibiscus brackenridgei* ssp. *mokuleianus*. Again the edge of the *Hibiscus* grass control area is shown in blue and the fire perimeter is outlined in red. The closest *Hibiscus* plant to the edge of the burn was approximately 150 meters away.



The photo below shows the Makai cliffs of Ohikilolo Ridge. The blue outlined area is the portion of the cliff where NRS have found the endangered daisy plant, *Melanthera tenuifolia*. This part of Ohikilolo ridge has burned numerous times in the past ten years as a result of fire started within MMR and also fires started similar to this one, from arson along Farrington Highway. It is no accident that plants remain on this small cliff. It appears that the cliff is in part naturally protected from fires because of the steep barren cliffs just below. The last monitoring on rappel that NRS conducted at this site was in September 2004. At the time there were 1 juvenile and 10 mature plants. Since NRS have been monitoring the site, the numbers of plants here have fluctuated below 22 total individuals. Although it is difficult to discern from the photo, the area all around the *Melanthera* cliff was blackened and parts of the cliff were singed. Since NRS had not monitored this population more recently, it is impossible to say the number of plants impacted by the heat of the fire. At most 22 plants could have been destroyed. NRS have collected extensively from this population of *Melanthera* as it is so vulnerable to wildfire. In addition, this population is unique in that, elevation-wise, it is the lowest known population.



The common native plants and alien plants which burned are listed in the tables below.

Native Plant Species

Argemone glauca (Puakala)
Dodonaea viscosa (A`ali`i)
Myoporium sandwichensis (Naio)
Psydrax odoratum (Alahe`e)
*Heterpogon contortus (*Pili*)*
Schiedea ligustrina
*Waltheria indica (*Uhaloa*)*
Coccinea trilobus (Huehue)
*Sida fallax (*Ilima*)*
Doryopteris decora

Alien Plant Species
Acacia mearnsii (Klu)
Andropogon virginicus
Chloris barbata
Leonotis nepetifolia
Leucaena leucocephala (Koa Haole)
Opuntia ficus-indica (Panini)
Panicum maximum (Guinnea grass)
Pluchea symphitifolia
Prosopis pallida (Kiawe)
Rhyncheletrum repens (Natal Red Top)
Stapelia gigantea

An additional impact is that the ungulate fence along Ohikilolo ridge burned. A total of approximately 600 meters were burned over, of this, approximately 175 meters had not been burned previously according to our records.

4. POC is the undersigned, 656-7741/7641.

Encl

KAPUA KAWELO
Biologist, Environmental Division

INSTALLATION OPERATION CENTER
Schofield Barracks, Hawaii 96857-5000

SERIOUS INCIDENT REPORT

RECORD DATA

REPORT NUMBER:	060703A	REPORT CATEGORY:	3.19

CATEGORY DESCRIPTION:	Makua Valley Fire

DATE TIME GROUP OF REPORT:	031600JUL06
LOCATION OF INCIDENT:	Vicinity of Kamehameha Hwy (Grid: EJ798050)
DATE TIME GROUP OF INCIDENT:	031600JUL06

SUBJECT: N/A

LAST NAME, FIRST, MI:	N/A
RANK:	N/A
SSN:	N/A
UNIT ASSIGNED TO:	N/A
RACE:	N/A
GENDER:	N/A
AGE:	N/A
MOS:	N/A
SECURITY CLEARANCE:	N/A
DRUG/ALCOHOL INVOLVED [IF YES-TYPE]:	N/A
INJURIES/ILLNESS:	N/A

MARTIAL STATUS:	Single>	N/A	Married>	N/A	Number of Children>	N/A
RESIDENCE:	Government Quarters>	N/A	Unit Billets>	N/A	Off Post>	N/A
OIF:	N/A	OEF:	N/A	REDEPLOYMENT DATE:	N/A	

REPORTING DATA

Reported By:	Chief Enriquez	Received By:	SSG Royce
Duty Position:	IFSO fire Chief	Duty Position:	Emergency Actions Controller
Duty Telephone:	438-3533/3531	Duty Telephone:	655-8763/4

Enclosure 1

NOTIFICATION DATA

Commanding General	E-mail	ADC(O)	E-mail	ADC(S)	E-mail
Chief of Staff	E-mail	DIV CSM	E-mail	Division Surgeon	E-mail
Chief, IOC	2050	Chaplain	E-mail	PMO	E-mail
Senior EA Controller	E-mail	OBSB	N/A	USAG-HI	E-mail
ACofS, G3	E-mail	ACofS, G1	N/A	SJA	E-mail
PAO	E-mail	ACofS, G2	N/A	USARPAC	Informed
SGS	E-mail	ACofS, G4	N/A	Ops Duty Officer	E-mail
Installation Safety	Rpt By	EOD	N/A	DOC NCOIC	E-mail
Subject's Unit	N/A				

IOC….SIR TEMPLATE 060315.doc

REPORT NUMBER:	**060703A**

CHRONOLOGICAL SUMMARY OF INCIDENT

Identify names, duty positions, and duty telephone numbers of persons other then Subjects whenever possible to increase clarity.

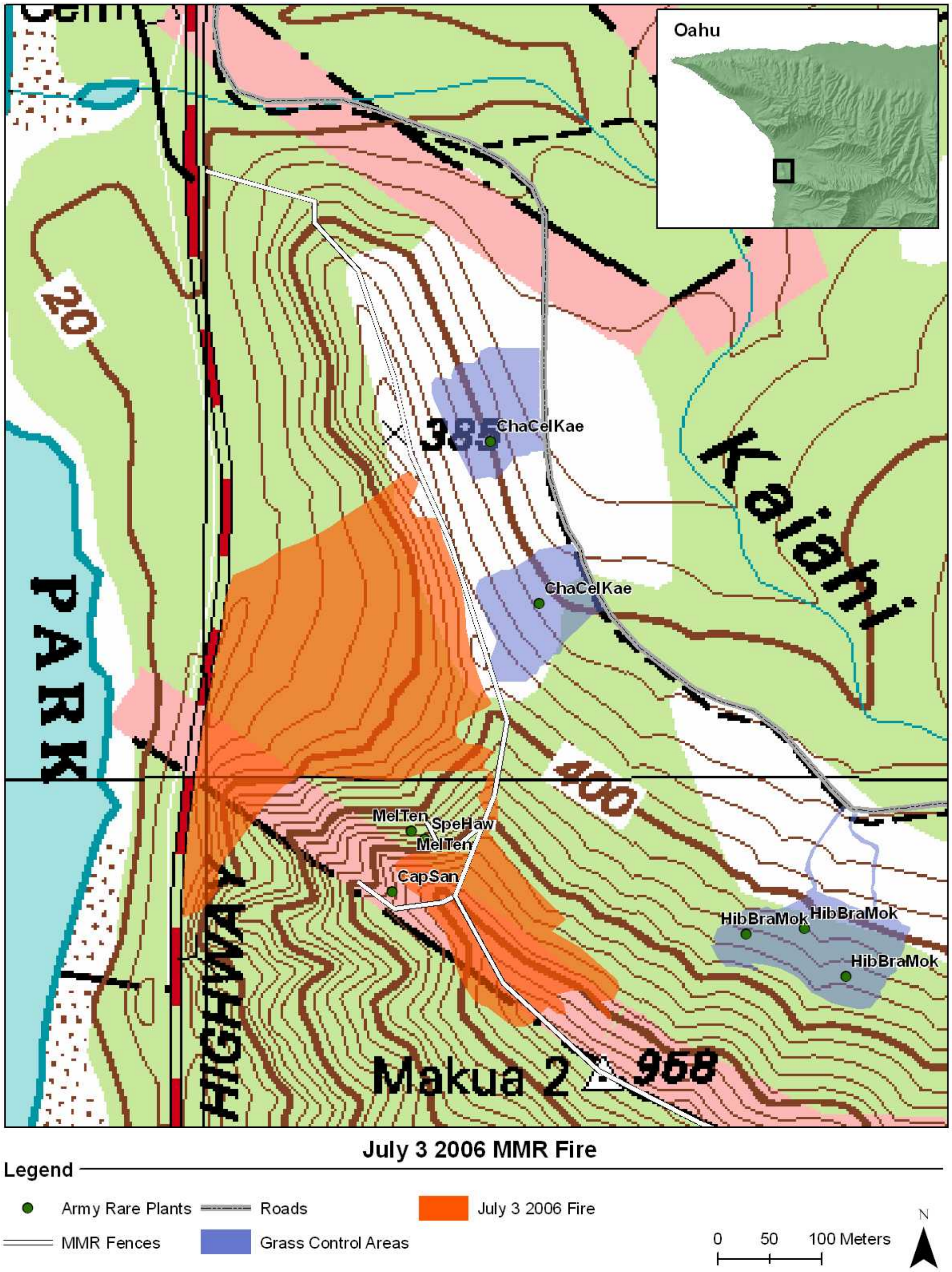
Final: At 032050JUL06, received the following information from Chief Enriquez: the fire is 100% contained with a few hot spots. The Honolulu Fire Department's Air 1 helicopter assisted with 70 drops in four hours of flight time and the contracted helicopter assisted with 43 drops in two hours of flight. An environmental team made an unofficial assessment and will be back on 5 JUL 06 to do an official assessment of environmental damage. At 040600JUL06, the Army Wildland Fire will return to check on hot spots. Until then, Makua Range Control will maintain hourly observation. The cause of the fire has been determined to start roadside from an unknown source.

The point of contact for this report is Chief Enriquez, IFSO at 438-3533. This is a final report.

At 031600JUL06, the Installation Operation Center, USAG-HI received the following information from Chief Enriquez IFSO, Fire Chief: At 031507JUL06, received call from Fed Fire Dispatch (Ms. Colleen) that there is a 10 acre brush fire in Makua Valley (vicinity: EJ798050) and are coordinating with USARPAC for fire bucket support. The cause of fire is currently unknown Currently FFD has Engine 111, Brush Tanker 105, and two HFD engines, and one Air One along with Chief Enriquez (USAG-HI –IFSO) is on-scene. Two contracted aircrafts have been requested and are enroute. The winds are currently blowing at 9 mph from the north to the south, causing the fire to spread towards Kamehameha Hwy. It is too early to report percentage of fire contained. At 031530JUL06, Makua Valley Range control has informed DPW and requested for an Environmental Survey Team.

The point of contact for this report is Chief Enriquez, IFSO at 438-3533/31. This is an initial report.

Enclosure 1



Oahu
20
PARK
385
ChaCelKae
ChaCelKae
Kaiahi
400
MelTen
SpeHaw
MelTen
CapSan
HibBraMok
HibBraMok
HibBraMok
HIGHWAY
Makua 2
968
July 3 2006 MMR Fire
Legend
Army Rare Plants
Roads
July 3 2006 Fire
MMR Fences
Grass Control Areas
0
50
100 Meters
N

Enclosure 2

Appendix II: SBW June 26, 2006 Fire

APVG-GWV 26 June 2006

MEMORANDUM FOR RECORD

SUBJECT: Reconnaissance for Fires at Schofield Barracks, West Range started on 6/15/06

1. On 26 June 2006 Kapua Kawelo (Biologist, USAG-HI), Krista Winger (Army Natural Resources), Eric Vanderwerf and Dawn Greenlee (U.S. Fish and Wildlife Service) and Charles Donaldson (Donaldson Enterprises Inc.) conducted a survey of the damage done by fires at Schofield West Range on 6/15/06. The purpose of the survey was to compile an exact map of the fire's extent and to assess impacts upon federally listed species and critical habitat for Oahu `Elepaio.

2. Maps displaying the extent of the fires is attached (encl. 1 & 2). A total of 3.89 acres burned in this fire. The Army is still determining the cause of the fire. It may have been caused by tracer ammunition. The fire extended from the firebreak road at 1,600 feet in elevation to approximately 1900 feet on the ridge top. The vegetation burned in this fire was dominated by *Eucalyptus robusta* (See the photo below). Very few native trees were present in and adjacent to the burned area. For a list of plants which burned and birds detected in the vicinity of the burn see enclosure 2. No known federally listed species are known from the burn location. Although this fire affected primarily *Eucalyptus robusta*, the northern and western edges of the burn destroyed thick alien forest dominated by *Psidium cattleianum*. This forest type is considered suitable habitat for Oahu Elepaio (*Chasiempis sandwichensis* ssp. *ibidis*) while the *Eucalyptus robusta* dominated forest is considered marginal habitat for Oahu Elepaio.

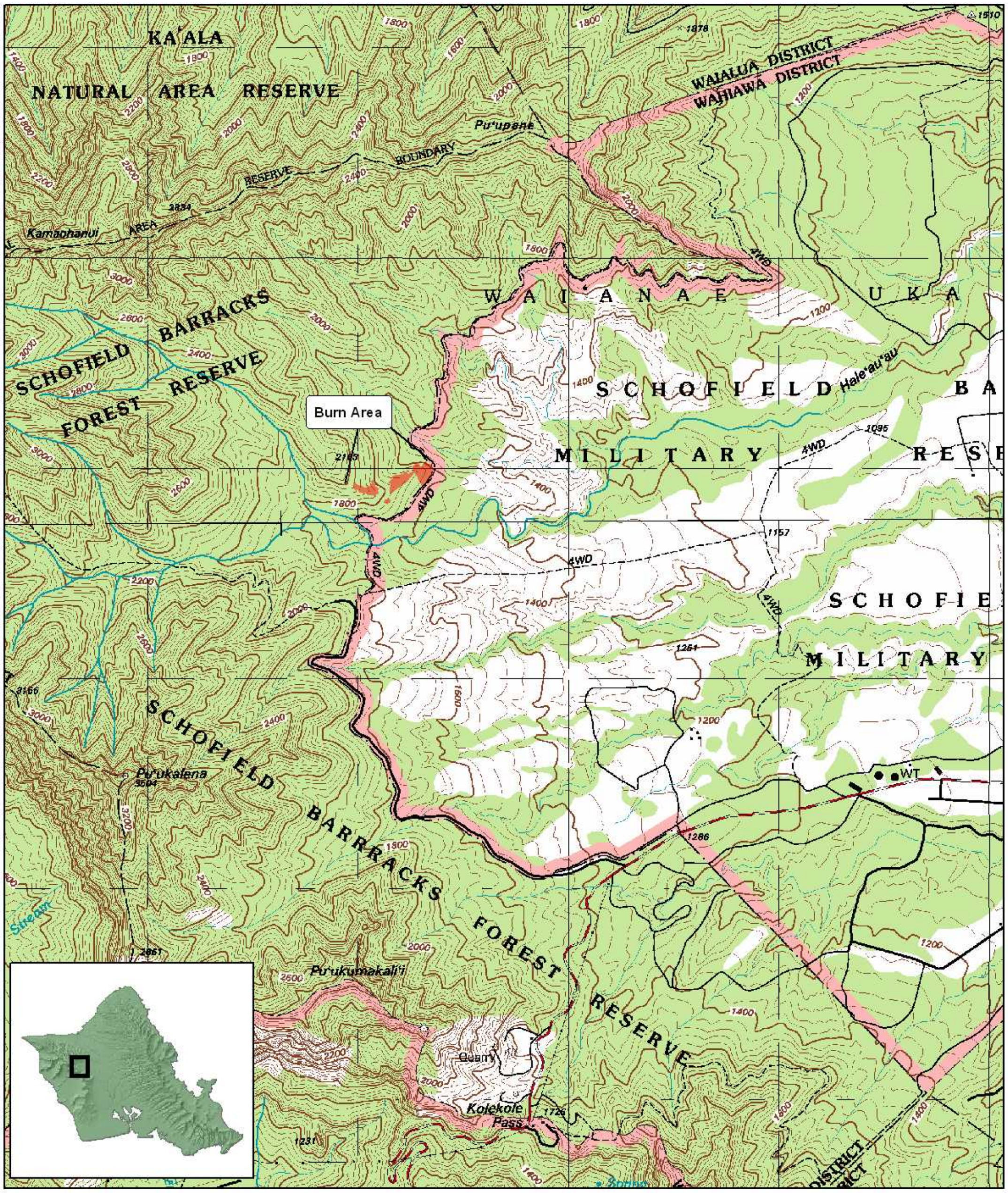
3. No rare plants or animals were impacted in this fire. The closest known Oahu Elepaio territory is 280 meters southwest from the western edge of the fire perimeter. This point is represented on the enclosed map. During the most recent observation in 2005, this territory was occupied by a lone male bird. A total of 2.44 acres of critical habitat designated for Oahu Elepaio was burned. The critical habitat that burned is a very small portion of that designated statewide and it was unoccupied habitat. The negative effect of this fire on the approximately 2.44 acres of Oahu Elepaio critical habitat is small considering that the total acreage of the designation is 66,354 acres.

4. POC is the undersigned, 656-7641/7741.

2 Encls

KAPUA KAWELO
Biologist, Environmental Division

Map removed,
available upon request



Schofield Barracks West Range

Legend

Burn Area

Enclosure 2

0 315 630 Meters

N

Plants and Animals Affected by the June 2006 SBW Fire

Native Plants

Scientific Name	Common Name
Acacia koa	Koa
Microlepia strigosa	Palapalai

Non-Native Plants

Scientific Name	Common Name
Acacia confusa	Formosan koa
Blechnum appendiculatum	None
Buddelia asiatica	Dog Tail
Casurina equisetifolia	Ironwood
Christella parasitica	None
Clidemia hirta	Koster's curse
Cordline fruticosa	Ti
Eucalyptus robusta	Swamp Mahogany
Ficus sp.	None
Grevillea robusta	Silk Oak
Lophostemon confertus	Brush box
Melaleuca quiquinervia	Paperbark
Melia azedarach	Chinaberry
Nephrolepis multiflora	Sword fern
Oplismenus hirtellus	Basket Grass
Panicum maximum	Guinnea grass
Passiflora suberosa	Corky Passion Vine
Psidium cattleianum	Strawberry guava
Schinus terebinthifolius	Christmas berry
Spathodea campanulata	African Tulip
Syzygium jambos	Rose Apple
Toona ciliata	Australian Red Cedar

Native Birds

Scientific Name	Common Name
Hemignathus virens	Amakihi

Non-Native Birds

Scientific Name	Common Name
Leiothrix lutea	Red-Billed Leiothrix
Paroaria coronata	Red Crested Cardinal
Pynonotus jocosus	Red-Whiskered Bulbul
Zosterops japonicus	Japanese White-Eye

Appendix IV: MMR Keawaula July 12, 2006 Fire

MMR Keawa`ula Post Fire Survey
July 25, 2006

APVG-GWV (200-3) 25 July 2006

MEMORANDUM FOR RECORD

SUBJECT: Reconnaissance for Fire burning into Makua Military Reservation, started on 7/12/06 in the Keawa`ula area, north of Makua Valley.

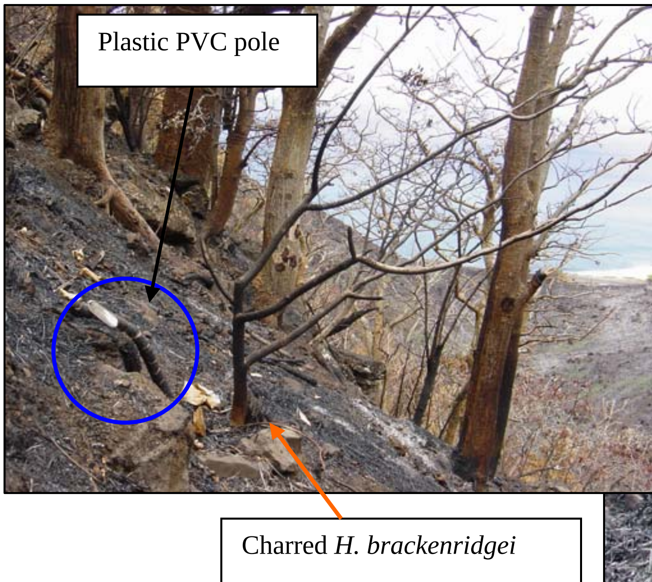
At 10:30pm on 12 July 2006, a fire was ignited in the Keawa'ula Beach Park area, north of Makua Military Reservation. According to the Honolulu Fire Department, the cause of the fire is arson; however the exact location where the fire began is unknown. On 25 July 2006, Natural Resource Staff members, Larry Abbott and Lasha-Lynn Salbosa, conducted a fire assessment survey to generate an exact map of the fires' encroachment in to Makua Military Reservation and to assess impacts to a reintroduction site and an existing wild site of federally listed plant species. A total of approximately 754 acres burned both on State and Military lands.

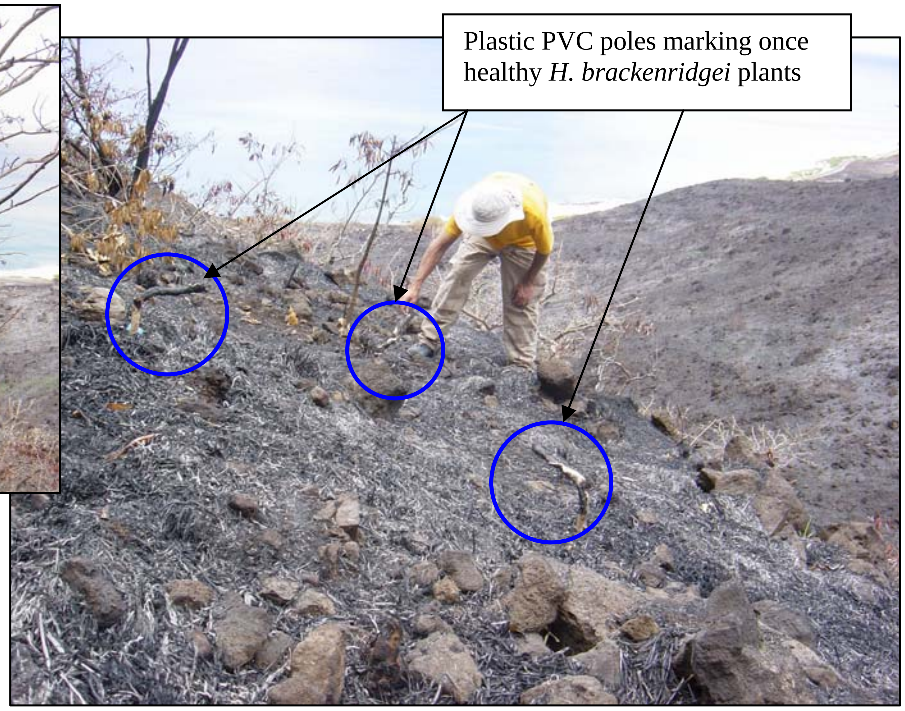
1. <u>Natural Resource Involvement.</u> Natural Resource Staff, Kaleo Wong and Julia Gustine were headed to Makua Valley to conduct rare plant monitoring. They diverted their trip when they saw the smoke from Keawaula, out of concern for the resources in the Kaluakauila Management Unit. They drove up the Yokohama road to the incident command center and remained there for approximately three hours in order keep our office informed of the status of the fire and to provide advice on the need for additional helicopter resources. Army Natural Resources called in and paid for additional helicopter support to battle the blaze. A total of 7K was spent and based on comments from the Division of Forestry and Wildlife staff, the contract helicopter support was critical in extinguishing the blaze in one day and protecting critical resources.

   Ms. Gustine and Mr. Wong left the Incident Command Center to return to their originally planned work. As they drove down the paved road to the Yokohama guard shack to return to MMR, they observed a back burn which was started to protect the cellular phone building near the bottom of the road. The need for this to protect the structure was logical. While waiting for the road to re-open, they observed that a back burn was conducted not only from near the building but also from that building down along the road to the Yokohama guard shack. It appeared that the back burn conducted was larger than necessary and that it increased the size of the fire's front. The front of the fire was being held on the north side of Kaluakauila gulch until this back burn was initiated. The ultimate result was that the fire crossed the gulch to the south side and subsequently burned into the Kaluakauila Management Unit. It is our observation that this may have been avoided had the back burning only focused around the building it was intended to protect. What this incident shows is that Army interests need to be better represented at these types of fires. It also shows that resource maps must be distributed to the fire crews on site at these fires. Natural Resource Staff will be making field maps to give to Army Wildland fire crews and will have some on hand to take to fires in the future.

2. <u>Extent of Fire.</u> Please see enclosed map showing the extent of the fire near Makua Military Reservation (Encl 1). In addition photos are also included to illustrate the fires' extent where natural resources are a concern.

3. Natural Resource Impact. The following photographs below are taken near the Kaluakauila Fenceline looking down slope and out into Keawa'ula Bay. At this location there is a reintroduction site of endangered *Hibiscus brackenridgei* subsp. *mokuleianus*, planted 10 December 2002. Highlighted in the photographs are charred remains of *H. brackenridgei* and plastic PVC poles used to mark each plant location. A number of other native plant species were also burned. See below for a partial list of native and alien species surveyed. It is estimated that 90 percent of the reintroduction site has been severely burned.



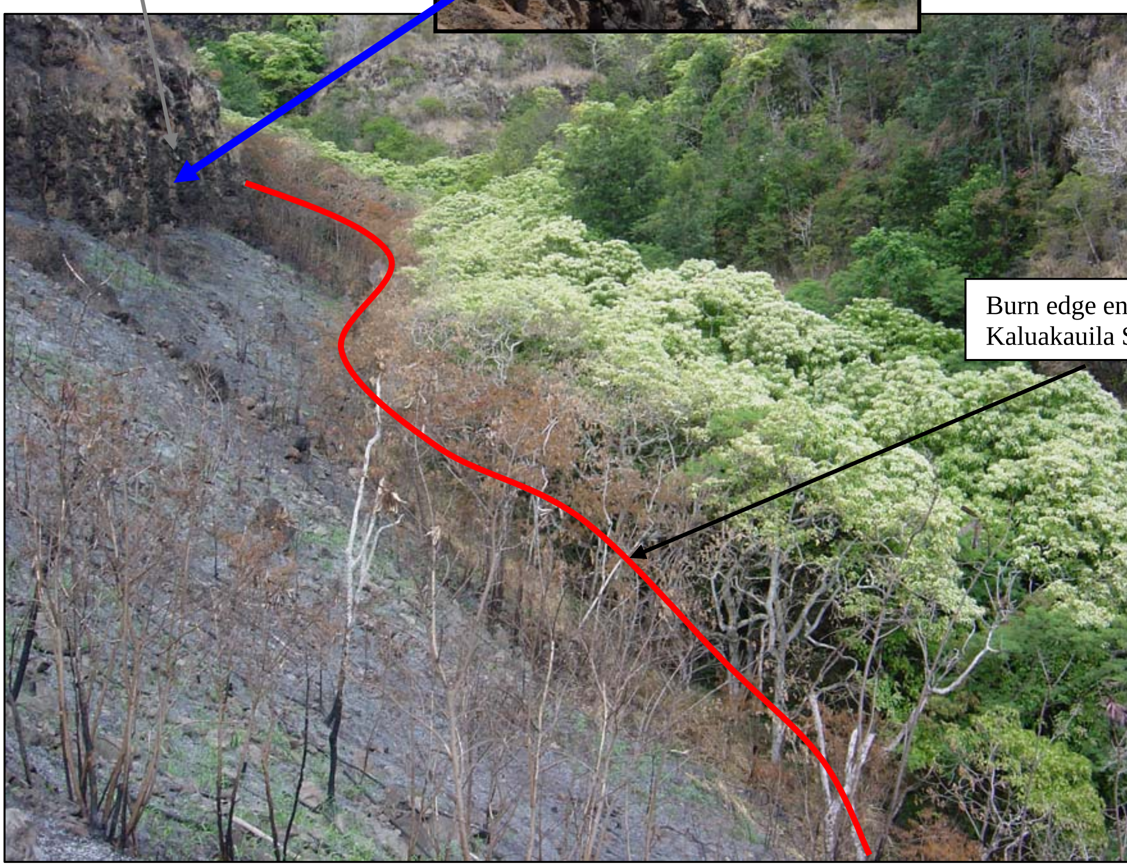


The following photographs are taken on the southeastern facing slope of Kaluakauila Stream at the wild site of the endangered *Chamaesyce celastroides* var. *kaenana* plant species. The area along the slope and cliff side appear to be severely burned.

Further monitoring will be done to determine whether or not *C. celastroides* var. *kaenana* will survive at this site.

Rare plant monitoring tag for *C. celastroides* var. *kaenana*

Wild site of rare plant *C. celastroides* var. *kaenana*

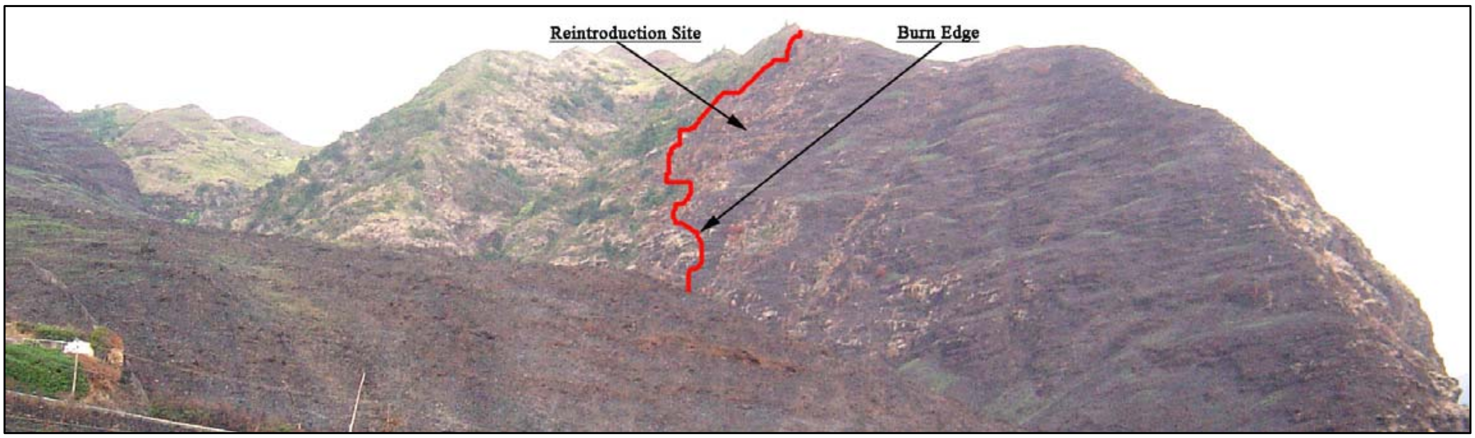


Burn edge encroaching in to Kaluakauila Stream

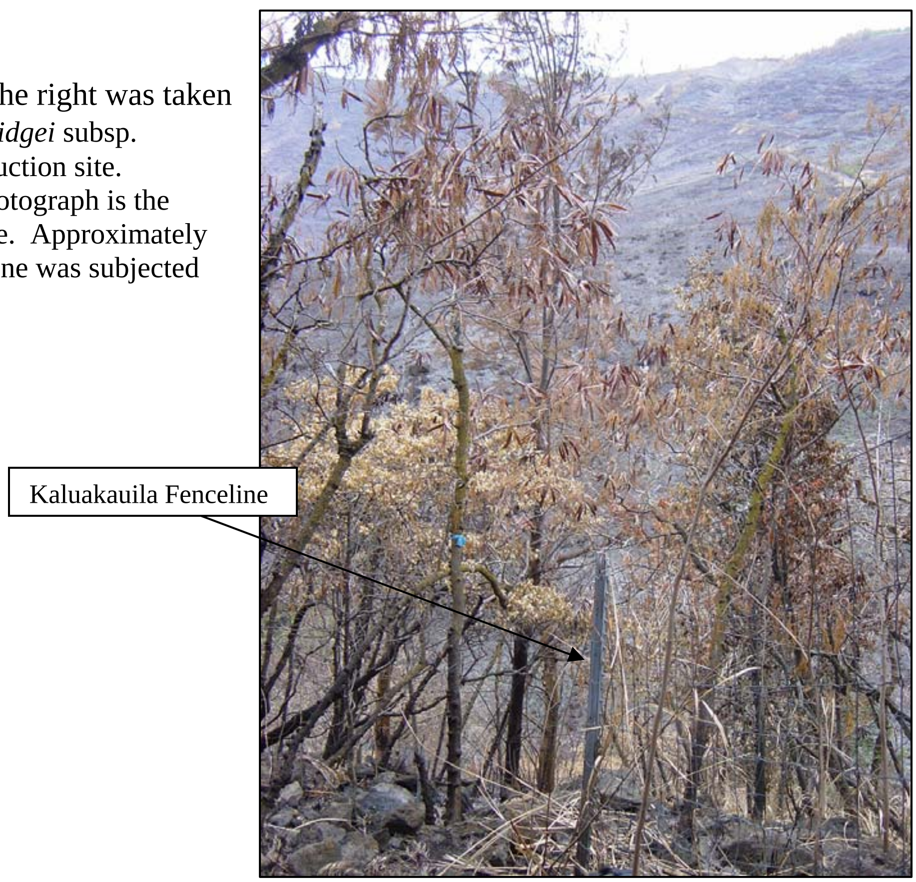
The following is a list of Native and Alien plant species surveyed in the burn area.

Native Plant Species	**Alien Plant Species**
Diospyros sandwicensis	*Leucaena leucocephala*
Santalum ellipticum	*Panicum maximum*
Hibscus brackenridgei subsp. *mokuleianus*	*Grevillia robusta*
Dodonaea viscosa	*Melinus minutiflora*
Erythrina sandwicensis	
Sida fallax	
Psydrax odoratum	
Chamaesyce celastroides var. *kaenana*	

The photograph below illustrates the extent of the fire along the northwest facing slope of Kaluakauila Stream. Outlined in the photograph is the surveyed burn edge of the fire and reintroduction site of *H. brackenridgei* subsp. *mokuleianus*.



The photograph to the right was taken near the *H. brackenridgei* subsp. *mokuleianus* reintroduction site. Highlighted in the photograph is the Kaluakauila Fenceline. Approximately 500 meters of fence line was subjected to fire.



Map removed,
available upon request

Appendix V: Taxa Abbreviations

Taxa Abbreviations	Taxa
Abugra	Abutilon grandifolium
Acacon	Acacia confusa
Acafar	Acacia farnesiana
Acaman	Acacia mangium
Acamea	Acacia mearnsii
Achasp	Achyranthes aspera var. aspera
Adihis	Adiatum hispidulum
Adirad	Adiantum radianum
Agasis	Agave sisalana
Ageade	Ageratina adenophora
Agerip	Ageratina riparia
Agecon	Ageratum conyzoides
Alemol	Aleurites moluccana
Alomac	Alocasia macrorrhiza
Altses	Alternanthera sessilis
Alyvag	Alysicarpus vaginalis
Amaspi	Amaranthus spinosus
Amavir	Amaranthus viridis
Ambart	Ambrosia artemisiifolia
Anaarv	Anagallis arvensis
Andvir	Andropogon virginicus
Angeve	Angiopteris evecta
Antodo	Anthoxanthum odoratum
Aracol	Araucaria columnaris
Arcale	Archontophoenix alexandrae
Ardcre	Ardesia cretica
Ardell	Ardesia elliptica
Artcil	Arthrostemma ciliatum
Arugra	Arundia gramminifolia
Ascphy	Asclepias physocarpa
Asygan	Asystasia gangetica
Atrsem	Atriplex semibaccata
Avefat	Avena fatua
Axocom	Axonopus compressus
Axofis	Axonopus fissifolius
Bidalb	Bidens alba
Bidpil	Bidens pilosa
Bleapp	Blechnum appendiculatum
Boecoc	Boerhavia coccinea
Botper	Bothriochloa pertusa
	Bouganvillea sp.
Bramut	Brachiaria mutica
Brasub	Brachiaria subquadripara
Brexmad	Brexia madagascariensis
Brugym	Bruguiera gymnorrhiza
Budasi	Buddleia asiatica

Taxa Abbreviations	Taxa
Budmad	Buddleia madagascariensis
Caedec	Caesalpinia decapetala
	Callitris sp.
Calvia	Calyptocarpus vialis
Cancat	Canavalia cathartica
Carpap	Carica papaya
Casarv	Castilleja arvensis
Casela	Castilloa elastica
Casequ	Casuarina equisetifolia
Casgla	Casuarina glauca
Cecobt	Cecropia obtusifolia
	Cedar sp.
Cencil	Cenchrus ciliaris
Cenech	Cenchrus echinatus
Cenery	Centaurium erythraea
Cenasi	Centella asiatica
Cerfon	Cerastium fontanum subsp. triviale
Cesnoc	Cestrum nocturnum
Chanic	Chamaecrista nictitans var. glabrata
Chahir	Chamaesyce hirta
Chahyp	Chamaesyce hypericifolia
Chapro	Chamaesyce prostrata
Chemur	Chenopodium murale
Chivir	Chielanthes viridis (green cliff break)
Chlbar	Chloris barbata
Chlrad	Chloris radiata
	Chloris sp.
Chlvir	Chloris virgata
Chrden	Christella dentata
Chrpar	Christella parasitica
Chroli	Chrysophyllum oliviforme
Chraci	Chrysopogon aciculatus
Ciclep	Ciclospermum leptophyllum
Cinbur	Cinnamomum burmannii
Cirvul	Cirsium vulgare
Citcau	Citharexylum caudatum
Citspi	Citharexylum spinosum
	Citrus sp.
Clihir	Clidemia hirta
Cluros	Clusea rosea
Cocgra	Coccinia grandis
Codvar	Codiaeum variegatum
Cofara	Coffee arabica
Coilac	Coix lachryma-jobi
Comdif	Commelina diffusa
Conbon	Conyza bonariensis

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Taxa Abbreviations	Taxa
Corgla	Cordia glabra
Corfru	Cordyline fruticosa
Cordid	Coronopus didymus
Corlae	Corynocarpus laevigatus
Cracre	Crassocephalum crepidioides
Criaug	Crinum augustum
Criasi	Crinum asiaticum
CroXcro	Crocosmia X crocosmiifolia
Cropal	Crotalaria pallida
Croret	Crotalaria retusa
Cupcar	Cuphea carthenagensis
Cyacin	Cyanthillium cinereum
Cyclep	Cyclospermum leptophyllum
Cyodac	Cynodon dactylon
Cypgra	Cyperus gracilis
Cyprot	Cyperus rotundus
	Cypress sp.
Datstr	Datura stramonium
Daupus	Daucus pusillus
Deppet	Deparia petersenii
Desvir	Desmanthus virgatus
Desinc	Desmodium incanum
Desint	Desmodium intortum
Dessan	Desmodium sandwicense
Destor	Desmodium tortuosum
Destri	Desmodium triflorum
Digcil	Digitaria ciliaris
Digins	Digitaria insularis
	Digitaria sp.
Digvio	Digitaria violascens
	Dracaena
	Echinochloa sp.
Ehrsti	Ehrharta stipoides
Elegen	Eleocharis geniculata
Eleobt	Eleocharis obtusa
Elerad	Eleocharis radicans
Eleind	Eleusine indica
Emifos	Emilia fosbergii
Emison	Emilia sonchifolia
EpiXobr	Epidendrum X obrienianum
Epipinaur	Epipremnum pinnatum var.aureum
Eraelo	Eragrostis elongata
Eraten	Eragrostis tenella
Erival	Erichtites valerianifolia
Erikar	Erigeron karvinskianus
Erijap	Eriobotrya japonica

Taxa Abbreviations	Taxa
Eucglo	Eucalyptus globulus
Eucrob	Eucalyptus robusta
	Eucalyptus sp.
Euphet	Euphorbia heterophylla
Euppep	Euphorbia peplus
	Euphorbia sp.
Falmol	Falcataria moluccana
Ficmic	Ficus microcarpa
	Ficus sp.
Frauhd	Fraxinus uhdei
Gampur	Gamochaeta purpurea
Neowig	Neonotonia wightii
Gomglo	Gomphrena globosa
Goshir	Gossypium hirsutum
Greban	Grevillea banksii
Grerob	Grevillea robusta
Haecam	Haematoxylum campechianum
Hedcor	Hedychium coronarium
Hedfla	Hedychium flavescens
Hedgar	Hedychium gardnerianum
Helpop	Heliocarpus popayanensis
Helprodep	Heliotropium procumbens var. depressum
	Hibiscus sp.
Hibtil	Hibiscus tiliaceus
Hollan	Holcus lanatus
Hypruf	Hyparrhenia ruffa
Hypgla	Hypochoeris glabra
Hyorad	Hypochoeris radicata
	Hypochoeris species
Hyppec	Hyptis pectinata
	Hyptis sp.
Indspi	Indigofera spicata
Indsuf	Indigofera suffruiticosa
Ipoalb	Ipomoea alba
Ipobat	Ipomoea batatas
Ipocai	Ipomoea cairica
Ipoobs	Ipomoea obscura
Ipooch	Ipomoea ochracea
	Ipomoea sp.
Ipotri	Ipomoea triloba
Ipovil	Ipomoea viloaceae
	Iris sp.
Jasflu	Jasminum fluminense
Junpla	Juncus planifolius
	Juniperus sp.

Appendix V: Taxa Abbreviations

Taxa Abbreviations	Taxa
Jusbet	Justicia betonica
Kalcre	Kalanchoe crenata
Kalpin	Kalanchoe pinnata
Kylbre	Kyllinga brevifolia
Kylnem	Kyllinga nemoralis
Labpur	Lablab purpureus
Lancam	Lantana camara
Leonep	Leonotis nepetifolia
Lepfla	Leptospermum flavescens
Lepsco	Leptospermum scoparium
Leuleu	Leucaena leucocephala
Lintri	Linum trigynum
Livchi	Livistona chinensis
Lopcon	Lophostemon confertus
Ludoct	Ludwigia octovalis
	Lychee sp.
Lycesc	Lycopersicon esculentum
Lycpim	Lycopersicon pimpinellifolium
Macint	Macadamia integrifolia
Macmap	Macaranga mappa
Macung	Macfadyena unguis-cati
Macatr	Macroptilium atropurpureum
Maclat	Macroptilium lathyroides
Macaxigla	Macrotyloma axillare var. glabrum
Malpar	Malva parviflora
Malcor	Malvastrum coromandelianum
Malpen	Malvaviscus penduliflorus
Manind	Mangifera indica
Medlup	Medicago lupulina
Medpol	Medicago polymorpha
Melqui	Melaleuca quinquenervia
Melcan	Melastoma candidum
Melaze	Melia azedarach
Melmin	Melinis minutiflora
Melumb	Melochia umbellata
Meraeg	Merremia aegyptia
Mertub	Merremia tuberosa
Mimpuduni	Mimosa pudica var. unijuga
Momcha	Momordica charantia
Mondel	Monstera deliciosa
Monhib	Montanoa hibiscifolia
Morcit	Morinda citrifolia
	Musa sp.
Myrfay	Myrica faya
Nepmul	Nephrolepis multiflora
Nerole	Nerium oleander

Taxa Abbreviations	Taxa
Nicphy	Nicandra physalodes
Ocigra	Ocimum gratissimum
Odocus	Odontonema cuspidatum
Oplhir	Oplismenus hirtellus
Opufic	Opuntia ficus-indica
Opucoc	Opuntia cochenillifera
Oxacorn	Oxalis corniculata
Oxacory	Oxalis corymbosa
Oxypan	Oxyspora paniculata
Panmax	Panicum maximum
Parfal	Paraserianthes falcataria
Pascon	Paspalum conjugatum
Pasdil	Paspalum dilatatum
Pasfim	Paspalum fimbriatum
	Paspalum sp.
Pasurv	Paspalum urvillei
Pasedu	Passiflora edulis
Pasfoe	Passiflora foetida
Paslau	Passiflora laurifolia
Paslig	Passiflora ligularis
Pasmol	Passiflora mollissima
Passub	Passiflora suberosa
Pencla	Pennisetum clandestinum
Penpol	Pennisetum polystachion
Penpur	Pennisetum purpureum
Penset	Pennisetum setaceum
Perame	Persea americana
Phatan	Phaius tankervilleae
	Philodendron
Phlaur	Phlebodium aureum
Phyded	Phyllanthus debilis
Phyten	Phyllanthus tenellus
Phynig	Phyllostachys nigra
Phygro	Phymatosorus grossus
Phyper	Physallis peruviana
Pilmic	Pilea microphylla
Pimdio	Pimenta dioica
	Pinus sp.
Pitdul	Pithecellobium dulce
Pitaus	Pityrogramma austroamericana
Pitcal	Pityrogramma calomelanos
Plalan	Plantago lanceolata
Plamaj	Plantago major
Plucar	Pluchea carolinensis
Pluind	Pluchea indica
	Plumeria sp.

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Taxa Abbreviations	Taxa
Polpan	Polygala paniculata
Porole	Portulaca oleracea
Porpil	Portulaca pilosa
Propal	Prosopis pallida
Psicat	Psidium cattleianum
Psigua	Psidium guajava
Pteglo	Pterolepis glomerata
Rhiman	Rhizophora mangle
Rhotom	Rhodomyrtus tomentosa
Rhyrep	Rhynchelytrum repens
	Rhyncospora sp. (Beak-rush)
Riccom	Ricinus communis
Rivhum	Rivina humilis
	Roystonea sp.
Rubarg	Rubus argutus
Rubros	Rubus rosifolius
Ruebre	Ruellia brevifolia
Ryncad	Rynchospora caduca
Sacspo	Saccharum spontaneum
Sacind	Sacciolepis indica
Salcoc	Salvia coccinea
Salocc	Salvia occidentalis
Samsam	Samanea saman
Sanalab	Santalum album
Schact	Schefflera actinophylla
Schter	Schinus terebinthifolius
Schgla	Schizostachyum glaucifolium
Senmad	Senecio madagascarensis
Sensur	Senna surattensis
Setgra	Setaria gracilis
Setpal	Setaria palmifolia
Sidrho	Sida rhombifolia
Sidspi	Sida spinosa
Sidmic	Sidastrum micranthrum
Solame	Solanum americanum
	Solanum sp.
Sonole	Sonchus oleraceus
Spacam	Spathodea campanulata
Spapli	Spathoglottis plicata
Speass	Spermacoce assurgens
Sphcoo	Sphaeropteris cooperi
Sphtri	Sphagneticola triloba
Spoind	Sporobolus indicus
Staarv	Stachys arvensis
Stadic	Stachytarpheta dichotoma
Stajam	Stachytarpheta jamaicensis

Taxa Abbreviations	Taxa
	Stachytarpheta sp.
Staurt	Stachytarpheta urticifolia
Stagig	Stapelia gigantea
Styfru	Stylosanthes fruticosa
Swimah	Swietenia mahagoni
Synnod	Synedrella nodiflora
Syzcum	Syzygium cumini
Syzjam	Syzygium jambos
Syzmal	Syzygium malaccense
Taroff	Taraxacum officinale
Tercat	Terminalia catappa
Termyr	Terminalia myriocarpa
Thepop	Thespesia populnea
Thugra	Thunbergia grandiflora
Tiburv	Tibouchina urvilleana
Toocil	Toona ciliata
Treori	Trema orientalis
Tripro	Tridax procumbens
Triarvarv	Trifolium arvense var. arvense
Tridub	Trifolium dubium
Trisem	Triumfetta semitriloba
Verlit	Verbena litoralis
Verenc	Verbesina encelioides
Vulbro	Vulpia bromoides
Wedtri	Wedelia trilobata
Xanstrcan	Xanthium strumarium var. canadense
Youjap	Youngia japonica
Zinzer	Zinziber zerumbet

Appendix VI: RESULTS SUMMARY: *Dodonaea viscosa* seeding experiment at Lower Ohikilolo

A study was undertaken in December 2005 to assess the validity of broadcast seeding as a method to increase the establishment and cover of a native shrub, *Dodonaea viscosa*, both inside and outside a current invasive species grass control area. Within the grass control area, invasive grass has been sprayed with herbicide in an effort to reduce its cover and as a result the vegetation in this area is dominated by *D. viscosa* and native herbaceous plants. The adjacent area is dominated by the invasive guinea grass, *Panicum maximum*, which reaches near 100% cover in most untreated areas.
The hypothesis was that a greater percentage of *D. viscosa* seeds would germinate and establish in the grass control area where the soil is exposed and there is less competition for space and light than in the adjacent *Panicum maximum* dominated areas.

Five 1 x 1 m quadrats were established and marked inside the grass control area and five were located outside but adjacent to the grass control area on December 13, 2005. The soil within each quadrat was left undisturbed and 500 heat scarified seeds were broadcast in each. The seeds were broadcast evenly throughout each quadrat by hand. The presence of any *D. viscosa* seedlings in the quadrats was noted.

The number of seedlings was counted 2 days after the first significant rain fell on January 3, 2006 and again on January 12, 2006. No seedlings were found in the quadrats outside the grass control area. Inside the grass control area ungerminated seeds as well as seedlings were observed on both dates. The quadrats may be reexamined at any time in order to determine the long term success of this method for increasing cover of *D. viscosa* at this site.

In conclusion, it appears as if broadcast seeding in areas without any control of invasive grass will not produce the desired increase in *D. viscosa* cover. In order to evaluate the success of the method within an area of grass control the quadrats will need to be revisited and the fate of the seedlings determined.

Table 1. Number seedlings observed within each quadrat either inside grass control area or outside

Date	Inside	Outside
Initially	0	0
1/3/06	1	0
1/12/06	16	0

Appendix VIII: Snail ground shell plot methodology

Purpose: Ground shell plots are set up in order to help assess current threats to snails at a given site and the effectiveness of our predator control actions. Recently deceased shells that are collected can be examined for rat damage and the age distribution of these shells provides clues to the health of the overall population. For example, if several recently deceased immature shells are collected, the population is suffering a dramatic decline. However, if only larger mature shells are collected the population is probably growing, mortality is due to normal causes, and the population does not require intervention.

Method: Locate an area that is densely populated with the species of interest.

Determine the center of density. This can be a tree, several small trees, or an area of vegetation that appears to contain a large number of snails.

The plot can be as large as ~5 x 5 m or as small as ~1 x 1 m. In certain cases the plot will need to be smaller, which is acceptable so long as it is demarcated. Pound PVC posts or other permanent marking in each of the 4 corners of the plot. Plots can be any shape that can be delineated with 4 corners marked. Fasten a metal tag with the plot number to one corner post and GPS the plot location.

Once the four corners have been demarcated, use flagging to outline the boundaries of the plot. Fill out the ground shell search data sheet with plot information, date and initials of searchers.

Assign sections to be searched by all searchers and work to the boundaries of the plot and to your assigned area being mindful not to extend you search beyond the bounds of the plot.

Searching: remove and 'sift' through all leaf litter for shells. Collect all shells in a zip lock bag labeled with the plot number and date of the search as well as your initials. The top of the soil should be slightly disturbed and raked with finger tips and bases of plants such as sedges and grasses must be separated and searched.

Note the presence of shell caches which are defined as groups of shells occurring at the same location that appear to be rat predated, live or dead *Euglandina rosea*, the number of each and collect or kill any that are found, and the number and species of slugs found. If live slugs or *E. rosea* are collected place each *E. rosea* in their own container properly labeled with location, date and your initials and all slugs in a separate container (not the shell bags or the *E. rosea* containers) and label with the location, date and your initials.

Continue searching until all areas within the plot have been searched and all searchers are satisfied that the area has been cleared of all shells.

BE MINDFULL OF THE SHINY SHELLS. Newly deceased specimens of *Achatinella* spp. will be shiny and should be investigated to determine if the specimen is in fact dead. Live snails sometimes fall from trees and appear to be dead. Live shells will usually not have any mud or debris clinging to the inside of the lip of the shell and can be persuaded to come out by leaving them on a moist leaf undisturbed for several minutes. Efforts should be made to return the live snail to the tree from where it likely fell, and the snail should not be collected.

After the search is completed the shell bags should be filled with air to protect fragile shells and returned to the office to the Monitoring Program Manager for measurements and cataloging. All collected slugs should be turned in to the Research Specialist for identification. Any live specimens of *E. rosea* should be turned over to the current predatory snail researcher or the Research Specialist.

Post search analysis: Each shell will be measured from (L) the apex to the lip and (W) the girth of the widest point and numbered with a unique number that represents where the shell was found and the date it was collected. Shells that appear to have been rat predated will be noted, as will shells that were mature.

The proportion of shells in each size class (small ≤ 8 mm, medium 8 ≤ 18 mm, and large > 18 mm) as well as the proportion of shells with evidence of rat predation will be plotted immediately. Data from subsequent searches (not the initial clearing) will be plotted and measured in the same way paying special attention to the age/size distribution looking for a distribution skewed to larger/older shells indicating a growing population. The number and distribution of each subsequent collection will be compared to previous collections from the same plot to compare the number of shells found and to detect any marked increase in mortality or predation. Such analysis must be done within one week of collection in order to address threats in a time frame that is meaningful and allows for action to be taken to reduce mortality. If such an increase is detected, resource managers must be notified.

Frequency: Ground shell plots in areas where active rat control is ongoing (ie. baiting every 6 weeks) shall be read at least annually, unless a need for information arises in which case they can be read more often. Plots in areas without active rat control OR areas where *Euglandina rosea* are seen often should be read at least quarterly to detect population decline.

Appendix VIII:

Impacts of alien rodents on Hawaiian plant communities

Scientific Research Proposal to the U.S. Army Environmental, Hawaii

Attn: Kapua Kawelo, Steve Mosher

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E-mail: ashiels@hawaii.edu

Proposed project period: 08/01/06 – 06/28/08

Project Summary

Seed predation and seed dispersal are two critical components for vegetation regeneration in ecosystems world-wide. Tropical forests exhibit a wide range of seed dispersers and seed predators that influence vegetation structure and community dynamics. In Hawaii, there is little quantitative evidence of the effects of rodents on native and non-native plant communities. In this study, I will determine the impact of alien rodents (rats and mice) on plant communities in the Wai'anae and Ko'olau Mountains, Oahu. Common fruits, seeds, and seedlings of both native and non-native plant species will be arranged in three types of treatments (total animal exclusion, access for rodents only, and open sites) in mesic montane forest. Rats (*Rattus exulans* and *Rattus rattus)* are anticipated to be the most pervasive rodent (rather than mice) at the study site, and preliminary studies at Lyon Arboretum suggest that rats are removing fruits and seeds (secondary dispersal) rapidly and possibly damaging seedlings of both native and alien species. At three study locations in Makaha Valley, I will first determine rodent densities using the mark-and-recapture technique. The densities of rodents will

enable comparisons across the three sites, as well as with sites both within and outside of Hawaii. In order to determine the home-ranges of rats, individuals at each site will be captured and tracked after attaching collars containing radio transmitters. Radio-tracking will also help uncover the locations of both nesting sites and husking stations. Obtaining the locations of husking stations, which are sites that rats take seeds and fruits for consumption and disposal, is particularly important for determining the fate of seeds removed from the forest floor. These sites will be observed using night vision to associate the rat behavior with the fate of rat-manipulated seeds. Feeding trials, followed by germination studies, will also be conducted on captured rats in order to determine seed fate of important seeds. The findings from this study will reveal how rodents are affecting forest structure in Hawaii by removing, destroying, and potentially dispersing fruits and seeds. Additionally, this novel research has direct and important implications for the conservation of Hawaiian plants, native tropical forests, and islands worldwide.

Projected Time Line

Year 1: August 1, 2006 – July 31, 2007. The three sites in the Wai'anae Mountains will be established**,** measured for various forest attributes, and microclimate data loggers will be installed. Rodent densities at the three sites will be determined using mark-and-recapture techniques. Determination of rat homeranges will begin by use of radio telemetry. Exclosures will be constructed and set up to begin testing fruit/seed and seedling removal of dominant plant species by rodents. Seeds found in rat feces (recovered from live-traps) will be identified, and germination/viability of the seeds will be determined. Summary reports for these results will be completed, and will contain information on the densities of rodents at each of the three sites and the rat home-ranges of the marked individuals. Indices of plant species 'vulnerability' to rodents will be established based on the seed and seedling trials. This information will be used to focus rat baiting and conservation efforts in Makaha Valley. I will give an oral presentation based on the results of this work at the international conference ("Rats, humans, and their impacts on islands: Integrating historical and contemporary ecology"; UH campus) in Spring 2007.

Year 2: August 1, 2007 – June 28, 2008. Determining rodent impacts on specific plant species will be expanded using exclosures. Rat home ranges will be finalized and husking sites will be located, both of which will be mapped using arcview GIS. Sites in the Ko'olau Mountains will be established and measurements similar to those in year 1 will begin. Feeding trials of captive rats will begin in effort to determine the direct effects rats have on particular seeds. Viability of seeds passed through the gut will be determined. Rodent densities will be measured again to determine seasonal effects. Summary reports for these results will be completed and will include the rodent densities and home-ranges in the Ko'olau Mountains sites, and a revised plant species 'vulnerability' list for both mountain ranges. Scientific publication 1 will be submitted.

Appendix IX: Proposed *Euglandina rosea* research

Project title: Feeding ecology, microhabitat utilization, population size estimates, and possible control of the introduced predatory snail *Euglandina rosea* on O‘ahu, Hawai‘i (Year 2)

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Proposed project period: 08/01/06 – 07/31/07

Project Description/Objectives:
The introduction of the predatory land snail *Euglandina rosea* has been implicated as a major factor influencing the decline of native Hawaiian and Pacific island land snail faunas. Despite its reputation of having a major effect on the land-snail fauna of the Pacific, relatively little attention has been focused on the biology of *E. rosea*. Instead, a large effort has been focused on studying the biology of the threatened/endangered land snail species of the Pacific, especially Partulidae and Achatinellidae species. There remains a need to understand the basic biology of *E. rosea* in order that managers can better design conservation strategies incorporating it.

With Year 2 funding, tracking technology will be used to elucidate the microhabitat preferences of *E. rosea*. Understanding how *E. rosea* utilizes microhabitats within its range will help managers determine which snail species are likely to be the most threatened. In addition, this information will help determine where traps or searches that aim to trap/catch *E. rosea* as part of a control effort should be focused.

Methods:
There are two phases to the Year 2 research: 1) testing the utility of three tracking methods, and 2) tracking *E. rosea* in the Wai‘anae Mountains.

<u>Testing the Utility of Tracking Methods</u>

The three tracking methods to be tested, the spool and line method, RFID technology, and harmonic radar technology, are described below. Each method will be tested on six individual *E. rosea* at the same time at Lyon Arboretum in the first two weeks of September 2006. The utility of each method will be addressed by comparing the distances moved and paths taken by individual snails tracked by each method, the ease of tracking and recapture, and the quality of data collected.

Spool and Line Method: The spool and line method uses the least complex technology of the three methods and has many advantages. A lightweight line is attached to the snail. The other end of the line is wound around a spool which will easily release line as the snail moves. This technique has advantages over the other methods because it leaves a trace of where the snail moves. Thus, total distance moved can be compared with a linear distance moved away from the initial starting point, and the habitat utilized between monitoring events can be determined. The only potential difficulty associated with this method is that the line could become caught and limit the movement of the snails. Although this method has been used elsewhere to track a range of species of snails, a pilot study suggests that it is likely that movement of *E. rosea* will be restricted by this method, as on many occasions the line was found wrapped multiple times around a plant or branch preventing the snail from moving further.

RFID Method: Radio Frequency Identification (RFID) technology has been used for many years to identify and monitor pets. RFID uses a small tag that can be attached to or incorporated into a product, animal, or person. RFID tags contain silicon chips and antennas to enable them to receive and respond to radio-frequency queries from an RFID transmitter. Recently the technology has been used by biologists to track wild animals, including small animals such as bees, and by golfers to find lost golf balls. The technology, appropriately modified for tracking snails, should allow a snail to be found within a 25 m radius. This method is considerably less expensive than the harmonic radar technique. However, it has never been used to track snails.

Harmonic Radar Method: Harmonic radar uses a diode attached to the animal that allows a receiver to locate it. Although this method has been used to track snails, the snails were either large or arboreal. Pilot studies in Hawai‘i suggest that this technique has difficulty locating snails close to the ground. This may be because the ground reflects the signal, and the receiver is thereby unable to distinguish the direct signal from the diode from the reflected signal from the ground.

Tracking *Euglandina rosea* in the Wai‘anae Mountains

Tracking will be undertaken at two field sites, one in the northern and one in the southern Wai‘anae Mountains. The locations of these sites have not yet been decided. The criteria for suitable sites include presence of *E. rosea*, presence of native snails, and the ability to get to and from the sites and monitor the snails in one day.

Six *E. rosea* will be tracked for two weeks at each site during two different times of the year (October 2006, March 2007) (total 24 snails, 56 days of observation) using the most suitable tracking method as determined in the experiments to be undertaken in September 2006. The northern site will be monitored for the first two weeks of the month and the southern site will be monitored for the second two weeks. The snails’ movements and habitat utilization will be recorded daily during the two week tracking period. Relative humidity and temperature will be recorded using Hobo data loggers during the experiment. Rainfall totals will be measured using a rain gauge. The precise daily location of each snail will be marked with wire and orange flagging and GPS coordinates will be determined. Each day the distance moved by each individual will be measured. Each site will be characterized according to the different microhabitat types present (these microhabitat types are still to be determined), and on each day the microhabitat where the snail is found will be recorded. At the end of the experiment the number of times the snails were found in each microhabitat type will be compared to the proportion of that habitat available in order to determine microhabitat preferences. If a snail climbs a tree, the tree will be surveyed for native snails. It may then be possible to determine if *E. rosea* can detect whether there are native tree snails in a tree before it climbs a tree or if it is indiscriminately searching trees for prey.

Projected Time Line:
August 2006: Obtain and become familiar with all the equipment needed. The harmonic radar for the trials will be provided by another University of Hawaiʻi graduate student (Kevin Hall).

September 2006: Perform experiments aimed at determining the utility of each method for tracking *E. rosea*.

October 2006: Undertake tracking experiments.

November 2006 – February 2007: Analyze data using spatial mapping programs and appropriate statistical packages. I will work directly with the Army Environmental GIS specialist to produce all the appropriate maps.

March 2007: Undertake the second set of tracking experiments.

April – June 2007: Analyze data using spatial mapping programs and appropriate statistical packages.

July 2007: Present results at Hawaiʻi Conservation Conference.

August 2007: Write up the results in the form of two papers to be submitted to scientific journals. The first will describe the utility of the different tracking techniques. The second will examine the microhabitat utilization of *E. rosea*.

Appendix X: Year 1 results: feeding ecology of the introduced predatory snail *Euglandina rosea*

Feeding ecology of the introduced predatory snail *Euglandina rosea* (Férussac) in Hawai‘i: implications for the preservation of native land snail species

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Project period: 08/01/05 – 07/31/06

Introduction

The introduction of the land snail *Euglandina rosea*, which feeds exclusively on snails, has been implicated as a major factor influencing the decline of the native Hawaiian land snail fauna (Hadfield 1986). It was introduced to Hawaii in 1955 to control populations of another introduced snail, *Achatina fulica*, the giant African snail (Davis & Butler 1964, Simberloff 1995, Civeyrel & Simberloff 1996, Cowie 2001). However, *E. rosea* has not reduced *A. fulica* populations (Civeyrel & Simberloff 1996, Cowie 2001) but it has been associated with the decline of many of the tree snail species, not only in Hawaii but also elsewhere in the Pacific (Hadfield & Mountain 1980, Clarke *et al*. 1984, Hadfield 1986, Murray et al. 1988, Hadfield *et al.* 1993, Murray 1993, Coote & Loève 2003), and may be the cause of the extinction of many other native land snails (Griffiths *et al*. 1993, Cowie 1998, 2001).

Despite its reputation for having a major effect on the land snail fauna of Hawaii, relatively little attention has been focused on the biology of *E. rosea*. Instead, a large effort has been focused on studying the biology of the endangered land snail species of Hawaii, especially the Hawaiian tree snails in the sub-family Achatinellinae (USFWS 1981). Therefore, there remains a need to understand the basic biology of *E. rosea* in Hawaii in order that natural resources managers may better design conservation strategies for the few extant native snails left in the islands.
Certain aspects of the feeding ecology *E. rosea* have been well studied. Feeding behavior and aspects of prey trail following have been well documented (Cook 1985 a, b). Prey size preferences have also been addressed (Cook 1989 a, b). Results from these and other studies suggest that *E. rosea* prefers smaller sized snails when given the choice (Davis & Butler 1964, Chiu & Chou 1962, Nishida & Napompeth 1975, Griffiths et al. 1993). In addition, the range of prey species in the field has been investigated on Mauritius (Griffiths et al. 1993).

Unfortunately, extrapolating these results to determine the effect *E. rosea* is having on the land snail faunas in other places such as Hawaii remains difficult. This is especially true since reasons for prey species preferences of *E. rosea* have not been adequately addressed, and consumption rates for *E. rosea* have never been reported. The literature suggests that *E. rosea* feeds non-selectively on numerous gastropod species (Cook 1989 a, b). However, the design of the experiments that aimed to address species preferences did not adequately control for the size of prey among prey species offered (Cook 1989 a, b). Instead, they standardized the total weight of each species offered in each replicate choice experiment. However, if prey size is as important as is suggested by all these experiments, the fact that the smaller species were preferred tells us little about species preferences other than that small snails are preferred. Although, this may be a more realistic approach for determining the impact of *E. rosea* at one place and time, it does not explain the reasons for preference among species other than for size. Since *E. rosea* does prefer smaller individuals as prey, it comes as no surprise that in trials in which species of different sizes were offered, the larger species were less preferred. In addition, the microcosms used in these experiments (clear glass dishes) did not provide conditions permitting possible predator avoidance behaviors.

The objective of the work reported here was to examine the feeding ecology of *E. rosea* in Hawaii. Particular attention was paid to determining the factors that influence prey choice, especially among prey species. Size preferences were also examined to confirm the findings of studies elsewhere. In addition, consumption rates were measured in an effort to begin to quantify, using community and population models, the impact of *E. rosea* on the land snail community of Hawaii and on certain target species that are considered particularly vulnerable to extinction. The goal was to gather accurate data on aspects of the feeding behavior of *E. rosea* that may help to quantify its impact and permit development of effective control measures.

Methods

Three microcosm experiments were performed at the University of Hawaii at Manoa between September 2005 and May 2006 to determine prey size and species preferences, as well as consumption rates. All experiments were done in 30 x 20 x 20 cm rectangular aquaria. Each aquarium was filled with top soil to a depth of 2.5 cm and kept damp to promote movement of both the prey and the predator. Five small pieces of lettuce were also added to provide food for the prey species and to entice certain species that had tendencies to bury themselves to come to the surface to feed and thereby become available to the predator. All prey were allowed to acclimate in the tank for 24 hr prior to the addition of the predator.

Euglandina rosea were collected at various sites throughout the island of Oahu between August 2005 and May 2006. Prior to their use in the experiments they were maintained individually in 15 cm diameter circular plastic aquaria and fed a diet of snail species other than those being used to test for differences in prey preferences. The species most commonly used was *Bradybaena similaris*.

Prey Size Preference

Seventeen adult *E. rosea* (35 to 55 mm in shell length) were used in size selection experiments. The predators were starved for two days prior to each experiment in an effort to standardize hunger levels. *Achatina fulica* were used as the prey and were divided into four size classes (0-1, 1-2, 2-3, and 3-4 cm in shell length). Ten snails from each of two of the four size classes were offered to one *E. rosea* after the prey had been allowed to acclimate for one day. Each day consumed prey were replaced with new individuals from the same size class. Experiments ran from four to ten days depending upon consumption rates and prey availability. Differences among size classes offered were evalulated using a Fisher's Exact test (Sokal & Rohlf 1995).

Prey Species Preference

Prey preference of *E. rosea* was assessed in microcosms that offered a choice of two prey species out of four. All prey were non-native species: *Achatina fulica*, *Paropeas achatinaceum*, *Veronicella cubensis*, and a *Succinea* sp. (there are native species of *Succinea* in Hawaii but these were not used). Each trial consisted of at least ten replicates, each with a choice of two prey species (ten snails of each). Prey were 5.0-12.5 mm in shell length. The size distribution, that is, the numbers of snails of various sizes, as measured by the length of their extended foot, was matched between the two prey species in order to minimize any effect size may play in determining a species preference. Using the length of the extended foot, rather than a shell size measure, was necessary since one of the prey choices was the slug *V. cubensis*. All six pair-wise combinations were represented in each trial but the number of each combination depended on prey availability. However, in total over the five trials there were ten replicates of each pair-wise combination. The number of prey items consumed was calculated by counting the number left at the end of the experiment and subtracting it from the total number of prey provided throughout the course of the experiment. A paired t-test was used for each pair-wise combination to determine whether prey preference was significant (Dowdy & Wearden 1991).

Additional experiments were performed using the same protocols specifically to examine the preference of *E. rosea* for slugs. Two slug species, *Deroceras leave* and *V. cubensis*, were used in combination with the snail *P. achatinaceum*. Five replicates of the pair-wise combinations *D. leave* vs. *V. cubensis* and *D. leave* vs. *P. achatinaceum* were performed in each of two trials. A paired t-test was used for each pair-wise experiment to determine whether prey preference was significant (Dowdy & Wearden 1991).

Consumption Rate

Twelve *E. rosea* were used in consumption rate experiments (seven adults 40-55 mm in shell length, five juveniles 10-25 mm in shell length). For a week prior to the experiments they were provided with prey snails (*Achatina fulica*, *Paropeas achatinaceum*, *Bradybaena similaris*) of various sizes *ad libitum*. Thirty prey snails (non-native *Succinea* sp., 15 in the size range 1.0-5.0 mm and 15 in the range 5.0-12.0 mm shell length) were then offered to an individual *E. rosea* for a period of 24 hr. Each prey snail was weighed to the nearest 0.0001 g and individually marked. At the end of the experiment, the number of snails remaining alive was counted and any shells remaining from consumed snails were weighed to the nearest 0.0001 g, these weights being subtracted from the weights of those snails at the beginning of the experiment to give a value of the weight consumed. Adding this amount to the know weight of snails consumed whole provided a value for the total weight consumed. Growth of prey snails over the 24 hr of the experiment was assumed to be negligible. Wet weight consumed was regressed on *E. rosea* size. A two-factor ANOVA was used to test prey size preferences of adult and juvenile *E. rosea*. There were two fixed effects, an *E. rosea* size effect (adult vs. juvenile) and a prey-size effect (small prey 1.0-5.0 mm vs. large prey 5.0 -12.5 mm).

Prey Value

The energy content of the snail species used in the *E. rosea* feeding trials, *A. fulica*, *P. achatinaceum*, *V. cubensis*, *D. leave* and the non-native *Succinea* sp., will be evaluated in July 2006. Shell length (for snails only), foot length, wet weight, dry weight, and total caloric value will be recorded for ten individuals of each snail/slug species. Shell length and foot length will be measured to the nearest 0.1 mm. For snails, the wet weight will be measured with the shell still intact to the nearest 0.0001 g. The shells will then be dissolved in a 1 M HCl solution and the bodies of the snails will be weighed in order to determine the weight of the shell, by subtraction. Snails (and slugs) will then be dried to a constant mass at 80^{o}C. The dry bodies will then be used to determine energy content, measured in a microbomb calorimeter. A regression will examine the relationship between size/weight and caloric value for each species, and an ANCOVA will examine the differences among the caloric values of the various prey species (Dowdy & Wearden 1991).

Results

Prey Size Preference

Regardless of which snail combination *E. rosea* was offered, it always preferred the smaller snails (Table 1). Pooling the data, 77 snails in the smaller size class were consumed compared to only two from the larger size class. In addition, consumption rate (number of snails consumed), decreased as size of prey offered increased.

Prey Species Preference

Prey preference experiments with *E. rosea*, using abundant introduced snails (*Succinea* sp., *Achatina fulica*, *Paropeas achatinaceum*) and slugs (*Veronicella cubensis*, *Deroceras laeve*) showed that it preferred the snail to the slug species but showed no preference among the three snail species (Tables 2 and 3). *Veronicella cubensis* was the least preferred prey, and *D. laeve* seemed to be preferred over *V. cubensis* but was less attractive than *P. achatinaceum* and therefore probably also less attractive than the other snail species (*Succinea* sp. and *A. fulica*).

Consumption Rate

The relationship between wet weight (g) consumed and the weight of *E. rosea* (g) is described by the following linear regression (Figure 1):

Wet weight consumed = 0.1193 (weight of *E. rosea*) + 0.0962;

$r^2 = 0.87$, $P < 0.01$, $N = 12$

Wet weight consumed increases as *E. rosea* weight increases. Although the sample size is small, the high r^2 value suggests that this mathematical model describes the relationship between the variables well. The regression line was not forced to go through the origin but the y-intercept was nevertheless close to it.

The size of *E. rosea* is important in prey size preference (Table 4, Figure 2). Larger *E. rosea* had a stronger preference for smaller prey (Figure 2). The ANOVA suggests that *E. rosea* size, prey size and the interaction of these two factors are important (Table 4).

Prey Value

These experiments remain to be done (see Methods section).

Discussion

Prey Size Preference

The results indicate that *E. rosea* has a strong prey size preference. When given a choice of prey sizes, *E. rosea* will eat significantly more small snails than large snails (Table 1). These results are consistent with many other experiments that have examined the prey size preference of *E. rosea* in the lab (Davis & Butler 1964, Chiu & Chou 1962, Nishida & Napompeth 1975, Cook 1989 a, b) and in the field (Griffiths et al. 1993). In addition, it seems that large (40 to 55 mm shell length) *E. rosea* have an even stronger preference for small prey (Figure 2).

One reason usually proposed for *E. rosea*'s preference for smaller snails is calcium intake. Cook (1989 a) suggested that there may be a compromise between the input of important nutrients, primarily calcium, when the prey is consumed whole (shell included), and the caloric intake that comes from the consumption of body tissue. Shells of small prey (> 1.0 mm in shell length) are usually consumed whole. Thus, the fact that *E. rosea* prefers to feed on smaller snails may be a response to its need to procure enough calcium and perhaps other essential nutrients in order especially to maintain shell growth. The predators do this despite the cost of the increased handling time involved in consuming the prey whole (Cook 1989 a).

The need for calcium and other essential nutrients present in the prey shells may explain some of the preference, but is probably not the only factor responsible for *E. rosea*'s preference of smaller prey. In the prey size preference experiments, no *Achatina fulica* were consumed whole but the smaller snails were nevertheless preferred. Most of the snails in the 0-1 cm size class were closer to 1.0 cm in size and perhaps large enough to discourage *E. rosea* from trying to consume them whole. However, if they were only choosing smaller prey for essential nutrients we would expect a more even distribution of preference between the 0-1 and 1-2 cm size classes. No data were collected on handling times, which may explain the difference between the two size classes. In addition, Griffiths et al. (1993) reported that *E. rosea* will swallow snails up to 1.1 cm in shell length, although the species consumed did not have as rounded a shell as *A. fulica*. Still, it is surprising that in the present experiments no *A. fulica* were eaten whole, since new hatchlings were often used.

The data suggest that the size of the *E. rosea* is important in prey size preference. Although counter-intuitive, larger *E. rosea* had a stronger preference for smaller prey (Figure 2). This may be because large *E. rosea* have a greater ability to consume snails whole. Thus, the impact of *E. rosea* on small snails may be even greater when *E. rosea* is large. This is consistent with experiments that have studied predation of *E. rosea* in the field where a large majority of the species consumed were swallowed whole (Griffiths et al. 1993).

Prey Species Preference

Euglandina rosea exhibited a clear preference for the three snail species over the two slug species in all the feeding preference tests (Tables 2 and 3). In all six pair-wise experiments examining the preference between either of the three snail species, *Succinea* sp., *Achatina fulica*, or *Paropeas achatinaceum* and the slug species, *Veronicella cubensis*, *E. rosea* preferred the three snail species to the slug. It showed no preference among the three snail species. In the experiment that examined the prey preference of *E. rosea* between the slug *Deroceras laeve* and the snail *P. achatinaceum*, *E. rosea* again preferred the snail to the slug. The results do suggest that *E. rosea* prefers the slug *D. laeve* over the slug *V. cubensis*, suggesting preferences among slug species.

I can only speculate on reasons why snails were preferred to slugs. The slugs seemed to spend a large proportion of their time buried in the soil compared to the snails. *Achatina fulica* also spent a large proportion of the time buried but seemed to come up to feed at night, coinciding with the time *E. rosea* was usually active. The other two snail species, *Succinea* sp. and *P. achatinaceum*, were always found on the surface of the soil or on the sides and top of the aquaria. This microhabitat preference of the slugs may have precluded them being available as often as prey items. Slugs may have evolved other defense strategies that enabled them to lose their shells, including production of copious amounts of mucus when provoked, having a relatively thick integument, and avoidance behaviors such as tail flicking and mantle flaring (Cook 1985 a).

Consumption Rate

The linear regression approximates the consumption rate of *E. rosea* well. As size of *E. rosea* increases, so does consumption, at a predictable rate. Therefore, if *E. rosea* population density and population size distribution are known, a model could be constructed to determine the impact of this predator on the land snail community as a whole and on populations of species of particular interest.

Prey Value

These experiments remain to be done (see Methods section).

Impact of *Euglandina rosea* on Native Snail Populations

The native Hawaiian land snail fauna used to be extremely diverse (over 750 species) and exhibited high endemism (over 99 %), but most of these unique species (perhaps as many as 90 %) are now extinct (Cowie 2002, Lydeard et al. 2004). Most of those species that remain appear to be reduced to sparse populations on every island they formerly inhabited (Lydeard et al. 2004). Therefore, even slight increases in mortality caused by predation may have serious detrimental impacts on the remaining land snail populations. Results from this work provide a grave reminder of the deleterious impact of *E. rosea*.

The most likely criticism of this work may be that no native snails were used in the feeding trials. Therefore, extrapolating these results to say anything about the impact of *E. rosea* on native land snails of Hawaii could be misleading. However, all the species used as prey in the experiments currently occur in Hawaii, all five species come from different families, and one of those families, the Succineidae, is represented by extant endemic Hawaiian species currently found on all of the main islands. All these facts suggests that *E. rosea* is a highly generalist predator of snails, that probably would prey on native Hawaiian snails in very much the same way as it did in the experiments described herein. Most of the extant native Hawaiian land snails are endangered or threatened with the possibility of extinction, so that use of large numbers of them in experiments of this kind is probably not justifiable. In addition, most of the prey species tested can be found living in areas where native species occur and the behavior of *E. rosea* in these areas in relation to both native and non-native prey may be similar.

The prey size preference results are consistent with many previous experiments (Davis & Butler 1964, Chiu & Chou 1962, Nashida & Napompeth 1975, Cook 1989 a, b, Griffiths et al. 1993). *Euglandina rosea* prefers the smallest snails available. This is of concern for conservation efforts since many of the native snails are small compared to many of the abundant introduced snails/slugs that have become established in the native forests of Hawaii (e.g., *Limax maximus* and *Meghimatium striatum*) where a majority of the native Hawaiian snails are found (Meyer 2006, Joe 2006). For instance, all species in the native families Endodontidae, Helicinidae, and Pupilidae are extremely small (< 1.0 cm in shell length for their entire life), still found in the Waianae Mountains, and appear reduced to sparse populations on every island they formerly inhabited (Lydeard et al. 2004, Meyer in press). The results suggest that *E. rosea* would readily consume these snails whole if it encountered them and may have had a large impact on their populations in the past. Many native succineid species are also relatively small, being less than 1.0 mm in shell length when hatched and rarely getting to be over 13.0 mm (personal observation). Snails in the family Achatinellidae come in all sizes. For instance the 'tornatellinids' (Achatinellidae belonging to subfamilies other than Achatinellinae) are widely distributed but patchy, and extremely small (< 1.0 cm in shell length). Snails in the sub-family Achatinellinae, the Hawaiian tree snails, are larger. One species, *Achatinella mustelina* is born at an average size of 4.6 mm and reach sizes greater than 21.0 mm in shell length (Hadfield et al. 1993). Despite being larger, their populations have declined with the introduction of *E. rosea* (Hadfield & Mountain 1980). Decline of Achatinellinae in particular is probably related to their slow growth, the long time they take to reach reproductive maturity (3-5 yr), and their slow reproductive rate, which make them highly vulnerable to unnaturally high levels of predation by not only the introduced predatory snail *E. rosea*, but rats and shell collectors (Hadfield & Mountain 1980, Hadfield 1986, Hadfield et al. 1993).

The results of the prey species preference experiments also have conservation ramifications. There are no native slugs in Hawaii. Although, *E. rosea* will consume slugs, the data suggest that given a choice it would probably consume a snail rather than a slug when both are present in equal numbers. Currently, in terms of biomass, slugs constitute a large portion of the Hawaiian land snail fauna (Meyer 2006) and have been shown to negatively impact the survivorship of young native Hawaiian plants (Joe 2006). Thus, predation of *E. rosea* on slugs could be seen as one positive conservation outcome. Unfortunately, the results suggest that *E. rosea* prefers snails to the slug species offered, and many of these slugs reach sizes that are well above *E. rosea*'s preferred size range for consumption.

Data from the consumption rate experiment suggest that if *E. rosea* did locate a patch of native snails it could quickly have a large effect. In two of the consumption rate trials, twenty snails were consumed in one day. Survey work conducted during 2005 led to the records of two small extant native ground-dwelling land snail species in the families Endodontidae and Helicinidae on the island of Oahu (Meyer 2006 b). These two species belong to two families that have been considered either extinct or extremely rare in the Hawaiian Islands (Lydeard et al. 2004, R.H. Cowie pers. comm., 2005). The endodontid population seems to be around a few hundred individuals, according to The Nature Conservancy (TNC), which have begun monitoring (D. Sailer, pers. comm. 2005). Thus one *E. rosea* may be able to consume all individuals in just a few days. Although these experiments suggest that small species of native Hawaiian snails may be especially susceptible to predation by *E. rosea*, in conjunction with previous studies of the larger Achatinellinae, they suggest that all extant native species are probably susceptible to *E. rosea*.

<u>Direction of Future Research</u>

It is not a surprise that *E. rosea* has proved to be an ineffective biocontrol agent and a serious threat to native species. In 1988 the World Conservation Union (IUCN) passed a resolution urging government agencies to stop further introductions of *E. rosea* for biocontrol purposes (Griffiths et al. 1993). Although this was a good initial step to control the impacts of *E. rosea* throughout the Pacific and other tropical areas, more drastic measures of control are needed to protect the native snails that are susceptible to predation in areas where *E. rosea* is established. To create effective control measures, a comprehensive understanding of the biology of *E. rosea* is needed. This report addresses aspects of the feeding ecology of *E. rosea*. With Year 2 funding, tracking technology will be used to elucidate the microhabitat preferences of *E. rosea*. Understanding how *E. rosea* utilizes microhabitats within its range will help natural resource managers determine which snail species are likely to be most threatened. In addition, this information will help determine where traps or searches for *E. rosea* as part of a control effort should be focused. In Year 3, attempts will be made to construct traps to determine *E. rosea* density and begin control measures.

Appendix XII: Use of cardboard, plastic, and wooden sampling sheets to estimate relative size of slug populations

Justification: In order to further our development of efficient and effective methods of controlling slugs (whether using beer traps or conventional molluscacides), knowledge of slug population response to these proposed strategies is needed to evaluate their efficacy. In the event that a molluscacide proves safe to use in a forest setting, whether one applies 10 or 100 lbs. of bait per acre will depend largely on whether slug mortality differs between the two application rates. Thus, control strategies can be compared using indices drawn from measurements of slug numbers.

Estimation of slug population sizes may be absolute or relative. Absolute methods are expressed as numbers per unit area and are more accurate than relative ones, but labor intensive. Such methods include soil core flooding (to drive all slugs to the surface) or branding of slugs for use in mark-recapture analyses. Relative estimates are usually related to some measure of slug-activity, such as catch per unit effort (*e.g.* time searching) or numbers obtained by some form of trapping (such as in the field trial described here). Since slug activity is largely governed by the weather, relative estimates are an imperfect measure of slug abundance and tend to vary more than absolute methods. Given our labor and time constraints, however, relative methods are more immediately practical. In the event that relative methods fail to provide us with consistent or sufficient numbers of slugs to evaluate future control activities then absolute methods may be necessary.

Methods: Here, we present results from a field trial using a relative method for estimating the size of slug populations (*e.g.* count of slugs using daytime refugia) wherein we tested the ability of three materials, wood, weed plastic, and cardboard to attract slugs. Thirty sampling sheets of each material, measuring 0.25 m^2, were deployed in Kahanahāiki on October 26 and monitored weekly until November 30 after which the study was concluded and a new configuration involving larger sheets attempted (discussed later). When checked, sheets were carefully lifted to minimize disturbance to animals beneath and the number of slugs, snails and planarians (alien terrestrial flatworms) recorded.

These latter two groups of invertebrates, though not the focus of this study, were of interest for several reasons. Snails, because they are among the non-target groups potentially affected by the application of molluscacides and include the predatory snail, *Euglandina rosea*. Planarians, because they prey upon slugs and snails and may reflect slug numbers secondarily in the event that slugs cannot be observed directly. In Hawaii, planarians have only been documented as feeding on alien snails, however, whether their diet is limited to aliens in areas where native snails exist, such as Kahanahāiki, is unknown. Therefore, numbers of planarians may be of concern for purposes of native snail conservation.

Results: Slugs were rarely found and made up only a small percent of all catches (Fig. 1); a result which may reflect either low slug numbers or low sampling sheet attractiveness. It should be noted, however, that when found, slugs were always beneath cardboard rather than plastic or wood. Compared to plastic or wood, cardboard sampling sheets were the most consistently occupied over time by at least one or more of the target invertebrates (Fig. 2). As they weathered, cardboard sheets attracted higher numbers of invertebrates; a fact that suggests wood sheets might function similarly, given time. Studies demonstrate high soil moisture has a positive effect on slug activity and population size. Given these findings, it is perhaps unsurprising to find that slugs generally preferred materials (like cardboard) which hold moisture. Soil was driest beneath the weed plastic, which, being both dark colored and breathable, dried quickly.

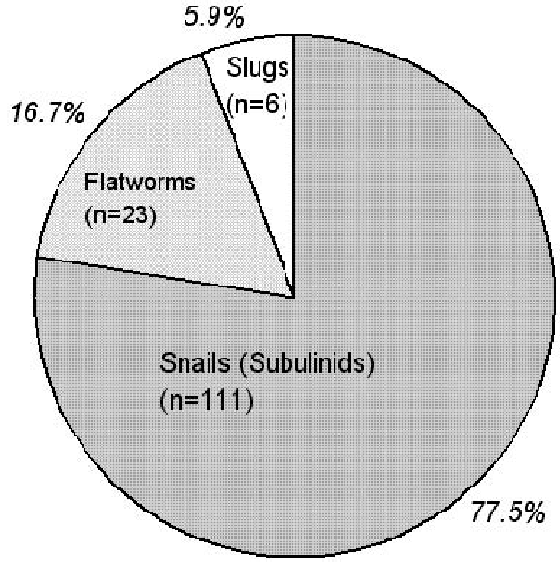

Fig. 1. Count of target invertebrates (by group) found utilizing sampling sheets from October 26-November 30, 2005. Snails are the most frequently encountered invertebrate followed by flatworms.

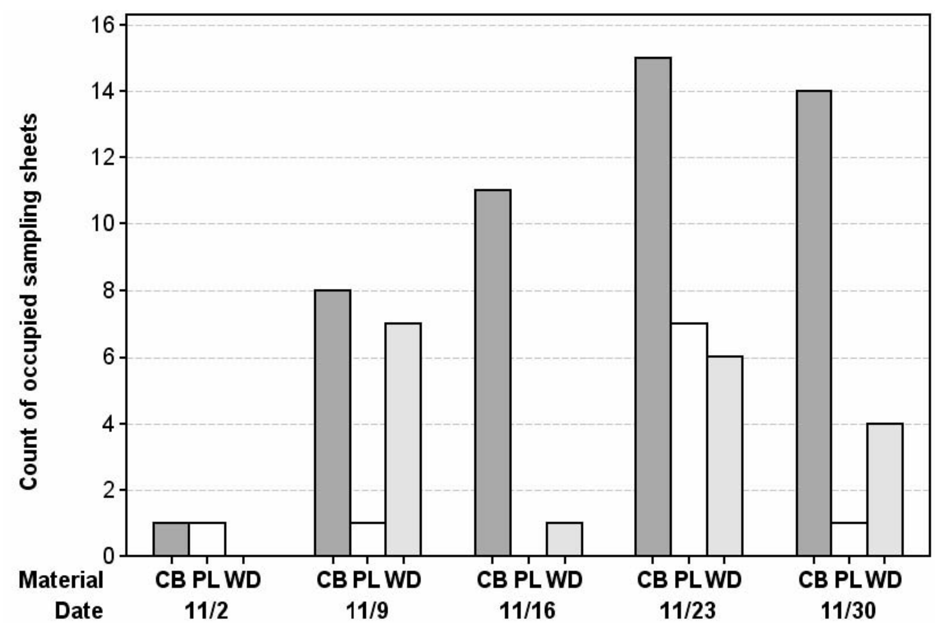

Fig. 2. Number of occupied sampling sheets by material over time (n=30). Key to materials: CB=Cardboard PL=Plastic WD= Wood. A sampling sheet is “occupied” when it harbors one or more of the target invertebrates (slugs, snails or flatworms).

Conclusion: Despite the low numbers of slugs utilizing the sampling sheets, slight modifications to the design could be made to improve catch rate. Prior studies of this kind used cardboard sheets 1 m^2 in size (Hawkins *et al*. 1998)[i]. It is possible 0.25 m^2 was simply too small to create an attractive habitat for slugs. On November 30, 2005, we pulled all the plastic sheets and increased the size of the remaining wood and cardboard stations to 0.75 m^2. Preliminary results are promising and suggest this size to be more attractive to both slugs and other invertebrates (Table 1).

Date	Stations occupied (out of 30)	Material	# Slugs	# Flatworms	# Snails (Subulinidae)	# *Euglandina rosa*
12/08/05	13	Wood	0	2	59	0
12/08/05	24	Cardboard	9	1	106	1
12/14/05	16	Wood	0	10	42	0
12/14/05	26	Cardboard	7	7	113	0
01/12/06	5	Wood	1	4	2	0
01/12/06	15	Cardboard	8	6	32	0

Table 1. Slugs (and other invertebrates) counted beneath sampling sheets on December 8.

[i] Hawkins, J.W., M.W. Lankester and R.R.A. Nelson. 1998. Sampling terrestrial gastropods using cardboard sheets. *Malacologia* **39**: 1-9.

Appendix XII: *Achatinella* sp. research proposal

Abstract:

Hawaii's *Achatinella* tree snails are disappearing at an alarming rate, with fewer than 10 of the 41 described species within this endemic Oahu genus extant today. All of the remaining fragmented and isolated populations (both wild and captive) may be at risk from inbreeding depression. Management strategies are now leaning towards translocation to minimize inbreeding depression, while also avoiding possible outbreeding depression. A three-year study has been initiated to observe the natural movement patterns of these snails with both harmonic radar and traditional capture-mark-recapture (CMR) methods, which will attempt to approximate the historical connectivity of remaining snail populations. Dispersal models developed in the context of population genetics theory will then be applied to determine the breeding compatibility between snails from these different locales. These results will be integrated with microsatellite data, thereby calibrating a less time-consuming and more cost-effective genetic shortcut to fieldwork.

Management Issue To Be Addressed:

Many years of observations have suggested that these long-lived arboreal snails have a very limited dispersal capability and sometimes spend their entire lives in a single tree (Pilsbry and Cooke 1912, Hadfield unpublished data). However, in previous achatinelline CMR studies (Hadfield and Miller 1989, Hadfield and Mountain 1980, Hadway and Hadfield 1997), it was found that either a moderate percentage of marked snails were outside of their original trees, or unmarked snails had appeared in well-searched trees. If achatinellids have evolved by frequently dispersing as the results imply, this could have major conservation implications.
Could snail enclosures and captive breeding chambers create even more dispersal barriers, preventing potentially vital gene flow in these already severely fragmented populations? Addressing this question should help provide management direction to ensure our conservation efforts are not contributing to the extinction threat from excessive and unnatural inbreeding.

Initial Results from Disperal Tests:

One marked snail at Palikea was found recently to have traveled over 20 meters in 4 months, and was found during a CMR search. CMR has yielded initial population #'s of 160 at Kahanahaiki, 62 at Palikea, 128 near Poamoho, and 138 at the Hypalon. At the Pahole Natural Area Reserve during a pilot study with harmonic radar, one transponder tagged snails was found over 4 meters away in just over one week. Transponder-fitted snails have often been found in vegetation that is not normally thought to be a prime host for snails, data that would have been missed entirely without the assistance of the radar. Some relocations have occurred in dense foliage that would have been difficult to search, as well as on high branches, obscured and out of reach. Currently, 90 % recapture rates are being obtained with the radar

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